2008 DISPLAY WEEK / DISPLAY OF THE YEAR AWARDS ISSUE

Information DISPLAY

SID

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Information DISPLAY

COVER: The 2008 Display of the Year Awards honor the best display products of 2007 with outstanding features, novel and outstanding display applications, and novel components that significantly enhance the performance of displays. *See page 16 for the details*

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For Industry News, New Products, Current and Forthcoming Articles, see www.informationdisplay.org

Next Month in *Information Display*

3-D Technology Issue

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- New Approach to Electro-Holography 3-D Displays
- Commercialization of Autostereoscopic Displays
- *Journal of the SID* June and July Previews

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editorial

Welcome to LA

Last issue, I discussed how fitting it was that Display Week, the biggest event of the year for the display industry, was taking place in Los Angeles, the world center of entertainment. It's hard to imagine a better convergence. The long-anticipated celebration of displays in the entertainment capital of the world has arrived, and it promises to be the best Display Week ever. Between the Short Courses, Display Technology Seminars, Business Conference, Symposium sessions, Keynotes, Applications Tutorials, Luncheon, Evening Panel, Special Event, and, of course, the world class Exhibition, it is literally impossible to see and do it all.

If you are new to SID, welcome! As a veteran of Display Week, I strongly encourage you to look beyond the world-class exhibition and consider all the other things going on during the week as well. I have been attending Display Week for too many years to count, and I still treat it like a trip to Disney World. I gather the maps and schedules, I mark off the things that are most important to me, I plan my days to try and minimize down time, I coordinate with colleagues to make sure the stuff I miss is covered by someone else, and I usually turn my cell phone off because this is ***my week*** to learn and grow with the industry. Usually there are a number of things I know I want to attend, such as technical presentations on technology areas I'm following, or specific speakers I want to hear, but there are always many surprises I don't anticipate that I can only find if I explore as much as possible.

At SID you will learn about the term "Session Surfing." The parallel tracks of the Symposium sessions are timed so all the talks begin and end at about the same time. You can literally hop from session to session picking the specific presentations that are most important to you, as long as you don't mind the walking.

Maybe one of the biggest benefits of Display Week is simply the chance to meet so many other colleagues from around the world that you might never have the chance to go visit. My memories of previous events are rich with chance meetings with people from Europe and Asia who have become friends and trusted advisors. Meeting people face to face establishes a relationship that e-mail and phone calls cannot do, and therefore Display Week is an important event for this as well as it's so many other features.

It's my suspicion that quite a few people join SID by registering for one of our many conferences – such as Display Week – and then fail to take full advantage of that membership throughout the rest of the year. This is unfortunate. Even if you attend only one additional SID event or take even partial advantage of your local chapter activities and the online resources, you get the value of your membership back many times over. The Society for Information Display is about much more than just one great event per year. In fact, SID offers a calendar abounding with exciting international display-industry events, some focused on a particular technology or field of research, and others almost as broad as the Symposium. For example, just within the next 6 months, there are many significant upcoming SID events, including Mobile Displays 2008, IMID/IMDC/Asia Display 2008, and 2008 Vehicles and Photons in October; IDRC, and the Color Imaging Conference in November; and IDW in December. For a complete list of SID events, visit www.sid.org. This is only a partial list, but it is indicative of the very rich calendar of SID events that spans the globe.

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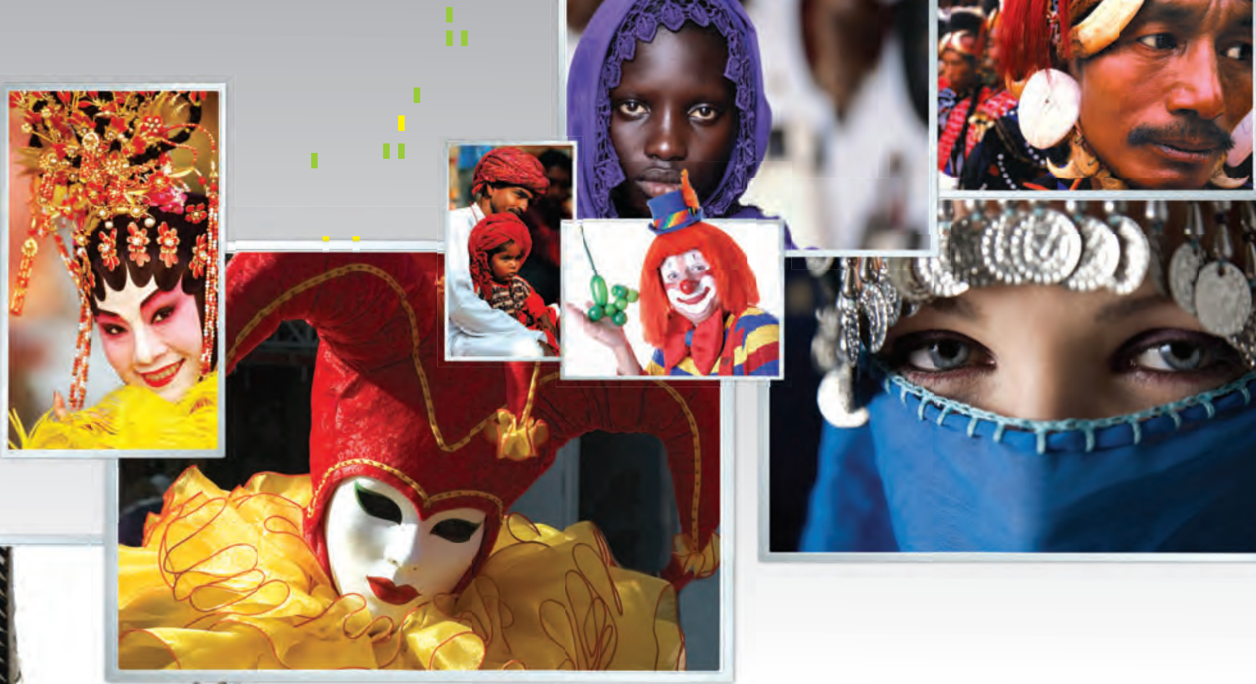

Werner Haas, LCD Pioneer at Xerox, Dies at Age 79

By Joel Pollack and Andy Lakatos

With so much of today's LCD fabrication coming from Asia, it is easy to forget that the early R&D for LCDs was being done in the United States, France and Russia in the mid-1960s. Those of us who own a notebook PC, an iPod or an LCD HDTV can lose sight of the early shoulders that this technology stands upon today. Only 40 years ago, nematic LCDs did not operate at room temperature, and an LCD TV was but a distant dream. So too, we cannot easily recall the time when we didn't have today's digital printers.

When we think of the most important technological inventors, we often think of theoreticians who approached problems through mathematical modeling. But often, some of the most important contributions came from creative minds that approached problems a very different way, such as **Werner Haas**. Haas, one of the pioneers in the LCD industry, died on March 30 of a heart attack in his Webster, NY home, at the age of 79. He was a prolific inventor at **Xerox**'s Webster Research Center, where many of the earliest innovations of the industry were developed, earning more than 50 U.S. patents. Between the short period of 1965 and 1972, a portfolio of more than 100 patents dealing with LCD materials and devices was generated under the leadership of Haas and his colleague, the late Jim Adams.

Haas led a life that had its share of stress, escaping Nazi Germany with his family in the mid-1930s as the Nazis rose to power. They traveled to Hungary, Czechoslovakia and Italy before settling in Portugal where Haas spent 20 years of his life, earned a masters in physics from the University of Lisbon, and met his wife, Maria, a romance-language student at the same university. Haas subsequently emigrated to the U.S. to seek opportunity that was not to be found in Portugal. As a young engineer, Haas was employed at Philco in Philadelphia before coming to Xerox's Webster Research Center. He retired from Xerox in 1994 as a Senior Research Fellow. Haas and his wife raised three sons: George, Rene and John.

Haas was a man with a well-tuned sense of humor and a gift for knowing people. He had insights and perspective on the developing LCD industry that had significant impact on Xerox R&D management. He delighted in every turn of events in the display industry and closely followed every new innovation, reading every publication as if it were the one that could save the world. His friends and colleagues found great comfort in a visit to his office, which was always stacked high with publications and copies of technical papers.

Haas was an inspiration to both of us and so many of his colleagues at Xerox. His expressions and sense of humor have stuck with so many of us for years. He would say, "Science is not a potato," meaning that unlike the highly complex nature of living things, the science of display materials and the technology of display devices could be understood if one only chose to do the proper experiments and measurements. He dedicated his life to doing just that.

When Haas began his research on LCDs in 1965, LCD technology was barely more than a laboratory curiosity. At that time, the key interest was in the enormous variety of LCD textures and alignments, rather than TN with an active matrix backplane. His lab at Xerox was filled with vials of LCDs, cell samples and a variety of optics to examine what he had found.

In the early days, the proper application for LCDs was far from obvious, and we all grappled for the best way to use these unique materials. At that time, cholesteric LCDs played a bigger role than nematic LCDs. One such device, using the cholesteric LCDs developed at Xerox, was referred to as the Thermally Induced Transition. As a very hefty laser was scanned across the surface, one could heat the material and change the texture from a scattering focal conic texture to a

(continued on page 5)

3M to Headquarter Optical Systems Business in Asia

ST. PAUL, Minn. - **3M** announced March 19 that it will headquarter its **Optical Systems** business in North Asia, effective immediately, as part of the company's overall strategy to accelerate growth by moving closer to customers.

"The move will improve 3M's ability to respond to LCD panel customers more quickly in this fast-paced market and helps ensure long-term sustainable success for our enduring franchise," said **Mike Kelly**, executive vice president, 3M Display and Graphics. "As the pioneer of microreplicated and multilayer brightness enhancement films, 3M is committed to protecting and building the optical film business over the long term."

In this fast-paced industry, headquartering the business in Asia will further improve customer intimacy and response rates. 3M announced last fall that its LCD optical film business would undergo a transition to expand its product offering beyond high performance, high price films to include basic performance, competitively priced films for all segments of the LCD industry.

Jim Bauman will be the new vice president and general manager for 3M Optical Systems Division. Bauman has held leadership positions for 3M in Thailand, Electro and Communications in Austin, and most recently, as vice president and general manager for the Automotive Division in St. Paul. While Bauman will manage the division from North Asia, business operations will continue to be deployed globally.

3M's optical films are used to make electronic displays, such as LCD TVs, laptops and cell phones, significantly brighter than displays without enhancement films, more energy efficient and more vibrant in real-life lighting conditions by optimizing and recycling light. By enabling vivid, lifelike pictures in environments ranging from natural daylight to a darkened room, optical films from 3M offer consumers more flexibility to use their electronic devices in a variety of locations.

— Staff Reports

Kodak Signs OLED Cross-License Agreement With LG Display for Use in Next-Generation Portable Media Devices

ROCHESTER, N.Y - **Eastman Kodak Co.** announced on March 14 an intellectual property cross-licensing agreement with **LG Display Co. Ltd.** of Korea. The license, which is royalty bearing to Kodak, enables LG Display to use Kodak technology, including yield-improving capabilities for Active Matrix OLED (AMOLED) modules, in a variety of small to medium size display applications such as mobile phones, portable media players, picture frames, and small TVs. The agreement also enables LG Display to purchase Kodak's patented OLED materials for use in manufacturing displays. Financial terms of the agreement were not disclosed.

"We are pleased with the opportunity to expand our relationship with LG Display beyond the Joint Evaluation Agreement we announced in February 2006," said **Mary Jane Hellyar**, President, Kodak Display Business, and Executive Vice President, Eastman Kodak Co. "As we said during our recent investor meeting, OLED is an important technology that will help fuel Kodak's future growth. Our goal is to see AMOLED panels that have been co-developed continue to appear in the industry during 2008."

"AMOLED is the newest generation of display technology and will compete in the full spectrum of size ranges," said **Andrew Sculley**, General Manager and Vice President, Kodak's Display Business. "AMOLED technology offers superior product performance, and ultimately low-cost manufacturing advantages. We're proud and pleased that LG Display has chosen to incorporate our OLED technology to power a variety of innovative new consumer display products."

Hyun He Ha, Executive Vice President and Head of Small & Medium Displays Business Unit at LG Display, said, "The agreement will help strengthen our small and medium size OLED business, and bolster our position in the large OLED market in the long run. We expect the win-win relationship to create vast synergy for the OLED business of both companies."

The agreement with LG Display is the latest in a series of moves that Kodak has made as the company commercializes its innovative OLED technology. Recently, KAGA Electronics of Japan announced plans to introduce the world's thinnest, lightest portable 1-Seg television featuring a full-color, 3.0-inch OLED display utilizing Kodak's AMOLED technology, which includes Kodak's patented Global Mura Compensation that provides overall yield improvement. The KODAK ELITE VISION AMOLED 1-Seg TV was co-developed by Kodak, LG Display, KAGA Electronics and Andes Electronics and will be available in Japan by the end of March 2008.

Pioneered by Kodak in the late 1980s, OLED technology and its practical applications have generated more than 1,900 Kodak patents and patent applications worldwide. Benefits over conventional technologies include higher contrast, fast response time that can deliver blur free video motion, industry-leading (180 degree) viewing angle, thinner design for better ergonomics, and potentially lower unit cost of manufacturing.

— Staff Reports

Werner Haas Dies at Age 79

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Grandjean nonscattering texture. When Xerox's top management came through for the critical demo, Haas was sarcastically asked if he was developing blackboards for Eskimos. Needless to say, this was not one of the ideas that went far. To his credit, comments of this nature didn't discourage him from pursuing the next good idea, and out of this work came some of the industry's earliest optical light valves. Perhaps one of the lessons many of us learned from Haas was the value of persistence and patience.

We must relate a story about the first 10-inch TFT LCD. Peter Brody and Fan Luo at Westinghouse made the very first large-area TFTs using CdSe and sold one sample to Xerox for the tidy sum of $50,000, which in 1972 was worth far more than today's $50,000. We set up the precious panel in Haas's lab, but neither he nor any of the rest of us had the courage to turn it on for fear we would wreck it. Literally months passed until any of us had the nerve to turn it on, but this was the precursor to Xerox's investment in the development of TFT backplanes, 5 years later.

Due to shifting corporate business priorities at Xerox, none of the early LCD patents were commercially developed nor enforced by the company. In 1973, Haas entered the equally exciting world of high-speed inkjet printing. His efforts in the early '70s contributed to Xerox's development of a synchronous multijet, high-speed printing device with performance far beyond the inkjet machines used today.

It was not until 1979 that Haas reentered LCD R&D activities at Xerox, but this time as a senior advisor to the newly formed LCD development team, which was also part of the pioneering Large Area Electronics Facility at the Webster Research Center.

Haas also worked on advancing the performance capabilities of electrophotographic or xerographic printers. A two color or highlight color high-speed printer was developed in collaboration between Haas' group in research and another group in engineering. This became a very successful Xerox product throughout the '80s and '90s.

Haas served the display and electronic printing industries well with his years of hard work and leadership. He had remarkable scientific insight into complex problems. With a very high rate of success, he was able to differentiate those problems which could be solved from those where the barriers to be overcome were out of reach.

He was a Fellow of both the SID and of the IS&T (Imaging Science and Technology). During the '80s as Engineering and then Conference VP of the IS&T he was a key driving force for establishing IS&T as the leading professional society in printing technologies. Few people have contributed so significantly in so many different ways over such a long tenure to both displays and electronic printing. He will be greatly missed by many for his incredible humor, his outlook on life, and for the inspiration that he offered to many of us who endeavored to turn LCD displays and electronic printing technologies into today's very profitable businesses.

***Joel Pollack** is the President and CEO of Clairvoyante Inc., which was recently sold to Samsung. **Andy Lakatos** is the editor of the* Journal of the Society for Information Display.

president's corner

Are You Hungry?

It's that time of year again – when Display Week returns for the 46th consecutive year, and I hope you bring your appetite. While the Society for Information Display (SID) serves up a steady menu of display-related content during the year, it's when Display Week arrives that the feast really begins. This year's multi-course banquet of display-related news, invention, and achievement promises to be a rich and flavorful experience.

People come to SID's Display Week because they know that they can count on high-quality information – the top people in displays bring the finest and freshest ingredients and ideas to this world-class event. SID has built a solid reputation as being the authoritative source of information for the display industry. People know that a SID event provides top-notch information – so rest assured, there will be no belly aches from poor quality offerings here! This year's event draws from more than 800 submissions, reviewed (and in some cases rejected) for quality by more than 100 SID volunteers who are vigilant in maintaining the high-caliber standards that have become the SID hallmark.

The menu for this year's DisplayWeek will feature several new specials along with some favorite standard fare that our members have come to expect over the years. Beginning with the appetizers: the Short Courses, Display Technology Seminars, and Applications Tutorials whet the appetite for those looking to get overviews surrounding some of the most important areas related to display technology. For those with different tastes, the SID Business Conference and SID Investors Conference provide alternative selections for those whose palate prefers the marketing and financial side of the industry.

Some reliably popular main courses are offered up mid-week. The technical symposium encompasses more than 550 papers and poster presentations, covering virtually every major aspect of flat-panel-display (FPD) development, cooked up by some of the leading innovators in display technology from around the world. It's fair to say that nearly all of the major FPD products sold today came to life as a paper presented at a SID Symposium. For the participant, it can be difficult not to overindulge, especially with the abundance of courses within reach.

Every great restaurant has specials, and Display Week is no different. For example, the SID keynote addresses, the SID individual achievement Honors and Awards, and the prestigious Display of the Year Awards rely on the freshest ingredients, namely, the most important industry news and accomplishments of the year. This year's Evening Panel on Tuesday May 20 will add some spice to the proceedings, as display industry experts and leaders gather together to discuss if active-matrix liquid-crystal displays (AMLCDs) will be dominating the industry forever, or whether alternative cuisines in the form of newer display technologies can make AMLCDs into the equivalent of fast food – filling but no longer the staple.

Many new menu items will make their debut this year. For instance, there is a major session on 3-D in Cinema on Wednesday afternoon, May 21, presented by experts associated with the movie industry – this is Hollywood territory, after all! Another new addition is the Display Applications Special Session, which will help educate and provide contacts for design engineers who need to implement displays into their products. If these offerings prove popular, they may find a permanent spot on Display Week menus in future years.

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OLED Displays on the Verge of Commercial Breakthrough

by Robert Jan Visser

This article is an adaptation of a presentation given at the SID Display Applications Conference (DAC) held October 23–25, 2007 in San Francisco. In the presentation, the important contributions that U.S. companies have made to the development of organic-light-emitting-diode (OLED) display technology and the industry were highlighted and used to illustrate important trends in the industry.

The general public, the press, display customers, and the display industry as a whole have been alerted to the superior image quality and possibilities to create super-thin, high-quality, and even flexible displays offered by OLED technology. Just about every OLED display device unveiled recently has created a strong impression, from Sony's OLED TV and Samsung Electronics' 40-in. OLED TV, to beautiful cell-phone displays from Samsung SDI, to the world's thinnest display by Samsung SDI, to very impressive full-color active-matrix flexible displays by LG Display and Samsung SDI. Now that companies such Samsung SDI and CMEL a.o. have shown that many issues that have plagued the industrial production of OLEDs can be overcome, the OLED industry has entered a new stage of additional investments and growth.

No article should start without mentioning the invention of the OLED by Ching Tang and Steven Van Slyke from Kodak. This is and remains the foremost of the U.S. OLED companies, not only because of their invention, but also due to important contributions to new materials, driving, structuring, and production technology over the years.

Currently, there are four main development themes for OLED technology: cost-effective and suitable methods for making RGB displays; active-matrix OLEDs; new materials; higher efficiency and longer lifetimes; and creating very thin and flexible displays. Let's look at each one.

Cost-Effective Methods for Making RGB Displays

Almost all OLED displays produced today use the evaporation of organic small molecules. In order to make a full-color display, the most direct method is to evaporate the different colors one by one using a shadow mask. This has a couple of drawbacks: moving from one position to the next can cause damage and/or contamination and requires very high precision from the thin and a stretched shadow mask and its positioning system. As of now, up-scaling to sizes greater than Gen 4 seems to be very difficult.

A technologically much easier way to make a full-color display is using white pixels, which utilizes a color filter and removes the need for complicated shadow masks. One sacrifices off-course energy efficiency with this approach. Kodak has successfully worked on two aspects of this approach, creating high-efficiency (23.6 cd/A) white materials and white-emitting structures, with good color rendering (>100% NTSC), long lifetimes (180,000 hours for TV), and without a shift in color point during the lifetime.

Because most images contain a lot of white, introducing a fourth white subpixel where the white is unattenuated by the filter (RGBW) improves the energy consumption for most images by 80%.

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We are always interested in hearing from our readers. If you have an idea that would make for an interesting Business of Displays column or if you would like to submit your own column, please contact Aris Silzars at 425/898-9117 or email: silzars@attglobal.net.

Qualcomm MEMS Technologies, Inc. (QMT)

Qualcomm MEMS Technologies, Inc. (QMT), a wholly owned subsidiary of Qualcomm Inc., has developed the industry's first direct-view MEMS display for mobile devices—mirasol™ displays—an innovative technology that offers low power consumption and superior viewability in virtually any environmental condition, including bright sunlight.

Qualcomm mirasol Technology – One of a Kind

Qualcomm's mirasol display is based on a revolutionary reflective technology called interferometric modulation (IMOD), a phenomenon that mimics the mechanisms that naturally create vibrant colors in a butterfly's wings. Though simple in structure, mirasol display's IMOD elements provide the functions of light modulation, color selection and memory while replacing the functionality provided by polarizers, liquid crystal, color filters, and active matrices provided by competing display technologies.

How mirasol Displays Work

A mirasol display, at its most basic level, consists of a self-supporting deformable reflective membrane and a thin-film stack (both of which work together to create a mirror within an optically resonant cavity), both residing on a transparent substrate.

When ambient light hits the structure, it is reflected both off the top and off the reflective membrane. Depending on the size of the gap, light of certain wavelengths reflecting off the membrane will *constructively* interfere, while others will *destructively* interfere. Certain wavelengths will be amplified with respect to others and, as a result, the human eye will perceive a color.

By applying a voltage to the thin-film stack, electrostatic forces will cause the membrane to collapse. The change in the optical cavity now results in constructive interference not visible to the human eye. Hence, the image on the screen appears black. A full-color display can be assembled by spatially ordering IMOD elements reflecting in any color wavelength.

To learn more about mirasol display technology, visit www.mirasoldisplays.com.

Qualcomm's Wireless Vision and mirasol™ Technology – A Perfect Complement

Qualcomm strongly believes that the broad delivery of wireless multimedia services is the next logical step in the evolution of the wireless industry. QMT's technology perfectly complements Qualcomm's overall strategy of increasing the capability of wireless devices while driving down cost, size and power consumption.

Consumers today are increasingly using convergent mobile devices, further taxing the device's power budget. Qualcomm's mirasol displays provide reduced power consumption and increased viewing time resulting in more time between charges: a value-add to users and service providers alike.

Qualcomm's strength and experience in the wireless market allow the company to rapidly bring mirasol displays to the marketplace. Qualcomm continues to leverage its long-standing relationships with wireless operators, handset manufacturers and content providers, its industry-leading chip position, as well as its strong financial position to accelerate the development and deployment of this technology and 3G solutions as a whole.

Qualcomm MEMS Technologies, Inc. is headquartered in San Diego, Calif., with offices in San Jose, Calif. and Hsinchu, Taiwan.

For more information on QMT and mirasol displays, visit: www.mirasoldisplays.com.

QMT Recent Milestones

Hisense – First mobile phone to incorporate mirasol displays as main display
February 11, 2008

Foxlink – Two design wins including GSM watch and Bluetooth® device
January 7, 2008

KTF – Marked QMT's entrance into Korean market with WCDMA camera monitoring device
January 7, 2008

Audiovox – The first product featuring mirasol™ displays to hit store shelves
January 3, 2008

For up to date press and media information, visit: www.qualcomm.com/qmt/press

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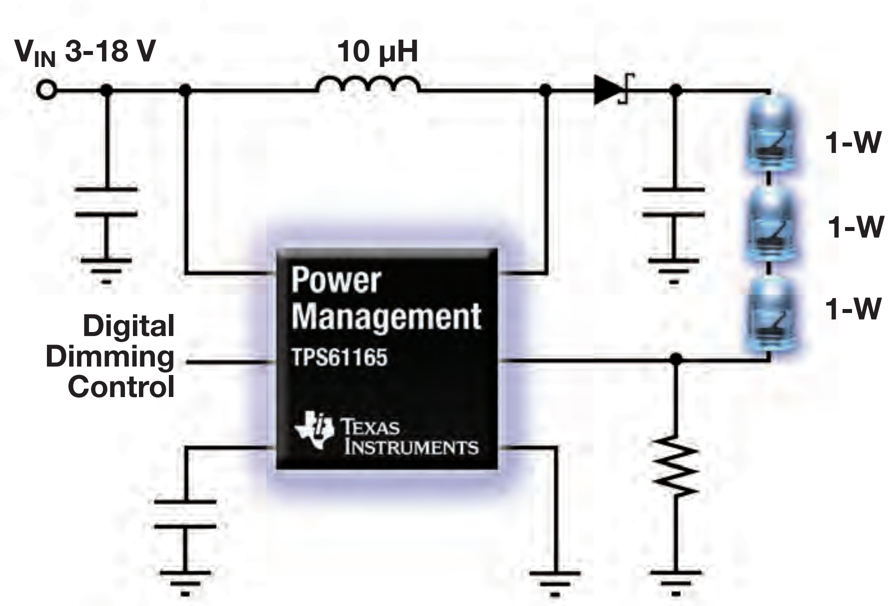

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Device	Topology	# of LEDs	V_{IN} (V)	Switch Current Limit (A)	V_{OUT}	Efficiency (%)	Package	Price (1k)*
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TPS61161	Boost	10	2.7 to 18	0.7	38	90	2 x 2 QFN	$1.00
TPS61165	Boost	10	3.0 to 18	1.2	38	90	2 x 2 QFN	$1.45
TPS61081	Boost	7	2.5 to 6	1.6	27	87	3 x 3 QFN	$1.45
TPS61150A	Boost	6 x 2	2.5 to 6	0.7	27	85	3 x 3 QFN	$1.65
TPS60251	Charge Pump	5 + 2 + 1	2.7 to 6.5	–	6.5	90	4 x 4 QFN	$1.40
TPS40211	Boost	12 x 10	4.5 to 52	6.0	5 to 250	90	3 x 3 SON	$1.10

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Texas Instruments

2008 Display of the Year Award Winners Show the Future is Now

From the commercialization of OLED displays to the rebirth of 3-D cinema, the best display products of 2007 point to the realization of many years of research and development.

by Michael Morgenthal

AS THE FIRST DECADE of the 21st century starts to wind down, the display products that are entering the marketplace are taking on a decidedly futuristic bent. This is illustrated perfectly by the six winners of the 2008 SID/*Information Display* Display of the Year Awards. From the commercialization of organic-light-emitting-diode (OLED) technology to innovative uses of touch technology, 3-D stereoscopic technology, and LED backlighting breakthroughs, the 2007 winners show the strength of the imagination of those currently designing displays, display components, and display applications right now.

"The Display of the Year Awards is hands down the most prestigious accolade commending the chief influential technologies across the global display community," said Dick McCartney, SID's Display of the Year Committee Chair. "The high caliber of products and technologies nominated this year has certainly made the decision process tough on our Awards Committee, but among the significant number of nominations received from around the world, these six products transcended."

A distinguished panel of display experts selected these six products as winners of the most prestigious awards in the display industry from the myriad entries submitted based on their technical innovation and commercial significance, in addition to their likely social impact. In order to qualify for a 2008 Display of the Year Award, a product had to be introduced into the marketplace (*e.g.*, available for purchase) during the 2007 calendar year.

"On behalf of SID, we would like to truly commend the award winners' ongoing commitment to innovation and to shaping the future of today's display arena," McCartney added.

The 2008 Display of the Year Awards will be officially presented during the annual Display Week Luncheon on Wednesday, May 21 at 12 noon in the Concourse Hall 151 of the Los Angeles Convention Center. Tickets for the luncheon cost $35. During the ceremony, the three 2008 Gold Award winners will each present a short video describing the winning product.

The award-winning displays, components, and applications are described here, based on information supplied by the winning companies.

***Michael Morgenthal** is Managing Editor of* Information Display *magazine; e-mail: mmorgenthal@pcm411.com.*

Display of the Year

This award is granted for a display with novel and outstanding features, such as new physical or chemical effects, or a new addressing method.

Gold Award: Sony Corp. – OLED TV XEL-1, The World's First OLED TV

The promise of OLED TV has been on the horizon for several years, and Sony won the race to market with its XEL-1, the world's first[1] commercially produced OLED TV. Stunningly thin with an incredible picture quality, the XEL-1 earned the Gold Award in the Display of the Year category. Sony has changed the form factor of television by delivering flawless picture quality that could soon become the standard against which all TVs are measured. The 11-in. (measured diagonally) XEL-1 model is about 3 mm thin at its thinnest point and offers picture quality with extremely high contrast, outstanding brightness, exceptional color reproduction, and a rapid response time. It was introduced Dec. 1, 2007 in Japan and in January 2008 in the U.S. and incorporates Sony's independently developed "Organic Panel."[2]

The "Organic Panel" has been under development for more than 10 years. With its light-emitting structure, OLED displays can prevent light emission when reproducing shades of black, resulting in very deep blacks and a contrast ratio of more than 1,000,000:1. The lack of a backlight allows the device to control all phases of light emission from zero to peak brightness. The innovative technology delivers exceptional color expression and detail without wasting power, so it is an exceptional energy-saver. Since OLED technology can spontaneously turn the light emitted from the organic materials layer on and off when an electric current is applied, it features rapid response times for smooth, natural reproduction of fast-moving content such as sports and action scenes in movies.

[1]*As of October 1, 2007. Based on Sony research.*
[2]*Name of Sony's OLED panel and module.*

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DISPLAY OF THE YEAR

Gold Award: *The Sony XEL-1 is the first commercialized OLED TV.*

Silver Award: *Samsung's 2-in. QVGA AMOLED is currently being used in Nokia cell phones.*

The "Organic Panel" features Sony's unique "Super Top Emission"[3] technology, with a wide aperture ratio producing high brightness and efficiency allowing the TV to deliver an accurate picture. The device's proprietary color filter and micro-cavity structure allow it to reproduce natural colors – even in darker scenes – and more faithfully recreate the colors that were originally intended.

"Super Top Emission" adopts the Top Emission and micro-cavity structure of the OLED layer, which enables higher brightness and leads to less power consumption and more accurate color reproduction. Top Emission refers to extracting light from the sealing substrate. To extract light from the cathode side in the Top Emission structure, the cathode must be transparent, or half-transparent with a metal cathode. The method of extracting light from the TFT substrate side is called Bottom Emission. Because drive circuits are placed on the TFT substrate in this method, the area from which light can be extracted is limited. The micro-cavity effect is achieved by optimizing the organic film thickness between reflective anode and half-reflective cathode, *i.e.*, the optimum optical path length. Thus, the thickness of the organic layer of each color is different. The micro-cavity effect enables the designated peak of the spectrum of emitted light, enhancing and sharpening the light and allowing the micro-cavity structure to achieve high brightness and high color purity simultaneously.

"Super Top Emission" adopts other unique technologies, including the color filter and complete solid-state encapsulation. Combining the color filter with the micro-cavity structure, by which ambient light reflection can be almost reduced, allows higher contrast, higher efficiency, and lower power consumption without employing a circular polarizer on the panel surface. Its all-solid structure, achieved by a transparent inorganic buffer layer on the substrate and bonding the sealing substrate together by resin with no air gaps, allows XEL-1's surprising thinness. A typical OLED panel with an inert-gas-enclosed air-gap structure is more susceptible to damage by external mechanical shock, and the damage can be more significant when the screen size is larger. This complete solid-state technology will allow the manufacture of OLED panels that are even larger in size and thinner in thickness, with the possibility of achieving a super-thin paper-like display with a plastic film substrate.

Silver Award: Samsung SDI Co. Ltd. – 2-in. QVGA Ultra-Slim Low-Power High-Contrast Wide-Color-Gamut AMOLED Module

Not all of the attention for OLEDs in 2007 went toward the efforts to develop OLED TV, however. Samsung SDI's 2-in. QVGA ultra-slim low-power high-contrast wide-color-gamut AMOLED module, which started mass production in August 2007, represents the

[3] *Sony's OLED device structure adopts both top-emission and micro-cavity structures of the organic layer simultaneously.*

DISPLAY COMPONENT OF THE YEAR

Gold Award: *The PhlatLight BLU is a breakthrough for LED-backlit large-screen TVs because it enables these panels to be edge-lit with far fewer LEDs than had previously been possible.*

Silver Award: *This shows a comparison of image qualities at an oblique angle for displays using FUJIFILM's WV-SA (top image) optical compensation film with the newly developed WV-EA film (bottom image), which was introduced in 2007.*

vanguard in OLEDs for mobile displays, which is why it earned the Silver Award in the Display of the Year category.

This product is a 2-in. QVGA AMOLED module that is used in the Nokia Prism and Arte collections of mobile phones. It contains applied fine-metal-mask (FFM) evaporation technology on low-temperature poly-silicon (LTPS) substrates. This AMOLED display has a resolution of 240×320, a luminance of 180 cd, a viewing angle of 180° (all directions), no visible flickering, 100% color gamut in comparison to NTSC with up to 16 million colors, and a power consumption typically around 120 mA. This model is the strongest entrant yet to compete with TFT-LCDs in the high-end mobile-phone market, thanks to its slim form factor, low power consumption, extra-wide color reproducibility, and extremely high contrast ratio.

Samsung SDI was the first company to mass produce AMOLEDs and is now manufacturing 1.5 million AMOLEDs a month, a number that is expected to double by next year.

Display Component of the Year

This award is granted for a novel component that significantly enhanced the performance of a display. A component is sold as a separate part destined to be incorporated into a display. A component may also include display-enhancing materials and/or parts fabricated with new processes.

Gold Award: Luminus Devices, Inc. – PhlatLight Backlight Unit

Replacing cold-cathode fluorescent (CCFL) backlights with LEDs has spurred considerable interest among manufacturers striving to differentiate their large-screen products. LEDs are more efficient, have longer life and high reliability, are mechanically robust, and are more environmentally friendly than CCFLs. However, such advantages have traditionally come with a cost because most LED-based backlight units being developed use conventional white LEDs requiring hundreds or thousands of LEDs to achieve adequate brightness and uniformity. This high-cost approach requires an impractical number of components and involves controlling a large number of LEDs to maintain brightness uniformity over the entire screen.

Edge-lit backlight units are favored in small LCDs for cell phones, portable DVD players, and notebook computers because they enable very thin form factors with low part counts to reduce system cost and complexity while improving reliability. Conventional LEDs, however, are unable to couple sufficient light into light guides for large edge-lit LCD TVs.

As manufacturers of the world's brightest LEDs, Luminus Devices has already made a considerable impact on the display market, having successfully proven its PhlatLight® LEDs as suitable replacements for mercury-arc lamps used in projection TVs and projectors. This experience provided Luminus with the insight and understanding to apply the unique characteristics of its PhlatLight technology to other display applications. The high flux and collimated light output of PhlatLight LEDs have now enabled, for the first time, edge-lit backlight units (BLUs) for very large-screen LCD TVs with diagonals larger than 40 in. This innovation has earned Luminus Devices the Gold Award in the Display Component of the Year category.

PhlatLight LEDs are the only LEDs bright enough to edge light large BLUs. Luminus incorporated its proprietary state-of-the-art technologies, including photonic lattice and advanced packaging, to develop a new PhlatLight RGB module that is specifically optimized for LCD-TV edge lighting. Based on extensive system-engineering work, the PhlatLight BLU is a modular LED edge-lighting system that uses these high-flux PhlatLight LED modules to couple light into a MicroLens™ light guide that is provided by Global Lighting Technologies.

This novel backlight is scalable to larger screen sizes in an ultra-thin form factor and uses significantly fewer LEDs to bring the benefits of RGB LED backlighting to manufacturers. These benefits include a wider color gamut, long lifetime, and the absence of mercury. Intelligent features, such as progressive scanning, are more easily implemented with the design's dramatically reduced LED count, while color uniformity and brightness are maintained for the life of the TV. A 46-in. PhlatLight BLU requires only eight PhlatLight LED modules and provides a cost-effective mass-market solution not possible with any other type of LED-based backlight unit.

The low LED count in the PhlatLight BLU solves another key problem of LED backlight units: cost. By eliminating some of the packaging costs associated with conventional LEDs used in direct-lit systems, and substituting thousands of small packages with a few high-performance packages, the PhlatLight BLU can reduce the combined LED chip and packaging cost by as much as 40%. This is a very significant advantage, considering that cost has proven the main hurdle to widespread adoption of LED backlighting for large-screen LCD TVs.

The PhlatLight BLU is making the large-screen LED-backlit LCD TVs viable by reducing the price premium of LED backlights and driving the adoption of LED backlighting into mass markets. High-volume production and system scalability to larger and smaller sizes will help bring the performance and ecological benefits of LED backlighting to all types and sizes of TVs, monitors, and digital-signage displays, with LCD TVs incorporating PhlatLight LED backlight units expected in stores by the end of 2008.

Silver Award: FUJIFILM Corp. – WV-EA Film

LCD monitors have almost totally replaced CRT monitors in the PC monitor market. Twisted-nematic (TN) mode LCDs are widely used in these monitors because the TN mode provides high light transmittance, relatively fast response time, ease of manufacture, and cost effectiveness. However, the viewing-angle performance in TN mode is poor compared to that of other modes. To solve this problem, many approaches were proposed, and the most successful method was the use of Wide View (WV) film. FUJIFILM has developed several WV films (first generation, "WV-A"; second generation, "WV-SA"; third generation, "WV-EA") and expanded the oblique viewing angle for TN-mode LCDs.

The WV film is an optical compensation film that enhances the large field of view of TN-mode LCDs. By using WV film, the viewing-angle performance is improved and clear images can be seen at oblique angles.

Before now, TN-mode LCDs were mainly used for monitors smaller than 19 in. In monitors larger than 19 in. and TV sets bigger than 20 in., IPS or VA mode were the norm, but of late, TN-mode LCDs have been appearing in these larger-sized displays as well due to lower cost, the faster response time of TN-mode LCDs, and the improvement of WV film. In particular, the development of "WV-EA" contributes to the size expansion of TN-mode LCDs. "WV-EA" is a new WV film for TN-mode LCDs suitable for large-sized wide-aspect-ratio LCD monitors and LCD-TV sets.

The "WV-EA" film that was initially developed in 2005 achieved a further viewing angle expansion (see figure) for monitors, but not for TV applications because of the existence of mura on the coating surface.

The thickness mura (non-uniformity or unevenness) in the alignment and polymerized discotic material (PDM) layer occurred with the conventional coating method, mainly caused by the fluctuation of airflow in the drying process. This mura gave rise to optical fluctuation, and it was a critical issue for larger panel sizes. Some additives were used and adjusted to improve the thickness mura. However, it is quite difficult to control both the thickness uniformity and the viewing-angle performance because the additive changed the optical properties of the WV film.

The "WV-EA" film introduced in 2007 has succeeded in remarkably improving the thickness uniformity. Here, FUJIFILM has introduced new airflow control technology with the precise control of airflow directions and speed in the drying chamber. In addition, we have developed a new additive that makes compatible the thickness uniformity with the optical properties. These improvements have allowed the "WV-EA" film to expand in TV applications, which have never been possible with the conventional WV films. For this achievement, FUJIFILM has earned the Silver Award in the Display Component of the Year category.

Display Application of the Year

This award is granted for a novel and outstanding application of a display, where the display itself is not necessarily a new device.

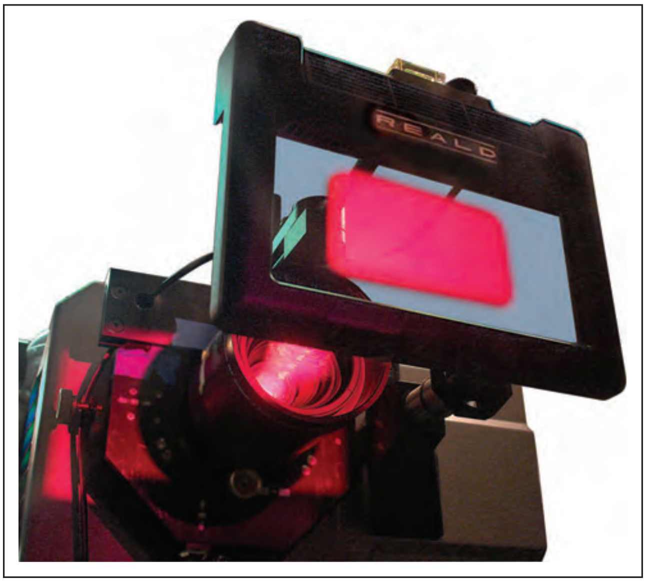
Gold Award: Apple – iPhone

Unless you had somehow left the planet Earth in 2007, you are surely aware of the Apple iPhone, one of the most eagerly anticipated consumer-electronics devices in years. Introduced in June 2007, the iPhone created a frenzy of interest that superceded the buzz for any consumer-electronics device that had come before it.

From a display perspective, the iPhone is notable for what Apple calls the Multi-Touch display, a 3.5-in. (diagonal) widescreen display with a 480×320-pixel resolution at 163 ppi. According to a February 2007 article in *Information Display* by Geoff Walker (now the Director of Product Management for ELO TouchSystems), the iPhone uses projected-capacitive touch technology in two different implementations as described in Apple's patent application. The first, which Apple calls "self capacitance," is a simple passive array of 24×36 sensing electrodes in a single plane. Commonly known as a "matrix" touch panel, this is often used in applications such as industrial control panels, membrane keyboards, and other situations where a limited number of well-defined areas on a surface

DISPLAY APPLICATION OF THE YEAR

Gold Award: *The Apple iPhone features an innovative multi-touch user interface that generated a tremendous amount of buzz in 2007.*



Silver Award: *RealD ZScreen® and the Electronic 3-D Cinema has helped spark a renaissance in 3-D movies.*

need to be made touch sensitive. Since it is basically a low-resolution architecture, it is not regularly applied to displays. The second implementation is a more-traditional structure consisting of two sets of parallel rows of transparent conductors, one on each side of a substrate, perpendicular to each other. Apple calls this implementation "mutual capacitance." What makes this remarkable is that Apple's firmware processes and outputs up to 15 simultaneous touches.

This gives the iPhone's user interface (UI) a tremendous amount of flexibility in terms of recognizing different types of touches, which is vital since there is no traditional phonepad – the entire display serves as the UI. The six fundamental touch-vocabulary elements (gestures) in the iPhone's UI are as follows:

- Single tap to select or activate something.
- Double tap to change the display format.
- Drag and drop to move something.
- A stroke ("swipe" or "flick") up/down/left/right to scroll.
- "Pinching" two fingers together to shrink something.
- "Spreading" (un-pinching) two fingers apart to enlarge something.

These elements work consistently everywhere throughout the iPhone's UI. For example, spreading two fingers apart zooms in on an on-screen photo or enlarges text/e-mail messages.

Pinching and spreading are the only touch-vocabulary elements that make use of multi-touch (multiple simultaneous touches), according to Walker. If the user is doing a pinch gesture, the array of data points output by Apple's firmware contains two sets of touch coordinates that are moving toward each other over time.

The iPhone's innovative touch screen and UI has earned it the Gold Award in the Display Application of the Year category.

Silver Award: RealD – ZScreen® and Electronic 3-D Cinema

It took 110 years from the birth of the cinema to release a perfected stereoscopic projection product. Numerous attempts at making such a product produced images that were uncomfortable to view and unreliable systems. The development of the electronic cinema created an environment in which stereoscopic technology can flourish. The key to stereoscopic projection is that a single electronic projector based on the Texas Instruments Digital Micromirror Device (DMD) light engine can take the place of two projectors to produce superbly coordinated and congruent images for both the left and the right eyes. The system is easy to install, set up, and use, and rarely requires calibration.

RealD created the electronic stereoscopic cinema and, as of today, licenses its product to 1148 theaters in 24 countries. The product is the ZScreen electro-optical modulator combined with a cross-talk reduction algorithm applied to release print files. The "Z" in ZScreen refers to the Z-axis of three-dimensional space, and the product offers the three-dimensional effect that comes with binocular stereopsis. The ZScreen encodes alternate left and right fields with circularly polarized light 144 times per second and the noise reduction algorithm, nicknamed "ghostbuster," subtracts the unwanted left image from the right and vice versa. Moviegoers are outfitted with comfortable plastic-framed disposable eyewear with circular polarizer analyzer lenses to select the appropriate image for the appropriate eye. Because both images pass through the same optical projection path, illumination and geometry are identical, and the high repetition of the field rate ensures that temporal congruence is emulated.

The ZScreen was developed by StereoGraphics Corp. of San Rafael, California, which was purchased by RealD in 2005. The team that created the ZScreen was lead by Lenny Lipton and included Art Berman and Lhary Meyer. Its original application was as a modulator for CRT monitors used for stereoscopic viewing of molecular modeling images for Evans & Sutherland workstations. The same team also designed the CrystalEyes product that has been the standard for scientific and engineering visualization for almost two decades. The ZScreen was developed into a projection device used with CRT projectors and then with DMD projectors. The modulator itself consists of a sheet polarizer in optical series with two pi-cells that are driven out of phase. The technology was first suggested by James Fergasen as a communications device, and he worked with Lipton to perfect its application to moving image projection. The ZScreen was applied for the theatrical application at RealD by a team lead by Josh Greer with Matt Cowan, who developed the cross-talk reduction process.

To date, half a dozen feature films have been projected in RealD cinemas beginning with Disney's *Chicken Little* in November of 2005. The 3-D Hannah Montana concert film, released early in 2008 almost entirely in RealD theaters, achieved the highest gross per theater of any motion picture in history. Films released both in 2-D and 3-D have done about three times the business in RealD-equipped cinemas capturing the attention of filmmakers and studios. A roster of about two-dozen features is scheduled for release in the next 2 years. The future looks bright for the stereoscopic cinema, which is experiencing a creative renaissance as filmmakers explore the new medium. This rebirth of the cinema is being enthusiastically greeted by audiences all over the world. For designing the leading system that has enabled this rebirth, RealD has earned the Silver Award in the Display Application of the Year category. ■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Highly Engineered Glass Substrates for LCD Television: Why Reducing Value Is Incompatible with Consumer Expectations

With the explosion of LCD TV in the past few years and price pressures becoming larger factors, it stands to reason that some manufacturers may look for cheaper alternatives when it comes to the glass used in the making of LCDs. Does highly engineered, specialized glass still offer the best value for manufacturers?

by Peter L. Bocko and H. S. Lee

As liquid-crystal-display (LCD) technology progresses to its full potential in the television market – with 50% penetration expected in 2008 – manufacturers will continue to experience pressure to reduce costs of the bill-of-materials: the backlight assembly, liquid-crystal materials, optical films, and, of course, the glass substrates. With this in mind, it is appropriate to re-examine the basic value propositions for these strategic materials. The substrate industry has been quite successful at providing highly engineered, high-value glass for panel manufacturers. But does this package of specialized properties and value still hold up?

The question is a timely one, given a late 2007 report that a commodity-type glass had been used in the fabrication of an LCD monitor. The industry response to this demonstration was intense and perhaps overwrought, but the question is still valid: Is it in the best interests of the industry to continue on the path of using highly engineered, high-value specialized glass compositions for LCDs?

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Historical Perspective

Corning entered the LCD market when it supplied glass substrates using the fusion-forming process. In comparison to the float-glass method, in which molten glass is pulled onto a molten tin bath and allowed to solidify, using fusion-forming, molten glass is poured into a trough, or "isopipe." The glass fills the isopipe, flows evenly over both sides, and fuses at the bottom. It is then drawn down to form a continuous sheet of glass, which, because it is formed in air, is flat, pristine, and smooth on both sides. Moreover, the resulting substrate is free of any defects or scratches produced by grinding or polishing (in contrast, other techniques currently require additional steps in order to remove surface artifacts). Fusion-forming by its nature also engenders potential for tight control of the dimensional properties of large glass sheets.

The first glass employed in early trials of fusion-forming for LCD applications was Pyrex®, a composition containing alkali in the form of sodium. As shown in Table 1, Glass Property Comparison, the unique feature of Pyrex was its low thermal expansion – the relative increase in size caused by an increase in temperature – compared to a typical traditional soda-lime glass composition. Even at the onset of AMLCD technologies, the low coefficient of thermal expansion (CTE) was essential to reproducible mask positioning at the elevated TFT processing temperatures.

Although glassmakers recognized that sodium could degrade the electronic performance of thin devices, experiments seemed to indicate that perhaps a low level of alkali could be tolerated in LCDs, provided the glass had sufficient chemical durability.[1] However, when it came to active-matrix technology, even a small amount of sodium was considered problematic. As glass compositions moved forward to match the ever-increasing demands on glass attributes, sodium as a mobile ion was reduced to trace levels to prevent numerous performance and reliability issues that could arise with ionic contamination of the liquid-crystal layer.

The first glass used on a commercial scale in AMLCD development was Corning 7059. Introduced in the early 1990s, 7059 had a simple composition with advantages in high-temperature durability and relatively low CTE. Nevertheless, this composition had its

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Table 1: Glass property comparison. The higher expansions and diminished low-temperature stability of soda-lime glasses could dramatically impact both process yields and panel performance.

Property*	Pyrex®	Typical Soda-lime	Corning 7059	Corning 1737	EAGLE2000®	EAGLE XG™
Anneal point (°C)	550	550	640	730		720
Strain point (°C)	505	500	590	670		670
Density (°C)	2.2	2.5	2.8	2.6	2.4	2.4
CTE (10^{-7}/°C)	33	87	46	38	32	32
Softening point (°C)	820	730	840	975		970
Alkali content (wt.% Na_2O)	4	4 to 12	0.1	0.05	Less than 0.05	Less than 0.05

*These properties are typical mid-line ranges for the various compositions. The actual properties of final product may vary.

own limitations, which were exacerbated as the display industry sought to increase yield and make the LCD platform practical for high-volume manufacture. In those early days, manufacturers were using a harsh wet chemistry during substrate cleaning and in photolithography, and the simple barium boroaluminosilicate composition of Corning 7059 lacked the chemical durability required for this aggressive chemistry. Also, although the CTE had been lowered to 46×10^{-7}/°C for high-throughput thermal processes and driver chip integration, concerns about expansion would only worsen as Gen sizes increased. Therefore, higher thermal and dimensional stability were critical.

The next step was Corning 1737, introduced in the latter half of 1996. Although developed in collaboration with a customer, this glass featured an attribute display manufacturers had not specifically requested: low density. Achieved by engineering the composition to lower levels of heavy, dense constituents, the low density of Corning 1737 reduced substrate glass weight in notebook computers (then the primary application), and also greatly facilitated larger substrate sizes, as the reduced weight eased automated handling. But an unanticipated benefit of the glass pulled it into the marketplace ahead of schedule. Customers were depositing highly stressed refractory metal films to reduce the electrical resistance of gate lines for larger notebook panels, and the intrinsic glass lattice strength of Corning 1737 created a more reliable surface for these films. This fortuitous circumstance set a recurring pattern in the LCD industry: highly optimized and perhaps (to some) over-engineered substrate compositions brought unanticipated benefits to panel manufacturers as they evolved their processes to achieve better display performance and greater manufacturing process throughput.

In the late 1990s, Corning began a structured collaboration with key customers to develop EAGLE2000®. The design team engaged with customer counterparts to create a joint vision of future display products and targets for LCD-manufacturing platform characteristics. The development targets for EAGLE2000® were driven by a continuing focus on key glass properties: density was reduced to 2.4 g/cm^3 and thermal expansion to 32×10^{-7}/°C. Of course, no one yet envisioned the three-meter-square platform of Gen 10, but customers did articulate their need for very large substrates capable of high-throughput processing. By design, EAGLE2000® had enough headroom in its basic specifications to meet unforeseen challenges, even though customers eventually scaled the platform well beyond their predictions.

That brings us to today's state of the art in glass substrates for LCDs: highly engineered, high-value specialized glass compositions, such as EAGLE XG™, an extension of the EAGLE family into an environmentally friendly glass substrate that contains no added heavy metals or halides.

Design Criteria for Glass Substrates

The basic design criteria for earlier display glasses have carried over to today's products: low density and low thermal expansion in a silica-rich composition.

- Low density offered low device weight for portable applications as well as more facile robotic handling during high-speed automation. Substrate gravitational sag was a special challenge in large sizes because equipment manufacturers had not yet learned how to support the substrate from the back side of the glass without inducing damage.
- Low CTE brought several benefits, including minimizing distortion during transient thermal steps and assuring the extremely tight tolerance requirements of high-aperture-ratio displays. Previously, the only way many notebook manufacturers could achieve an aperture ratio above 80% in commercial production was to employ a glass with the expansion coefficient of Corning 1737.
- Lastly, the trend has been toward increasingly silica-rich compositions with high-temperature attributes and mechanical reliability throughout all the stresses of display manufacture and device lifetime. High silica compositions can withstand extremes of chemical processing during panel manufacturing, as well as mechanical pressures generated by customers.

While design criteria have remained largely the same, much has changed in the LCD process. The mechanical engineering design for glass substrate handling has evolved significantly. In array technology, the use of compliant low-resistance metal films based on aluminum and its alloys has been mastered, reducing stress at the glass/gate metal interface. Advances such as color-filter-on-array could reduce alignment issues associated with the manufacture of high-aperture-ratio, high-resolution displays. Current substrate cleaning and etching processes contrast with the brute force of the typical Gen 1 and 2 lines. It is logical to wonder whether these advances have relaxed some of the stringent design criteria of current-generation AMLCD substrates.

The short answer is no. Even with these improvements, the simplistic value proposition deployed in the mid-90s for Gen 3 still holds up. For most customers, removing value from the substrate to achieve a lower bill-of-materials is an unattractive option, given the difficulties inherent in compensating for lower substrate performance in their process. In addition, LCD trends have further reinforced the value proposition of highly engineered, high-value specialized glass through less obvious yet equally vital process and application challenges.

Impact of Commodity Glass Attributes on AMLCDs

To understand the implications of using commodity-type substrates in a contemporary AMLCD manufacturing process, including required end-device performance, we will contrast the behavior of today's state-of-the-art substrate with commodity-type glass, focusing on a few increasingly important, though subtle, differences.

Figure 1 provides a concise summary of the key attribute issues associated with adopting the current AMLCD process and device structure from the current state-of-the-art substrate, such as Corning's EAGLE XG, to a *hypothetical* commodity glass. We emphasize "hypothetical" because an infrastructure to supply a commodity-type glass of the sizes, thinness, and extrinsic quality currently required for meeting even the most basic requirements of a modern LCD fab simply does not exist. In the past 20 years, the divergence of the AMLCD substrate platform's technology curve from that of conventional commodity glass manufacturing has produced a significant gap between their respective capabilities for dimensional attributes (large, thin, and flat) and intrinsic quality (surface and bulk).

Furthermore, in virtually all applications, commodity-type glass contains significant levels of alkali; therefore, glass properties typical of the soda-lime type have been applied in this analysis. Alkali, predominantly in the form of sodium and potassium oxides, has long been used to facilitate glass melting and remains an essential constituent in substantially all commodity glass manufacture. However, while high alkali content facilitates glass melting in a low-cost all-refractory brick melting apparatus at a high pull rate, it also impacts glass physical and chemical properties in a way that reduces thermal stability, increases the CTE, degrades mechanical properties, and increases ionic contamination risk. Historically, the presence of small, highly mobile ions such as sodium at the parts-per-billion level have led to degradation in performance. Key variables impacting this performance risk are the quality, composition, and location of barrier layers as well as device lifetime.

In typical soda-lime glass compositions, sodium is frequently batched as a glass component at between 4 and 12 wt.% of the glass. In sharp contrast, with highly engineered, alkali-free substrates, the sodium content is held to trace levels that are many hundreds of times lower than those in float-glass compositions – a 2 to 3 order-of-magnitude difference.

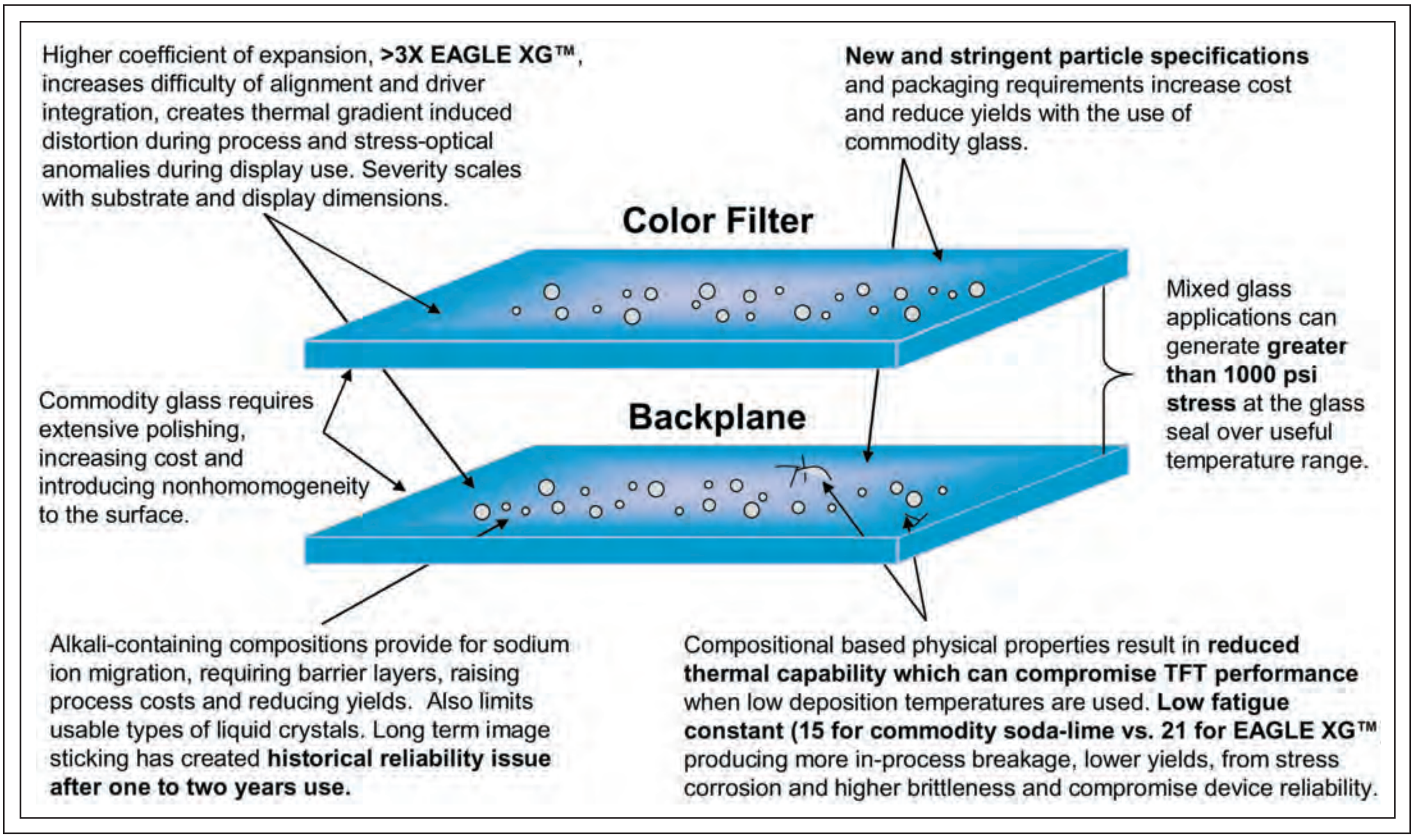

Fig. 1: *Summary of some of the key attribute issues associated with the use of commodity-type glass compared to EAGLE XG™ in a modern LCD panel.*

Thermal Stability

The most obvious impact on the glass is its reduction of thermal stability. Reducing film deposition temperatures in the thin-film-transistor (TFT) processes has been an active area of research, as many labs have attempted to fabricate TFT arrays on exotic substrates. While amorphous-silicon (a-Si) films have been deposited at temperatures below 200°C, there is a complex trade-off between the modified processes' deleterious effects upon the resultant film's electronic properties[1] and the benefits of reduced temperature. Lower process temperatures can reduce but not remove the potential for increased substrate shape changes associated with commodity glass. TFT performance is typically negatively impacted by increased electronic trap densities, unless extensive process modifications are made, frequently in the form of extra process steps or increased process times. The practicality of such low-temperature approaches has been the subject of vigorous debate.

Thermal Expansion

An increased thermal-expansion coefficient can exacerbate warp and in-plane dimensional distortion to the substrate when the substrate is exposed to a thermal gradient during the manufacturing process. These distortions can cause feature misalignment (in the TFT plane or between the TFT and color-filter plates) or handling problems. Thermal expansion for typical soda-lime glass is 90×10^{-7}/°C – nearly three times that of highly engineered, alkali-free glass, such as EAGLE XG, at 31×10^{-7}/°C.

Optical Retardation

Recently, optical retardation changes, which can be induced from panel design, manufacturing, and operation, have become a matter of concern as expectations for panel performance continue to advance. Figure 2 illustrates the results of a finite-element model: a numerical simulation of the impact of optical retardation on a panel's viewing performance. The conditions illustrated are for matched glass composition panels of EAGLE XG and typical soda-lime glass, with the two glass substrates in each panel assumed fixed at their edges and held stationary in a rigid frame. The TFT plate, closer to the backlight, experiences a higher temperature than the front plate, with a stress-producing temperature gradient of 10°C, back to front. Stress birefringence caused by the relative thermal expansions of the two compositions, along with their respective stress optic coefficients – a measure, higher for typical soda-lime glasses, of how much birefringence is caused in a material from a stress – produces a 5x greater retardation in the commodity-glass-based panel.

Brighter areas on the display screen indicate increased light leakage through the panel's polarizing films, causing unacceptable contrast irregularities on the LCD screen, which are more apparent with large-sized panels and worsen with more high-expansion glass content in the display. Some may think substituting a typical soda-lime color-filter plate in an LCD is straightforward compared to attempting a typical soda-lime TFT plate, but given this effect, this is far from the case. When a combination of a low-expansion backplane is paired with a high-expansion color filter, the backplane serves as an unyielding frame for the high-expansion color-filter glass, and the retardation persists.

Mechanical Reliability

Scratches and flaws on a glass surface dictate the breaking strength of the glass article under stress. A non-polished glass, such as EAGLE XG, has an advantage in panel strength due to

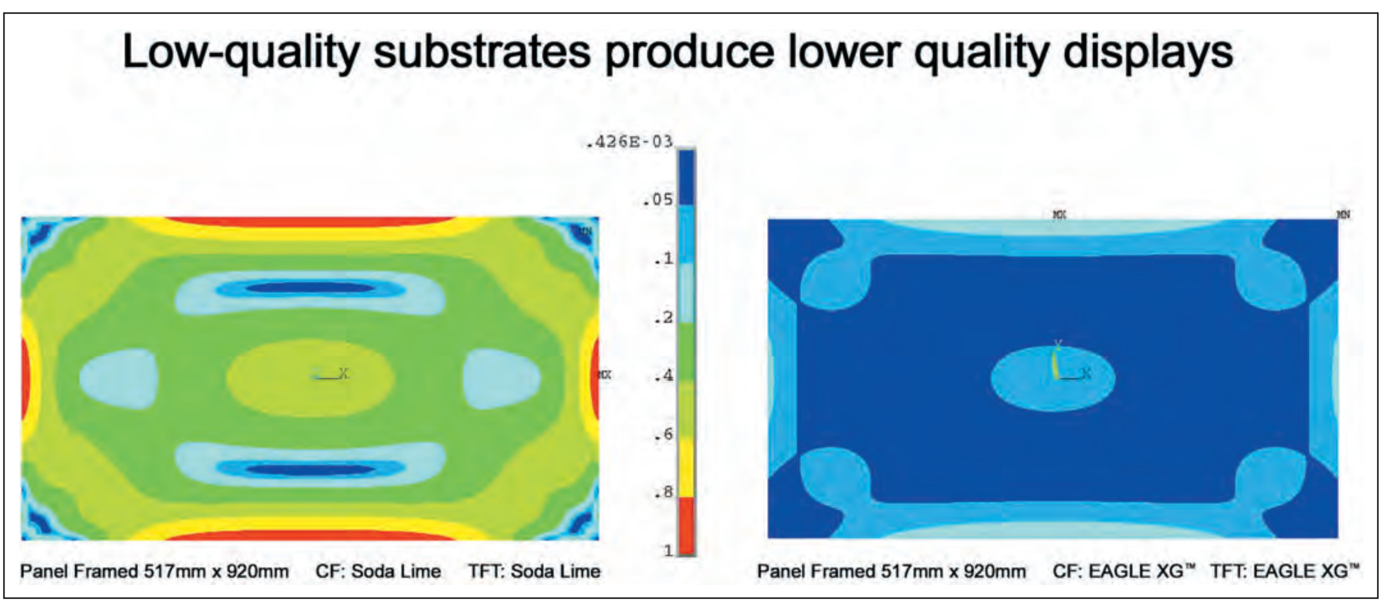

Fig. 2: FEA numerical simulation of the optical retardation in 40-in.-diagonal panels. The simulated soda-lime glass display panel on the left shows significant retardation in the center of the panel – 3x the EAGLE panel on the right and 5x the retardation at the panel edges – thereby producing a panel with poor contrast.

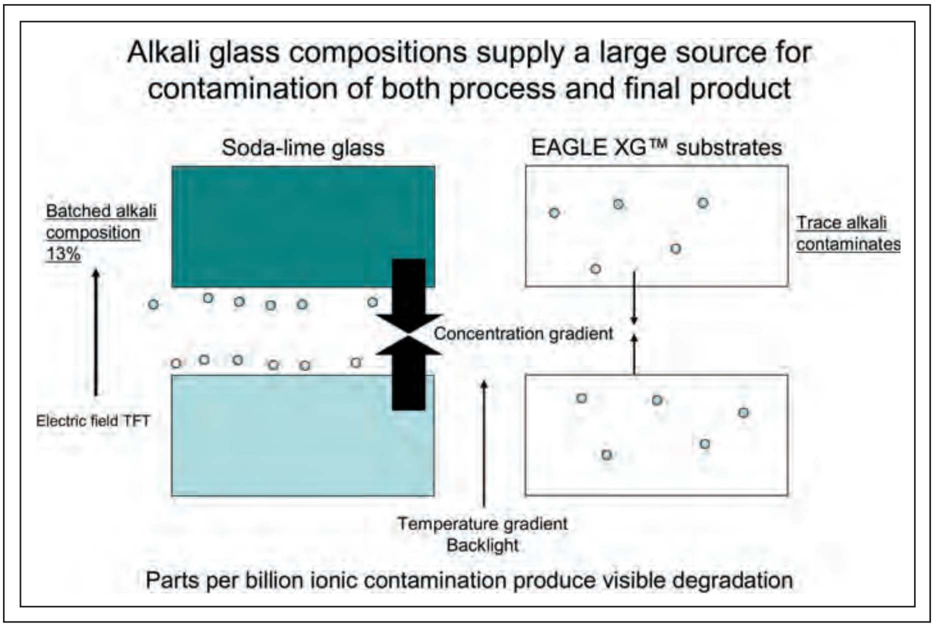

***Fig. 3:** High levels of alkali in a commodity-type glass result in a strong tendency for migration from the surface especially under an electric field. EAGLE XG™ shows no such tendency.*

fewer microscopic flaws on the fusion surface compared to polished glass. Commodity-type flat glass will need extensive grinding and polishing to reach the desired flatness, which for the LCD industry is measured in surface peak-to-valley variations on a nanometer scale. These exacting tolerances are necessary to fabricate displays of high contrast because variations in flatness cause differences in cell-gap thickness, which induce changes in the amount and path of light passing through the liquid-crystal cell. For commodity-type glass, the required grinding and polishing introduces microscopic flaws and increases manufacturing costs. Moreover, fatigue results when stress is applied to a flaw in the presence of water vapor, and a seemingly minor flaw can enlarge to become critical. Even among non-alkali AMLCD substrates, there are substantial differences in the dynamic fatigue properties.[2] The fatigue constant of typical commodity soda-lime glass is such that the fatigue resistance of EAGLE XG is about a third higher. Long-term degradation in strength can occur if low-fatigue-constant substrates are employed in the panel. In addition, panel separation processes, always a source of yield loss, are more reliable with dynamic fatigue-resistant substrates such as EAGLE XG.

Impact of Ionic Contamination

If mobile ions, such as sodium, migrate into the liquid-crystal material, the electrical instability of the liquid-crystal layer will increase. Ions dissolved in the LC from peripheral materials have a direct and immediate impact on image quality through the development of a pathway for a leakage voltage.[3] Thus, liquid-crystal suppliers have focused on the reduction of ionic contamination in the LC material. While the application of a barrier film on a commodity-type substrate may help minimize the risk of ionic contamination, this involves additional cost and is never foolproof.

Recently, image sticking on LCDs has been found to result from spatial differences of the photo leakage current in a-Si TFT-LCDs as well as from the parasitic capacitance induced by ionic impurities.[4] Eliminating image sticking requires an optimized TFT device design and the removal of ionic contamination. A sodium-bearing commodity-type glass would be a move in the wrong direction.

Conclusion

Highly optimized specialty glass compositions have evolved to meet the needs of the LCD industry. Collaborations between glass suppliers and panel manufacturers have resulted in glass designs that brought substantial benefits to the LCD platform and contributed to LCD's leadership in the TV application. We have discussed some differences between a highly engineered, high-value specialized glass composition and a hypothetical commodity-type glass substrate in LCD process performance, display optical performance, and panel reliability. The risks these comprise far outweigh the potential benefit of a reduced bill-of-materials.

By "designing in" the glass benefits rather than "designing around" glass limitations, highly engineered glass substrates are actually the lower-cost solution. Reducing substrate value seems incompatible with consumer expectations for an excellent viewing experience and high panel reliability. With more complex content emerging and increasingly challenging requirements in almost every dimension of display performance, the highly competitive environment of information display will necessitate staying on the path of highly engineered, high-value specialized glass compositions for LCDs for some time to come.

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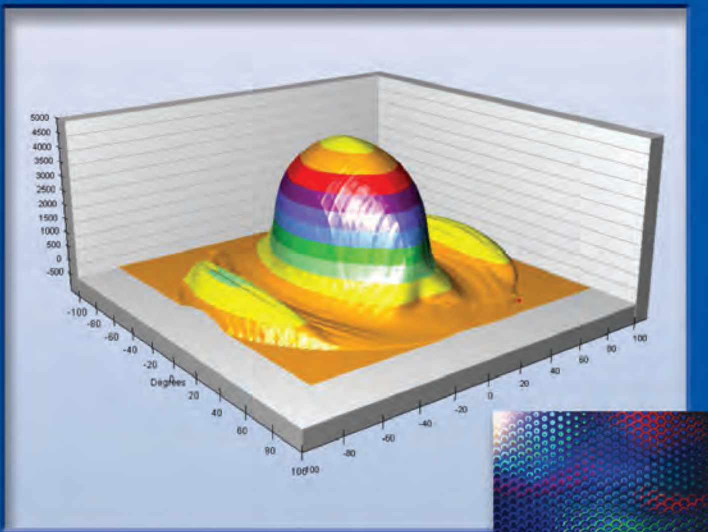

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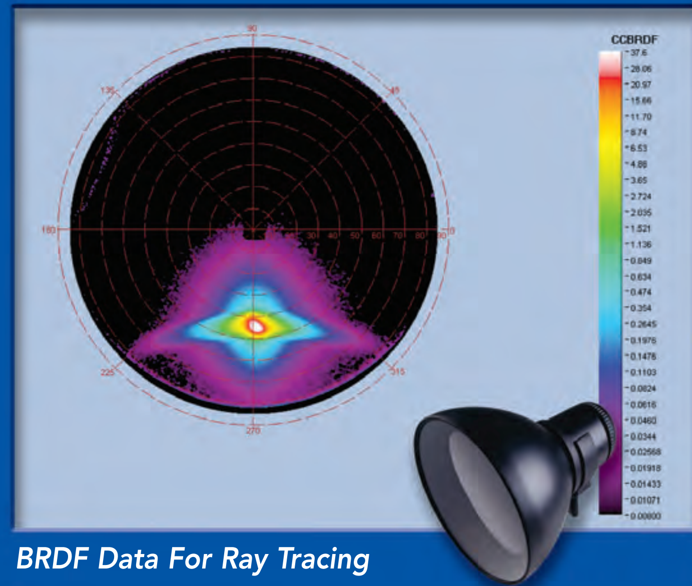

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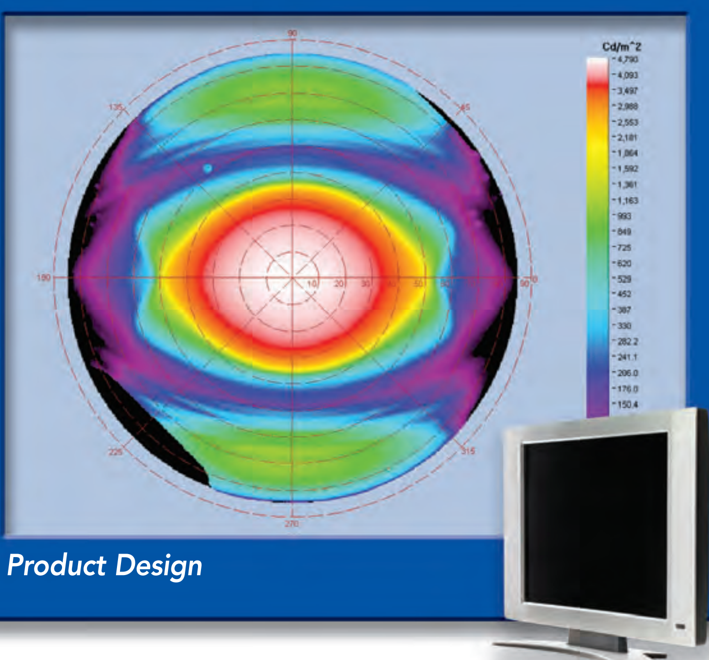
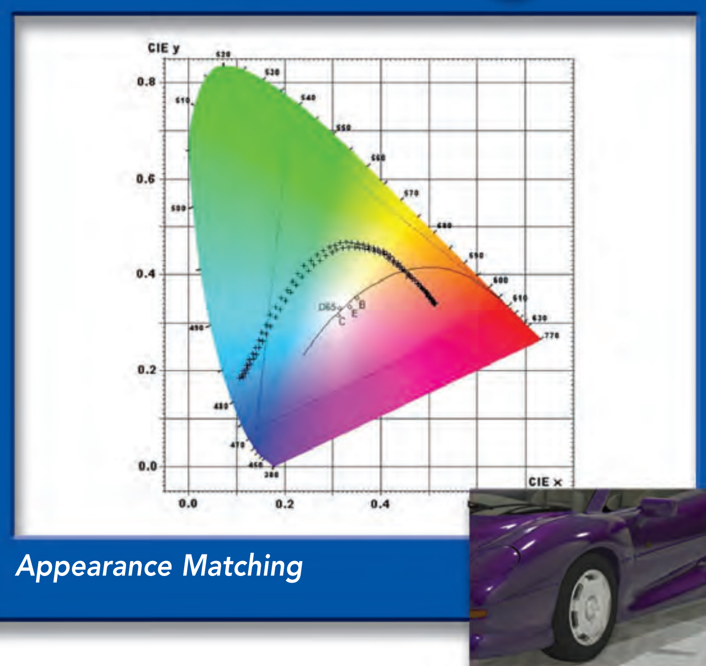
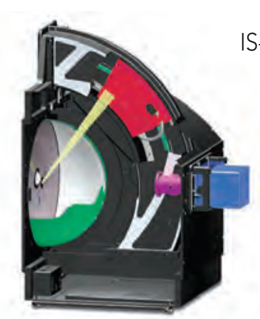


Product Design



Appearance Matching



The Evolution of Projection Displays. Part I: From Mechanical Scanners to Microdisplays

The development of projection-display systems has encompassed numerous technologies since its beginnings in the early 1930s. CRTs have always played a crucial role, but other critical technologies such as the Eidophor oil-film light valve, Hughes's light amplifier, liquid-crystal devices in various forms, diffraction gratings, mechanical scanners, and digital micromirrors have all played an important role in the evolution of projection systems. The first installment of this two-part article explores the innovations from the 1930s until the early 1990s. In Part II, to be published in the August issue of ID, *we'll continue the story to the present day.*

by Matthew S. Brennesholtz

THE FIRST electromechanical television system was patented by German scientist Paul Gottlieb Nipkow in 1884, having 18 lines of resolution. It is not known if he built an actual working system. The first recorded working system came in 1902, where synchronized disks rotating at 30,000 rpm were used to produce an image with a 40-Hz frame rate. This would result in a 12.5-line image, except it was not line-scanned; the scan was a spiral. The projected image was so dim it could only be viewed in total darkness. The inventor planned to solve this problem by eliminating the screen and projecting directly on the retina.

While the Nipkow system, as later developed by John Logie Baird, was ultimately unsuccessful in competition against electronic image systems, it established the principle of image transmission by decomposing the image into lines and transmitting the lines sequentially.

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The years 1929–1939 were seminal years for the development of modern television. The question of mechanical *vs.* electronic TV continued into the 1930s[1] and, indeed, continues today. Certainly, electronic scanning at the camera was the clear long-term winner. To modern eyes, it might seem like the electronic answer would be the obvious one for displays as well. On the other hand, disks rotating at the field rate have never really

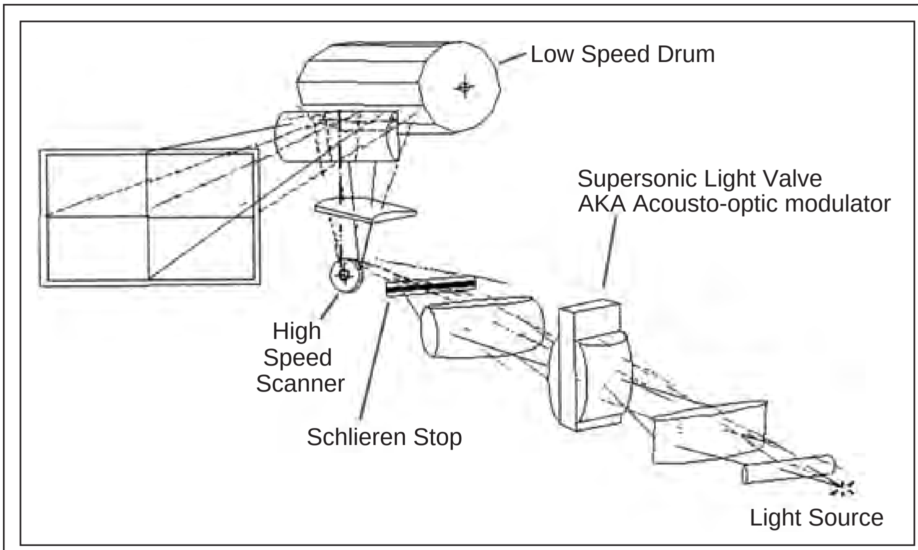

***Fig. 1:** Layout of Scophony mechanical scanning projection system. Note the use of cylindrical lenses because spherical lenses of sufficient size would have been too expensive.*

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vanished from the television scene. The field-sequential-color system from CBS in the early 1950s used a rotating color wheel, as did color pictures sent from the moon by NASA in the early 1970s. The rotating wheel continues to exist today in most consumer digital light-processing (DLP) systems from Texas Instruments (TI). In addition, scanning mirrors fundamentally similar to the vibrating mirrors described by Priess in 1936 and 1937 are used in modern handheld projector prototypes from companies such as Microvision. Priess could create a picture 3 ft. on a side at a projection distance of 6 ft. In the Priess system, the lamp was modulated, much like the modulation of the laser in a modern laser-scanning system. Priess wrote in 1936: "I do not believe – other things being equal – that the public will choose a small picture system when they have the opportunity of purchasing a large-picture device. They have been trained to theater and home movies."

The Scophony system,[2] shown in Fig. 1, was another mechanical projection system developed during the 1930s. Based on two rotating mirrored drums for horizontal and vertical scan, this system featured a light source that operated at a constant brightness and was not directly modulated. Rather, an acousto-optical modulator based on the diffraction of light by sound waves passing through a crystal or fluid was used as a modulator. A dark-field schlieren optical system blocked all undeflected light rays and allowed the diffracted rays to pass on to the scanner and projection screen. The system initially used Kerr cells for the light modulation, but in 1934 switched to the more efficient Jeffree cell. For a 441-line image, the motor driving the high-speed drum needed to rotate at 39,690 rpm. The lifetime of the synchronous motor driving the drum had a nominal lifetime of 1000 hours, although reportedly they actually lasted longer than that. Scophony projection systems intended for public presentations with screens up to 9 × 12 ft. were installed in several theaters. Consumer versions were designed but were never put into production because of the onset of World War II.

Table 1 shows the improvements in television displays from 1929 through 1937.[3] In Table 1, the original ratings of candle power per Watt are given, with modern lumen per Watt values in parentheses. The first number is the estimated value if an ƒ/4.5 projection lens (considered a normal lens in 1937) were used while the second value was calculated assuming a modern ƒ/1.0 cathode-ray-tube (CRT) projection lens. While the 5.6 lm/W for a monochrome CRT projector is not competitive with a modern efficiency of about 10 lm/W for a full-color microdisplay projection system, it is still respectable.

Table 1: Improvements in electronic television displays from 1929 through 1937. Modern estimates of lumens per Watt for ƒ/4.5 and ƒ/1.0 projection lenses are given in parentheses.

Year	Lines	Receiver Cost	Color	Candle power per Watt (lm/W)	Quality
1929	60	$2000	Sepia	1.06 (0.08, 1.7)	Entirely inadequate
1931	120	$2000	Bluish	0.23 (0.02, 0.4)	Entirely inadequate
1934	240	$1200	Greenish	0.86 (0.07, 1.4)	Hardly passable
1936	343	$800	Yellowish-Greenish	1.54 (0.12, 2.5)	Satisfactory
1937	441	$400–$600	White	3.5 (0.28, 5.6)	Excellent

Fig. 2: *Dr. Law with a 3 × 4-ft. image produced by an RCA projector at the 25th IRE Meeting in 1937. (Photo courtesy of David Sarnoff Library, Princeton, NJ.)*

The viewing public largely validated these quality ratings, which were based on the best available televisions in a research laboratory, not the ones used routinely in public. For example, the 1936 Berlin Olympics was televised, but was widely ignored by the German public since the poor image quality sometimes made it impossible to even recognize the images being broadcast. By 1937, these 441-line systems were referred to as "High Fidelity" and even "High Definition" television.

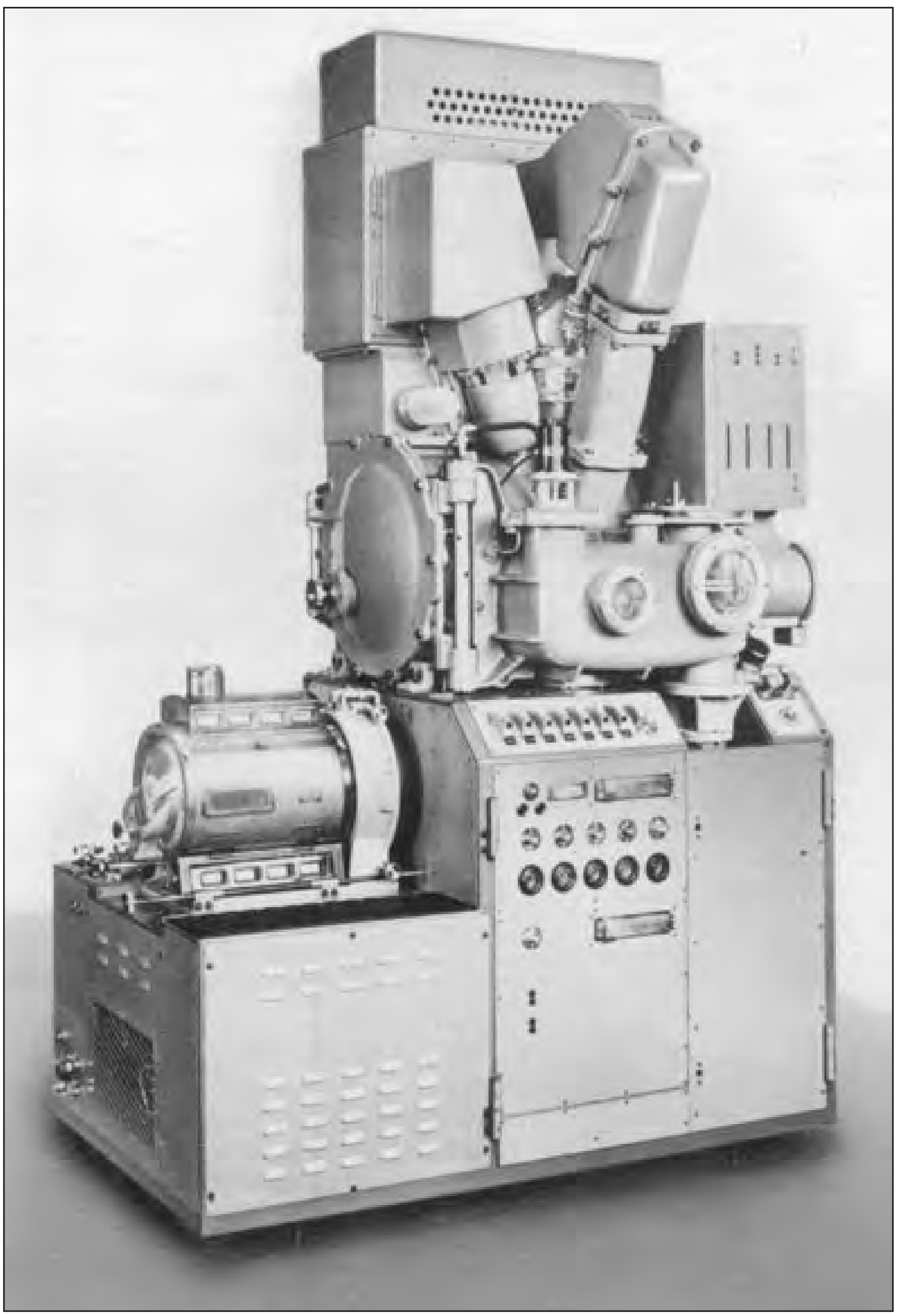

Fig. 3: First prototype of the Eidophor large-screen projection system as demonstrated in 1943.

In 1937, at the 25th annual meeting of the Institute of Radio Engineers (IRE), predecessor to the Institute of Electrical and Electronics Engineers (IEEE), a CRT projector was demonstrated.[4] Twelve-hundred IRE members at the Hotel Pennsylvania in New York saw a demonstration of a 10-ft.-diagonal projected image. The monochrome CRT system was built by Dr. Harold Law of RCA Laboratories in Harrison, New Jersey, as shown in Fig. 2. The tube had magnetic deflection, an anode voltage of 10 kV, an image of 1.5 × 2.25 in., a flat faceplate, and a $f/4.5$ projection lens. The system was normally used to create 3 × 4-ft. images, but for the IRE demonstration it was used to project a 10-ft. image, presumably, with all the room lights off.

The CRT used in this demonstration had a flat faceplate, compared to the convex face plates of previous projection systems that were needed to provide the glass envelope with sufficient strength. The flat faceplate coupled with what today seems to be a high-f/# projection lens provided good focus across the full screen. For previous convex faceplates, it had been necessary to compromise center-to-edge focus quality.

By 1937, surprisingly modern CRT projectors were appearing in the literature. For example, M. Wolf[5] published a paper on a rear-projection system that would be recognizable as a modern CRT projector except it was monochrome. The system used a concave faceplate instead of a convex or flat one. According to Wolf, to obtain satisfactory focus quality on a flat faceplate, the central area no larger than 48-mm diameter could be used. With the concave faceplate designed to match the curvature of the image plane of the $f/1.9$ projection lens used, Wolf could focus the 48 × 55-mm 405-line image from the CRT faceplate onto a rear-projection screen that could be as large as 100 × 120 cm, although a 40 × 50-cm screen was used more commonly. The tube used 20–25-kV anode voltage and magnetic focus and deflection. With the anode at 25 kV and the grid at 0 V, 400–800 µA could be produced with a spot size of 0.1 mm. The system produced 4–8 lux.[6] This was considered inadequate by Wolf and Philips, so they used a screen with an estimated gain of 2.5 and provided an estimated viewing angle of ±25°.

Oil-Film Light-Valve Projectors

During World War II, most television and CRT research was directed toward military purposes such as radar and remote guidance of weapons. However, research into television projection systems continued during that time in Switzerland, a neutral country. Professor Fritz Fischer, working at the Technical Physics Department of the Swiss Federal Institute of Technology in Zurich, built the first prototype of what would later grow into the Eidophor[7] projector from 1940 through 1943. This prototype, shown in Fig. 3, was demonstrated on New Year's Eve in 1943.

Here is how the eidophor worked. An electron beam wrote a diffraction grating onto the surface of a thin layer of oil in a vacuum. The optical path of both systems was dark-field schlieren, as shown in Fig. 4. When the surface was flat there was no diffraction, the light passing through the oil film hit the schlieren stop and that portion of the image produced a dark area on the screen. When the electron beam, which ran at a constant current, was wobulated with an RF field, the charge distribution on the oil film was non-uniform and the surface deformed under the electrostatic forces. These surface deformations diffracted the light so it missed the Schlieren stop and was projected onto the screen. A Schlieren lens ensured all diffracted light missed the stop and all undiffracted light hit the stop. The projection lens worked with the schlieren lens to image the oil film on the projection screen. Note that the light was diffracted, not refracted or scattered. Regardless of the amplitude of the diffraction grating on the oil film, the diffraction angle was always the same. Low-amplitude diffraction gratings left most of the light in the zeroth order, producing a dark but not black spot. High amplitude produced maximum white.

While, obviously, there was nothing "Micro" about this system, it had all the aspects of a modern microdisplay projection system, including an external light source, a small image to modulate the light, and a projection lens to generate the image on the screen. The Scophony system and other mechanical scanning systems scanned the light and generated the image by modulating the light intensity. In the Eidophor and other light-valve, light-amplifier, and microdisplay systems, the light is not scanned. Instead, the light is steady, illuminates the entire image simultaneously, and the scanning is done electronically in the microdisplay.

The 1943 system used a carbon arc source, the brightest and most compact source at the time (Fig. 4). In 1957, when the first pre-production Eidophor system was under construction, it was switched from a carbon arc lamp to a 1600-W high-pressure xenon lamp introduced by Osram.

In 1953, a color field-sequential Eidophor was demonstrated at the Pilgrim Theater in New York City. 20th Century Fox was impressed and ordered two improved models. The contract for these projectors required the electronics be built by General Electric (GE), so they were shipped to Syracuse, New York, for this work in 1955.

A planned follow-on order for 1000 of these color sequential units was put on hold and ultimately canceled with the introduction of the RCA simultaneous color transmission system. Another factor in the cancellation was the development of Cinerama and Cinemascope, which drew viewers back into the theaters and reduced the perceived need for theater television systems. A final issue would be familiar to modern ears: the theater owners and studios could not agree on how the projectors would be paid for and what type of television content could be shown.

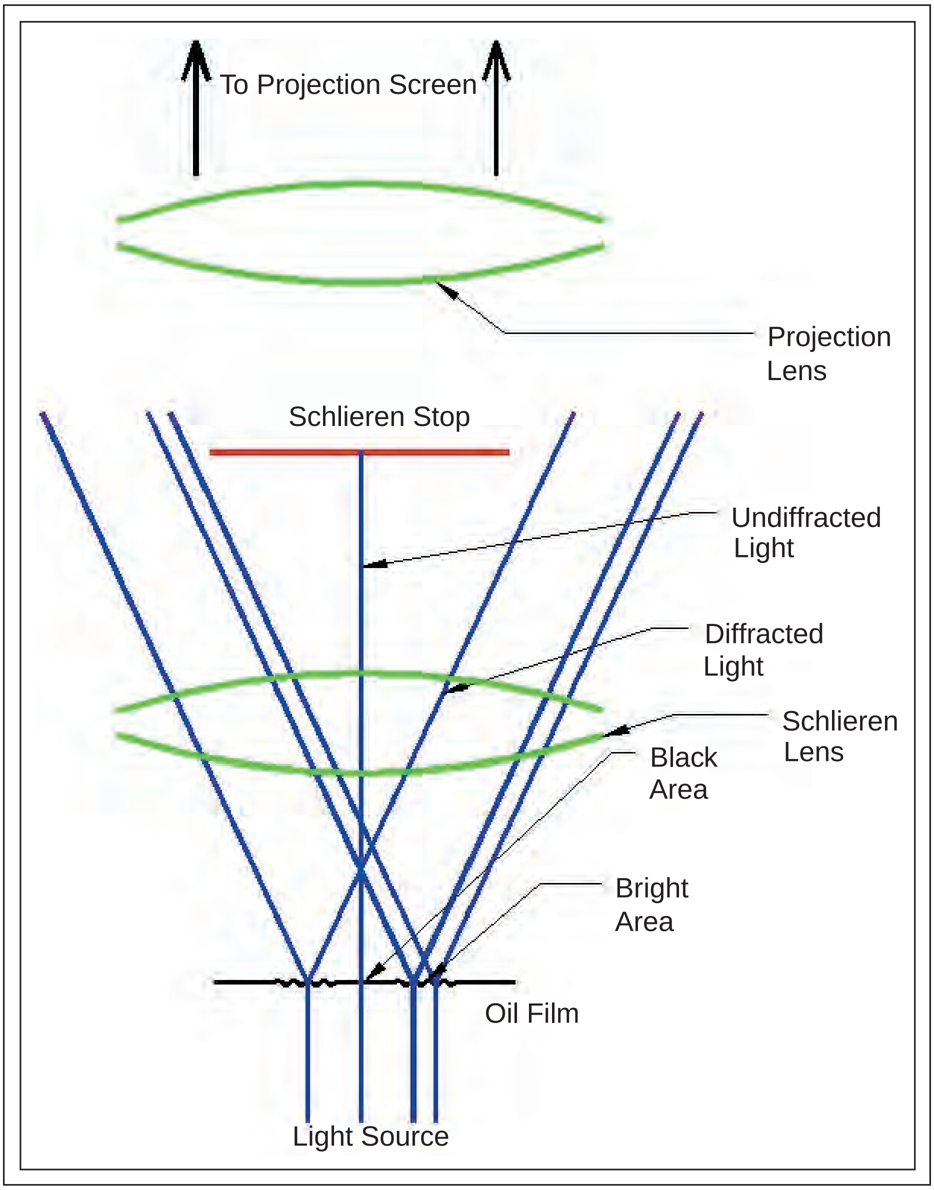

***Fig. 4:** Principle of operation of an oil-film, dark-field, schlieren optical system.*

The prototype simultaneous color Eidophor system had four channels: red, green, blue, and white. Tests of this monster machine where all four channels were in a single vacuum chamber were disappointing: the system could only be used to make a 3 × 4-m image on a 196-in.-diagonal screen. While the system had been paid for by 20th Century Fox, it was never shipped to the U.S. and went into storage.

In 1958, Gretag decided to go into production with the Eidophor. Six pre-production Model ep.1 units were built; four were finished as color-sequential projectors with 500 lm and two as black and white systems with about 2000 lm. This was followed by full production of Model ep.2 with a planned production rate of 5 units/ per month. Gretag did not have the marketing or support networks needed for full production. Therefore, CIBA, Gretag's parent company at the time, set up a joint venture with Philips called Eidophor, Ltd., to market and support the projectors. The first production unit was sold as a color-sequential version to Redifon, Ltd., in England for use in a flight simulator.

Gretag returned to the multi-channel design in 1961, using a more-conventional three-channel system. Gretag designed the basic projector while Philips developed the electronics. This projector is shown in Fig. 5 and produced 2500 lm from the 1600-W xenon lamp, the brightest color-television image that had been shown to date. Note the prominence of the protective cover over the electron gun. Access to the electron gun was needed because the lifetime of a cathode in the Eidophor was at best 100 hours. The cathode could be replaced in approximately 2 minutes by the operator, minimizing disruption of the performance, since the other two color channels continued to operate. With a three-channel Eidophor used 12 hours a day, this failure and cathode change during a performance could occur several times a week.[8]

Gretag continued to bring out new models with improved light output and reduced service requirements. Eventually, they reached 4000 lm from a 2500-W xenon lamp. In 1965, Gretag signed an agreement with JVC to produce Eidophor projectors in Japan. The first projector built in Japan was finished in 1967. Unfortunately, JVC had tooled up to produce the single-channel version, which could be used either as a black-and-white projector or as a color-sequential one.

Demand for these types was dwindling while demand for the simultaneous three-color projectors was increasing. Changes in the oil material used that simplified the design of the projector and made the system more reliable also reduced the response speed of the oil film, so the Eidophor could no longer operate in a color-sequential mode. JVC ceased production after building nine Eidophors.

New models of Eidophor projectors continued to be developed and sold into a variety of professional markets. By 1989, there were about 600 projectors in use worldwide. With the introduction of first LCD and later DLP projectors with comparable brightness and image quality, demand for the Eidophor declined rapidly. The Gretag Display Systems Division closed at the end of 1997, after production of approximately 650 projectors. AmPro of Melbourne, Florida, acquired Gretag's Eidophor business in 1998. They are believed to have built a few projectors from existing parts acquired from Gretag. Support for all Gretag Eidophor projectors came to an end in June 2000. The last Eidophor was believed to have been removed from service in 2000.[9]

Fig. 5: Eidophor Model ep.6 simultaneous color projector capable of 2500 lum.

Talaria Projectors

The Talaria projector was developed under the technical leadership of Bill Glenn at GE in Syracuse, New York, and the first systems appeared in 1958.[10] The initial Talaria system was introduced in monochrome and color versions. A 1977 Talaria model is shown in Fig. 6. The Talaria projector was similar to the Eidophor in some ways, and derived some of its technology from the Eidophor during the 1955–1958 time period when Gretag and GE were cooperating. But the Talaria was not just a copy of the Eidophor; it had several major differences, including:

- The light valve was transmissive rather than reflective.
- The light valve was sealed and no vacuum pump was designed into the projector.
- The initial color design used a single light valve to produce all three colors without color-sequential operation.

Fig. 6: *1977 Talaria PJ5050 Projector, mounted on optional accessory stand. Detachable control unit allows remote operation to 200 ft.*

Each of these changes conferred a major cost advantage on the Talaria compared to the Eidophor. The transmissive optical path was simpler and more compact than the Eidophor's reflective path. The sealed light valve, designated the T1, not only eliminated the vacuum pump, reducing cost and making the system more compact, but it increased the lifetime of the system to several thousand hours. It also reduced the warm-up time from the 1 hour reported for the Eidophor to about 30 minutes, since no time was used to pump the system down to a vacuum on start-up. The remaining warm-up time was needed to bring the oil up to its operating temperature.

Since the initial color Talaria was a full-color single-light-valve design, no optical convergence was necessary. On the other hand, the Talaria had about 46 trim pots that needed to be set up correctly in order to get a proper image on the screen, a formidable task for even the most experienced engineer at GE. The single-light-valve design of the Talaria limited it to about 600–1000 lm, depending on the model and the lamp power. There were also serious color and gamma artifacts in the image. The physics of the Talaria was similar to the physics of an Eidophor.

The full-color Talaria operated by wobulating the electron beam with three different radio frequencies, producing diffraction gratings with three different spatial frequencies on the oil film. The color-segmented pupil and the Schlieren bars were designed to have each RF modulate only one wavelength band of light (red, green, or blue). This minimized but did not fully eliminate interactions between colors. Red and blue, in particular, interacted strongly, especially in the mid-brightness levels.

Operation of the transmissive Talaria system shown in Fig. 6 was very similar to the operation of the reflective Eidophor. The effect of the diffraction gratings was doubled because of the double pass, requiring lower modulation of the oil film to achieve maximum white.

To overcome the brightness and color problems, a version of the Talaria with two light valves called the MLV was introduced in 1987.[11] This unit had one monochrome light valve dedicated to green and one two-color valve split between blue and red. Each light valve had its own xenon lamp. The two images were then converged at the screen. This dramatically improved the colorimetry of the system because a Talaria light valve could satisfactorily modulate two colors with diffraction gratings parallel and perpendicular to the raster lines. The third color, however, was modulated by a second diffraction grating with a different spatial frequency also perpendicular to the scan lines. These two parallel gratings, used to modulate red and blue light in the single-light-valve version, interacted with each other to affect the color. In the MLV, the red/blue light valve used diffraction gratings perpendicular to each other to modulate the light, avoiding this problem.

The ultimate Talaria contained three monochrome light valves and three lamps. Again, all light valves were screen-converged to produce the full-color image. The 3LV (Fig.7) could produce about 7000 lm at the screen, if a handy 50-A 230-V outlet was available.

Cost was a serious problem with the Talaria projectors, as can be seen in the 1992 MSRP price list shown in Table 2. The light outputs in Table 2 are approximate for two reasons. First, output of Talaria varied from projector to projector. Second, 1992 was before ANSI lumens were commonly used, so the specified lumens for these projectors was not measured by a standard method. For example, the 10k in LV 10k stood for 10,000 "CRT equiva lent peak lumens." This measure was typically 3×–10× what would be measured by the ANSI lumen test method.

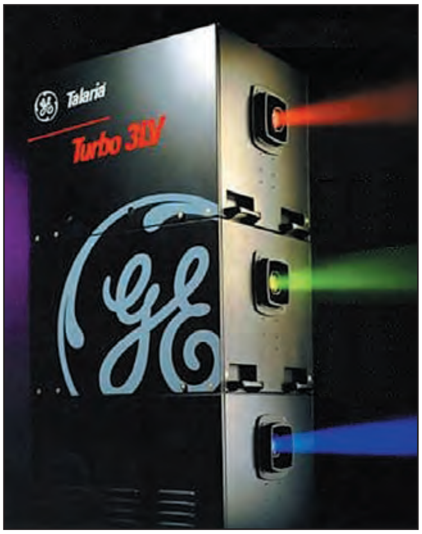

Fig. 7: *1991 Talaria 7000 Lumen 3LV Projector.*

The T1 light valve remained in production in monochrome, two-color, and three-color versions, essentially unchanged from the first experimental units in 1958 until the business was shut down in 1994. General Electric sold its Talaria business along with its defense business to Martin Marietta in 1993.[12] which in turn sold the Talaria business to NEC in 1994. Like the Eidophor, the Talaria was unable to handle the competition from LCD projection systems such as the Barco Light Cannon and went out of production shortly after the sale to NEC. While no Eidophor

Table 2: Price list for Talaria single-light-valve LV series and two-light-valve MLV projectors in 1992.

Model	List Price	Approximate lm
LV7000 DF	$46,980	700–1000
LV7000 MP	$56,950	700–1000
LV10k DF	$79,980	1000–1300
LV10k MP	$89,950	1000–1300
MLV-SC	$149,750	2500–3000

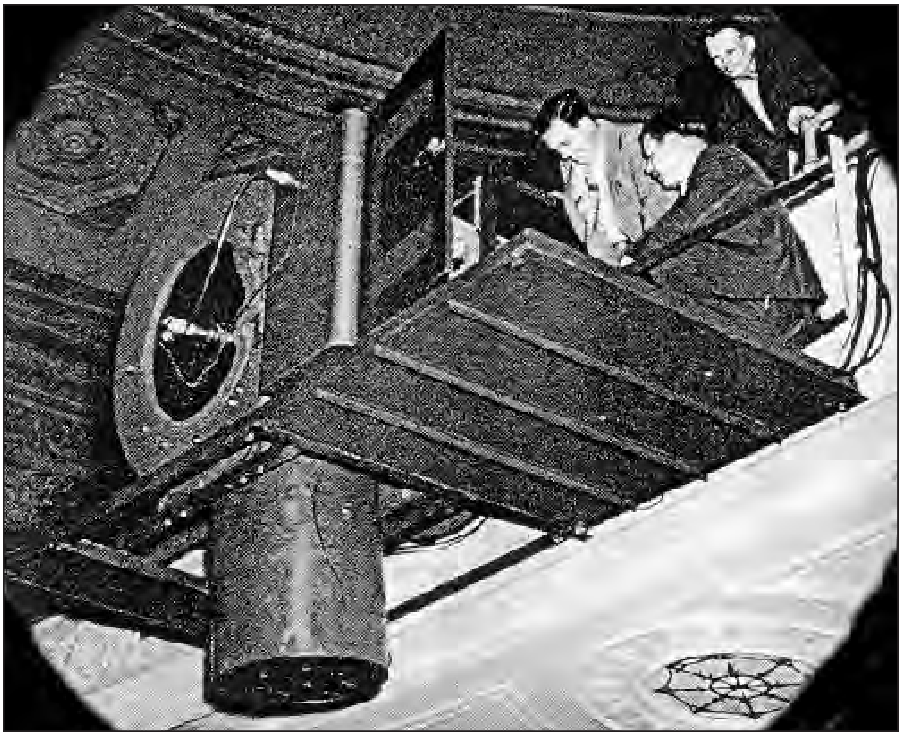

Fig. 8: 1948 RCA Monochrome CRT Projector for Theatrical Use with a 15" CRT and 42" Schmidt Optics (Photo courtesy of Radio Age)

projectors are believed to be operable today, functioning Talaria with its sealed light valve still remain in service. Due to the very high operating cost for a Talaria (estimated in 1992 to be about $100 per hour), plus the difficulty in getting service and replacement parts,[13] it is believed that the Talaria remaining in service today are targeted for replacement. For example, in 2006, the Dutch National Aerospace Laboratory replaced the Talarias in its F-16 pilot-training simulator with Barco SIM6 Ultra II projectors.[14] The Barco press release said its projector represented "an ideal replacement for the end-of-life Talaria projectors because they fit perfectly with the complex existing configuration."

CRT Projectors in the Post-War Years

Research and development into CRT projection systems continued through World War II. In the post-war years, a number of CRT projectors were installed in theaters. In 1948, RCA demonstrated a balcony-mounted projector that used a 15-in. CRT with an anode voltage of 80 kV, as shown in Fig. 8. The Schmidt-type optical system consisted of a 500-lb. 42-in. mirror with a 36-in. lens.

By 1951, there were about 100 theater projector installations, with RCA having about a 75% market share. That year, there were about 300 live shows transmitted. For example, in 1952 the Opera "Carmen" was cinemacast in black-and-white live from the Metropolitan Opera in New York to movie theaters in 27 cities.

Color CRT projection systems have almost always used three CRTs. Figure 9 shows a 1951 color CRT theater projector specifically designed to receive the simultaneous color video signal proposed by RCA that was eventually adopted as the NTSC color standard.15

The consumer was not ignored by the CRT projection business. CRT projectors were sold, or at least offered for sale, to consumers interested in images larger than the direct-view televisions of the time could produce. Figure 10[16] shows a 1951 advertisement for a TV projector for £146.15. At an exchange rate of $5/£, this is a total of $734.

In the 1950s and 1960s, the interest in CRT projection systems declined for large-screen applications because they could not compete with light-valve projectors such as the Eidophor and Talaria. The consumer-electronics industry produced direct-view CRTs in larger and larger sizes, reducing the need for projection systems. During this period, the CRT projector was mostly limited to professional applications where the screens were not large enough to justify the use of a light-valve projector.

The lull in consumer CRT projectors ended in 1972 with the introduction of the Advent VideoBeam projector with Schmidt optics, developed by Henry Kloss from a design by Art Tucker.[17] In the Tucker and Kloss designs, the Schmidt mirror was inside the CRT vacuum-tube envelope. While this ensured the mirror remained clean, it lead to a very expensive CRT. This cost was acceptable in a military simulator where the alternative at the time would have been an oil-film light valve, but a difficult sell in the consumer market.

The VideoBeam was a two-piece three-CRT system housed in a coffee-table-sized console with the picture projected on a 7-ft.-diagonal curved aluminized screen that had to be placed precisely 8 ft. away. Kloss left Advent in 1976 and founded Kloss Video, where he built the NovaBeam series of CRT projectors of similar design to the VideoBeam. Again, the high prices of the Advent and Kloss Video systems prevented widespread sales, and Advent went bankrupt in 1981. Kloss Video was eventually bought by Ampro.

While at the time, Kloss got much of the publicity, other companies introduced CRT front projectors of a more conventional design. In 1972, for example, Sony also introduced its popular VPH series of CRT projectors intended primarily for professional applications. These continue to be popular with home-theater enthusiasts to this day.

Consumer-electronics manufacturers concentrated on CRT projection systems in the years following the re-introduction of consumer projection by Kloss, Sony, and others. Products included two-piece front-projection systems such as the Advent 760; one-piece front-projectors such as the Advent VB125, Sony KP-5000 and Quasar PR6800QW; and one-piece rear-projection systems such as Quasar CT-4500 "CinemaVision" with a 45-in. screen. The sales of large-screen consumer systems was spurred, in part, by the introduction of Beta and VHS videotape systems in 1976. While the Sony Beta system initially only had a 1-hour capacity, the JVC VHS system introduced only months after Beta had up to 2 hours of capacity. This made most films available in prerecorded form, and consumers wanted to watch these films on large screens.

Two key product introductions in 1979 enabled the rapid growth of the rear-projection TV business. The first was the ƒ/1.0 projection lens from U.S. Precision Lens. This extremely low ƒ/# allowed the collection of enough light to make an image of sufficient brightness. While a ƒ/1.0 refractive lens did not collect as much light as a ƒ/0.7 mirror in the Schmidt optical system used by Advent and Kloss video, it cost much less and produced enough light when a relatively high-gain rear-projection screen was used. By the 1980s, these lenses were typically liquid coupled in a process originally developed for military CRTs. This increased the brightness at the screen by cooling the tube, allowing higher powers. The elimination of the air space also eliminated reflections and increased brightness and contrast.

A liquid-coupled CRT projection lens is shown in Fig. 11.[18] While this particular design comes from USPL near the end of the CRT projection business, it has design features common with all liquid-coupled lenses. The liquid was contained between the CRT faceplate and a deeply curved thin element. This lens element/liquid combination formed a strong negative lens near the image plane. The effect of this lens was to correct the field curvature of the lens/faceplate combination so the image could be focused on the flat projection screen, a problem discussed by Wolf in 1937. This design has five elements but other designs had either four or six elements, depending on the vintage and the quality of the image to be produced. Typically, one of the elements would have most of the power in the lens, L2 in Fig. 11, while the other elements served to correct aberrations introduced by this strong wide-field-of-view low-ƒ/# element.

The second enabling product was the development of the color-corrected lenticular projection screen commercialized by Freen Screen. Rear-projection screens based on Fresnel lenses had been around since 1940.[19] These screens were intended to have the image source on axis and were not suitable for use in high-gain three-CRT rear-projection designs. This problem was solved with the invention of a color-correcting screen in 1970.[20] This color-correcting screen allowed the use of off-axis CRTs in relatively high-gain screen applications. With previous high-gain screen designs, the on- and off-axis CRTs produced angular light distributions that differed from each other, leading to color shifts for viewers that were not on the centerline of the screen.

Fig. 9: *RCA Tri-color receiver-projector, which provides theater-size screen images, is shown with its developer, Dr. David Epstein (Photo courtesy of David Sarnoff Library, Princeton, NJ)*

While growth in consumer CRT rear-projection systems continued through the 1980s and 1990s, professional CRT projectors felt the same pressure from LCD, DLP, and LCoS systems that had doomed the Talaria and Eidophor, especially at lower resolutions. For example, in the 1998 projection shoot-out at Infocomm,[21] there were only six CRT projectors in the VGA, SVGA, and XGA categories. In the high-resolution 1280 × 1024/1600 × 1200 section, there were four CRT projectors, and only a single LCD projector, from ASK.

Hughes/JVC ILA projectors

The Hughes Light Amplifier LCD technology began at the Hughes Aircraft Research Labs (HRL) in Malibu, California, in the 1970s. Solid-state physicist W. P. Bleha and liquid-crystal scientists J. D. Margerum and A. M. Lackner developed a photoconductor/liquid-crystal image spatial light modulator. While the original intention had been to develop an optical signal-processing system for use with lasers, another HRL development, the value of the system as a display was recognized. In a display application, the photoconductor was driven by an image generated on a CRT and relayed to the photoconductor surface. The

Fig. 10: British advertisement for a CRT projection system in 1951 from the Daily Mail "Guide to Television."

spatial variation of the conductivity of the photoconductor changed the spatial voltage distribution on the liquid crystal. This in turn spatially changed the liquid-crystal orientation and controlled the polarization of the light from an external lamp. This use of a dim CRT image to control a very bright image at the screen led to the phrase "Light Amplifier," although at the time the technology was more commonly known as a liquid-crystal light valve (LCLV). By 1972,[22] this system had shown sufficient image quality to interest the U.S. Navy in the use of the system for a shipboard display. A full-color version of the projector suitable for television was developed by 1977.[23] Production of the LCLV began for the U.S. Navy and Air Force began in the early 1980s.

In the 1980s, Hughes continued to develop the technology and developed the second-generation LCLV, based on an amorphous-silicon photoconductor. The higher speed of silicon allowed full-motion high-resolution video images to be displayed. In addition, the homeotropic alignment of the liquid crystal was stabilized leading to substantially improved contrast ratio over the hybrid field-effect mode that had been used in the first-generation Hughes LCLV.

Interest in LCLVs was not limited to Hughes. For example, the November 15, 1989 special issue of *Applied Optics* had 26 papers on spatial light modulators, most of them based on liquid crystals. The 89 authors of these papers included representatives of 30 different institutions, including of course, Hughes and Texas Instruments. Several of the institutions were represented by several papers. One of the papers,[24] while not intended as a review paper, had a massive bibliography of 89 references.

Hughes Aircraft Co., recognizing the future commercial importance of this display, spun off the LCLV activities into a subsidiary, Light Valve Products, Inc., in 1989. At this time, the LCLV was given the trademarked name ILA or Image Light Amplifier. Soon Light Valve Products, Inc., was demonstrating large-screen displays for digital cinema in Hollywood and large-venue applications.

In 1992, Hughes and JVC formed a joint venture, the Hughes-JVC Technology Corp. (HJT), to produce ILA projectors and take advantage of the global JVC operations. From 1992 to 2000, HJT shipped over 3500 ILA projectors into large-venue applications around the world. In June 1999,[25] two 12,000-lm ILA projectors from HJT were used for the world's first demonstration of digital cinema to paying customers when Star Wars Episode 1 was shown in Los Angeles and New York. The projectors used were similar to the one shown in Fig. 12. Simultaneously, DLP projectors from Texas Instruments showed the same movie in two other theaters, also in Los Angeles and New York.

HJT worked with JVC to develop the D-ILA microdisplay, which was launched in 1997. In this system, the LC drive voltage produced by the a-Si photoconductor was replaced by a voltage drive from an active-matrix silicon backplane. This eliminated the bulky, troublesome, and expensive CRT used to generate the image. This significantly reduced the size of the panels and the optical system. Although single-lens ILA projectors had been built,[26] their performance was not fully satisfactory compared to the three-lens versions. The smaller size of the D-ILA panel not only allowed single-lens operation but it enabled the development of consumer versions of the D-ILA system. Improvements in optical components and architectures were also instrumental in the development of single-lens LCoS projectors.

In the next installment of this article, in the August issue of *Information Display*, we will continue the chronology and explore how the development of LCOS, DLP, and LCD technologies threatened the dominance of light valves and CRTs as the industry of projection displays took on the period from the 1990s to the 2000s.

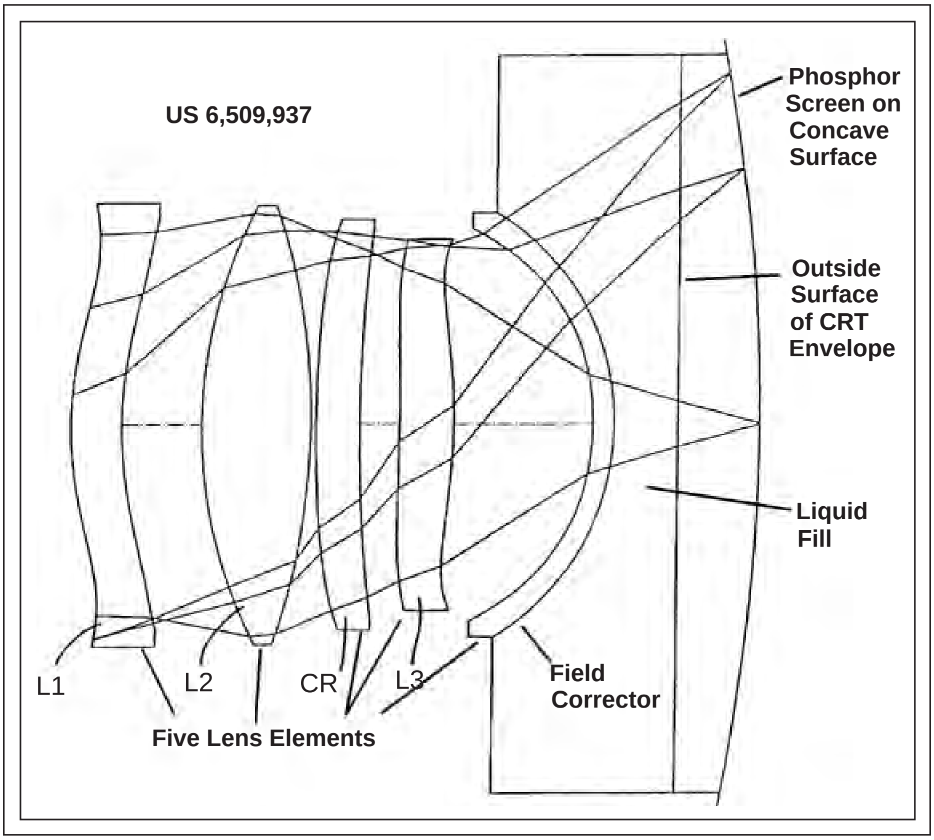

Fig. 11: *High-Performance, Liquid Coupled CRT Projection Lens from U. S. Precision Lens*

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[5] M. Wolf, "The enlarged projection of television pictures," *Philips Technical Review* **2**, No. 8, 249–253 (August 1937). Gain and viewing angle were estimated by MSB by scaling from the drawings in the paper.

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Fig. 12: Hughes/JVC 12K projector used in 1999 digital-cinema tests.

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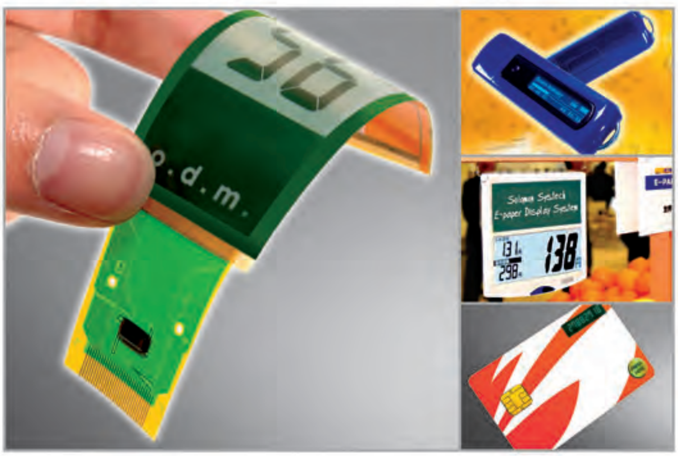
Single chip bistable driver for both cholesteric and electrophoretic displays

Raymond Ho
Solomon Systech Limited

Bistable display is a non-traditional display method. It is a display device illuminated by reflecting ambient light. The image is retained on the display even after the panel power supply has been removed. Bistable display offers paper-like readability, with features such as high contrast, a wide viewing angle, reflective, and readable under sunlight. It is ultra thin and lightweight. Some bistable displays can even be twisted out of shape. Moreover, the system power can be saved by bistability characteristics, since the image remains on display even without power.

Specialized bistable display driver controller SSD1623 developed by Solomon Systech makes these advanced bistable display technologies become a reality. This highly integrated driver consists of MCU interface for command and image data input, display RAM to buffer image data, high voltage driving outputs. To minimize system cost and space, the driver has built-in DC/DC converter to supply high voltage to drive the display. The driver can be applied to different bistable display technologies such as cholesteric and electrophoretic displays since it can generate different driving waveform flexibly according to the requirement of these displays.



Because of the niche characteristics of bistable display: thin, flexible and bistable, with the highly compact and competitive design of SSD1623, bistable display is enabled in applications such as memory devices, IC cards, electronic shelf labels, mobile phones, and timepieces etc.

Dynamic backlight control saves backlight power consumption by up to 50% for portable devices

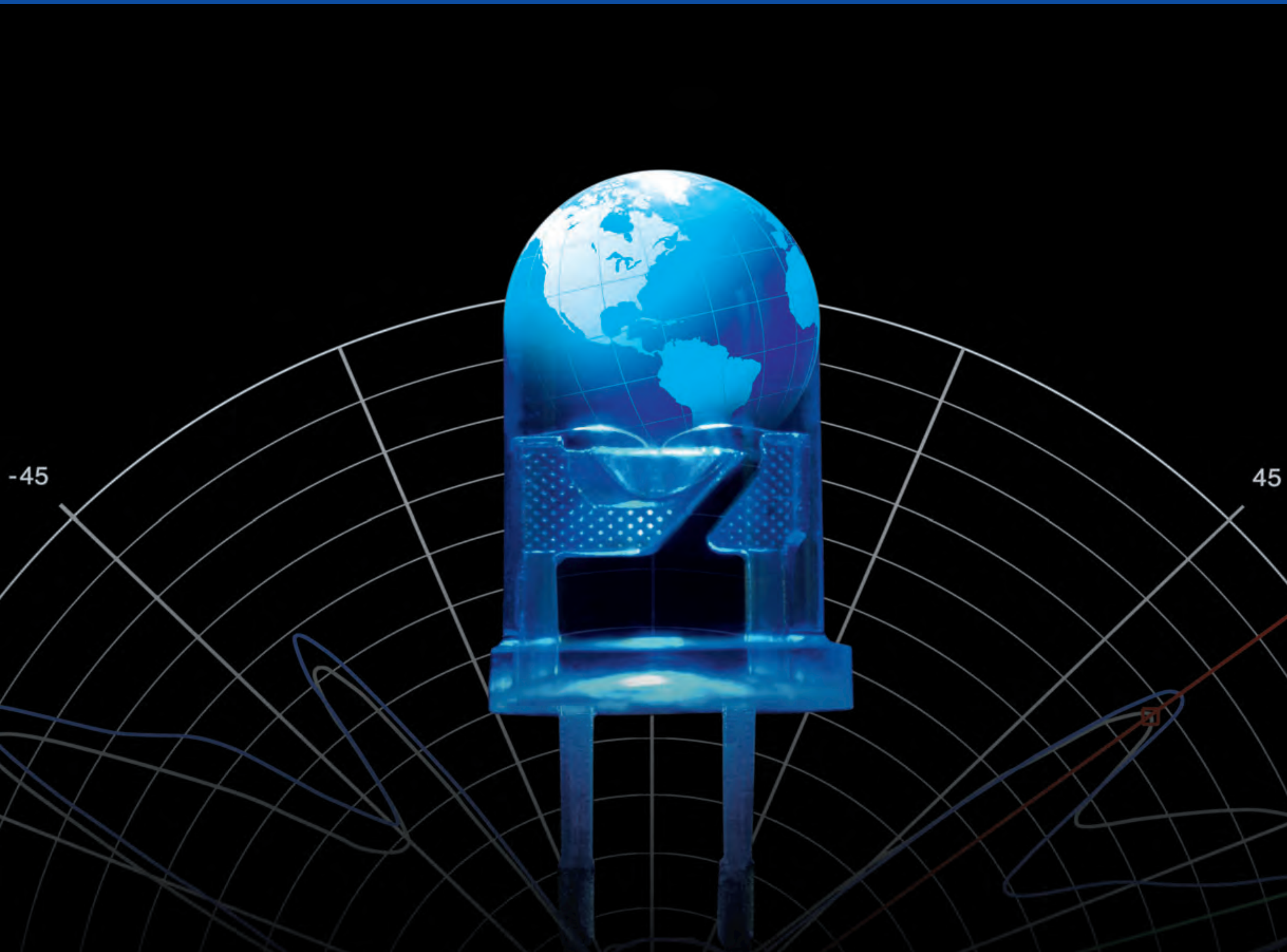
Jacky Chan
Solomon Systech Limited

The dynamic backlight control technology by Solomon Systech is designed to reduce backlight power consumption while maintaining image fidelity and quality. Reducing power consumption is one of the most important tasks for battery-operated portable devices nowadays as small physical size and being lightweight are the general norm. And the backlight is always the most power consuming part in the application. Solomon Systech's driver ICs SSD2118B, SSD2225 with the dynamic backlight control can reduce up to 50% backlight power consumption and bring added value to portable device manufacture without sacrificing the display quality of the end products.

SSD2118B is a highly integrated single chip driver for portable 16-million color Audio Video TFT (AV TFT) displays in landscape QVGA resolution (320x240). It integrates source driver, gate driver and external power chip into a single chip solution. SSD2225 is a high speed interface version of SSD2220, which supports TFT LCD with wQVGA resolution (240x432). For the input pin side, the integrated Mobile Industry Processor Interface (MIPI) on SSD2225 enables high data rate transfer with low EMI and minimized pin count for connection, while at the output pin side to LCD panel, the SSD2225 is made compatible to SSD2220 such that they can share the same LCD panel design.

By deploying Solomon Systech's dynamic backlight control technology, the power consumption of the backlight can be reduced by up to 50% while maintaining the image quality. (a) Without dynamic backlight control; (b) With dynamic backlight control.


The Barcelona® Chair by Knoll, Inc.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Products on Display at Display Week 2008

Some of the products on display at North America's largest electronic-display exhibition are previewed.

by The Editorial Staff

THE SID 2008 International Symposium, Seminar, and Exhibition will be held at the Los Angeles Convention Center in Los Angeles, California, the week of May 18. For 3 days, May 20–22, leading manufacturers will present the latest displays, display components, and display systems. To present a preview of the show, we invited the exhibitors to highlight their offerings. The following is based on their responses.

3M
Saint Paul, MN 651/733-3497
www.mmm.com
Booth 307

Brightness-enhancement films

3M is demonstrating how its Vikuiti™ optical films lower LCD energy consumption by 30% or more. On display will be a 70-W 32-in. LCD TV and a 20-W19-in. monitor that uses only two CCFL bulbs. Visitors can see both LCDs adjacent to identical models with and without Vikuiti brightness-enhancement films. The LCD TV without Vikuiti optical film requires 122 W to deliver equal brightness. The monitor without Vikuiti films requires four CCFL bulbs and 30 W to deliver the same brightness.

3M TOUCH SYSTEMS
Methuen, MA 978/659-9379
www.3M.com/touch
Booth 301

Touch sensors

Touch is becoming the standard interface for mobile devices. 3M Touch Systems and MicroTouch™ TPC1000 touch sensors (formally known as Flex Capacitive) can help bring ideas to reality. 3M's experience in developing button, analog X,Y and multi-touch sensors can help speed new product introductions into the increasingly competitive mobile-handheld-device market. TPC1000's thin touch sensor enables sleeker device formats while index-matching capability maintains the brightness and true color of the LCDs.

AAEON SYSTEMS
Brea, CA 714/671-1800
www.aaeon.com
Booth 655

Human–machine interface

The AOP-8080XT operator panel is an Intel 600-MHz/1.3-GHz processor computer that is designed to serve as a human–machine interface (HMI). It is a PC-based system with an 8.4-in. color TFT-LCD, on-board Ethernet controller, multi-COM port interfaces, and an audio controller. With a built-in CompactFlash socket, the AOP-8080XT is as compact and user friendly as a multi-function computer. In addition, its "fit anywhere" design makes it very flexible and able to be used in many different kinds of installations. It can be wall mounted, panel mounted, or DIN rail mounted.

ABRISA INDUSTRIAL GLASS
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With the addition of the new Ekra X4 fully automated printing system, Abrisa moves into a leading position for display and bus-bar printing. This machine is now installed in our Class 100 clean-room environment to maximize our print-to-packaging efficiency and cleanliness standards. This technology works with an accuracy of ±15 µm @ 4 sigma, ensuring the highest level of precision printing.

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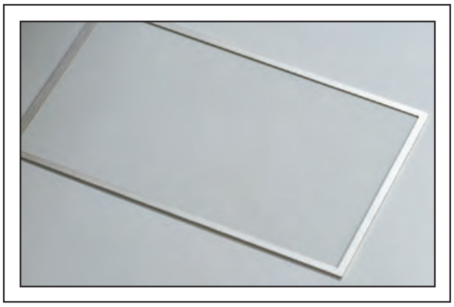

ADHESIVES RESEARCH
Glen Rock, PA 717/235-7979
www.adhesivesresearch.com
Booth 912

Self-wetting adhesives

Adhesives Research offers surface protection films for touch screens and flat-panel displays utilizing the company's self-wetting adhesive optical bonding technology. ARclear® 90854 and ARclear® 90684 are designed to provide temporary protection to the surface of touch screens and flat-panel-display screens in high-use, abusive, or harsh environments, such as mobile phones, MP3 players, and PDAs. The adhesives can be repositioned repeatedly and are cleanly removable, even after an extended period of time and can be diecut to any size. ARclear® 90854 is supplied on a clear hard-coated film and ARclear® 90684 is supplied on an anti-glare hard-coated film.

adt GmbH
Bad Soden, Germany +49-6196-22712
www.arcor.de
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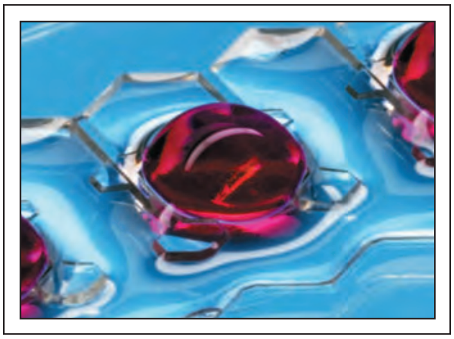
Droplet-driven display technology

The innovative Droplet-Driven-Display (D3) Technology® allows for the fabrication of power-saving bistable diplays of various sizes and resolutions. adt (Advanced Display Technology Group) has developed this new display technology using electrowetting function principles. The D3-Displays® offers unique features such as variable pixel sizes of 0.1 mm up to 10 mm, paper-like optical and color properties, high reflectivity, and reflective as well as transflective structures. The total bistable characteristic in combination with the highest temperature tolerance (from <–40°C up to +100°C without any temperature control) offers benefits for various applications, even for single-pixel indicators.



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Thin-film deposition

Organic Vapor Phase Deposition (OVPD®) technology is an innovative technology for the thin-film deposition of small-molecule organic materials. It utilizes the advantages of gas-phase deposition, where the materials are transported to the substrate by an inert carrier gas. Aixtron combined its proprietary Close Coupled Showerhead™ (CCS) with the OVPD® technology to accommodate mass-production requirements. In collaboration with UDC, Aixtron has developed and qualified OVPD® production tools addressing the requirements of OLED manufacturing.

APPLIED CONCEPTS
Tully, NY 315/696-6676
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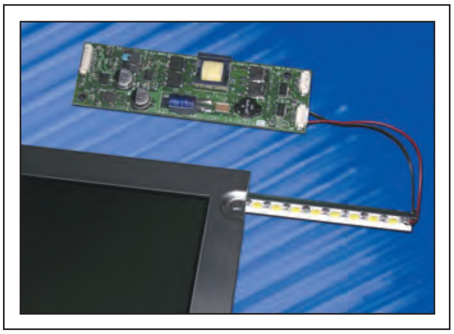
Booth 539

LED-backlight solutions

Applied Concepts will be showcasing their turnkey-engineered LED-backlighting solutions for LCD panels ranging in size from 6.4 to 20.1 in. on the diagonal. A new line of LED-backlit LCDs, which are sunlight readable for daytime use, and also offer NVIS capability, will be introduced. These edge-lit LED solutions offer at least a 2:1 improvement over stock CCFL backlights for panels up to 18 in. on the diagonal, which means that system designers can expect to double the brightness for the same amount of power consumed.



ARIZONA STATE UNIVERSITY FLEXIBLE DISPLAY CENTER
Tempe, AZ 408/727-8936
www.flexibledisplay.asu.edu
Booth 928

Integrated technology demonstrators

General-purpose integrated technology demonstrators for the military utilizing low-power flexible-display technology, including the Soldier Flex Personal Digital Assistant (SF-PDA) produced with InHand Electronics and FDC member E Ink, and the Mission Briefer produced with FDC member General Dynamics. Both demonstrators incorporate high-performance daylight-to-moonlight–readable 3.8-in. QVGA electrophoretic displays fabricated using FDC's low-temperature a-Si:H TFT pilot-line process and E Ink's Vizplex imaging film. The combination of the intrinsically rugged low-power display with system-level electronics design and effective power management results in dramatic decreases in size, weight, and power (SWaP) compared to situational-awareness military products currently available.

ASTRI

Hong Kong Science Park, Shatin, Hong Kong
+852-340-62470
www.astri.org
Booth 856

High-dynamic-range LCDs

By combining an LED backlight with 2-D RGB-adaptive local-dimming algorithm technology, ASTRI has fabricated product prototypes with wide color gamut, high brightness (>2000 nits), high contrast (>100,000:1), and power savings. This development is targeted for LCD-TV and the public-information-display market.

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www.astro-systems.com
Booth 601

Programmable video signal generator

The Astro VG-870 is the newest addition to our distinguished line of video generators. The VG-870 is a standalone 2U-sized generator with a modular design (three slots) for a variety of interface options, such as HDMI, DVI, LVDS, DisplayPort, and more. This unit supports HDMI Version 1.3a, which includes Deep Color (max 12 bit), xvYCC, LipSync, and High Bit Rate Audio. This expandability of the VG-870 will provide support of future interface and signal standards as well as future functions. The high-speed drawing processor supports Deep Color RGB (16 bit each) and ultra-high resolution up to 330 MHz with an optional upgrade.

AU OPTRONICS CORP.

Hsinchu, Taiwan 281/807-2630
www.auo.com
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In-cell multi-touch panels

AUO has launched two 4.3-in. multi-touch technologies: Voltage-Sensing and Charge-Sensing types. AUO's in-cell multi-touch technologies integrate touch-function features into the TFT-LCD manufacturing process without adding additional glass, and thus are able to retain a thickness of 2.2 mm – thinner than conventional touch-panel applications. Also, they both have superior anti-glare properties to retain proper image color saturation and readability under sunlight conditions. Targeted to enter mass production in mid-2008, the two newly introduced AUO in-cell multi-touch panels are claimed to be the world's first mass-produced in-cell multi-touch panels.

AUTRONIC-MELCHERS GmbH

Karlsruhe, Germany +49-72-1962-6462
www.autronic-melchers,com
Booth 329

Colorimeters

Conoscopic systems are colorimeters that capture the complete viewing-angle range in a single image. The ConoScope features a color (measurement) camera with a conoscopic lens for ultra-rapid measurement, requiring less than 1 sec to perform a full-viewing-cone measurement for luminance and color up to a viewing angle of 88°. A further benefit of this combination of color camera and conoscopic lens is the "live preview," a real-time display of the color and luminance for the complete viewing cone. Further unique features include switching time and gray-to-gray measurement using an integrated photomultiplier. The diffuse reflective illumination enables full-viewing-angle characterization of reflective displays. The unique focal-plane stage features BRDF measurement and provides an interface for spectro-radiometer connection.

AXOMETRICS

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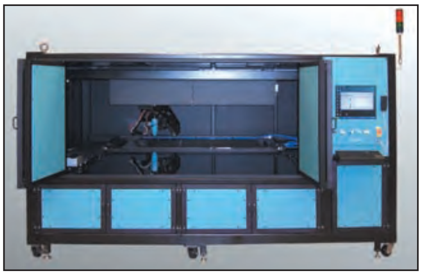
Booth 354

Panel mapper

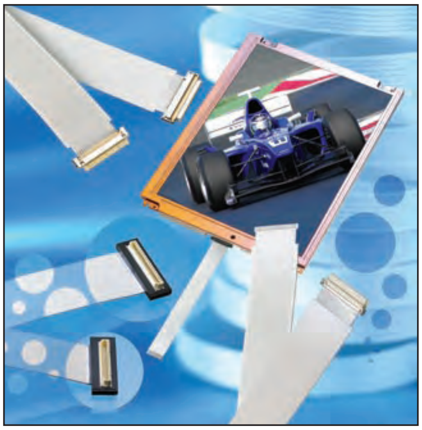
Axometrics's new high-speed AxoScan™ Panel Mapper (APM-60H) completely characterizes any type of LCD panel (TN, STN, VAN, IPS, OCB, *etc.*) up to 60 in. on the diagonal, providing measurements for cell gap, twist-angle, rubbing direction, and front and back pre-tilt angles. The APM measures the complete polarization properties (full Mueller Matrix) of the panel while adjusting the XY coordinates, azimuth angle, polar angle, and spectral wavelength. These measurements are then used by Axometrics's patented LCDView™ software to quickly and accurately calculate the panel's parameters. In addition to LCD panels, the polarization properties of other materials may be measured, including polarizer films and retarder films (A-plates, O-plates, and c-Plates).



AXON' CABLE
Schaumburg, IL 847/230-7800
www.axoncableusa.com
Booth 471

Shielded cables for flat displays

Axon' Cable adds shielded assemblies for LVDS interfaces to its line. Named AXOLINK®, these flat cable assemblies include DF-19 (Hirose) and FI/FI-X (JAE) connectors. Other connector types are also available. The shielding is carried out with a ground plane grounded on the connector, thus assuring a constant impedance of 100 Ω for a very stable picture transmission. These cables are able to work at up to 1 Gbit when terminated with the appropriate connectors.



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Burn-in chamber

The BigByte BB-2000 burn-in chamber provides continuous closed-loop monitoring of both temperature and humidity, providing accurate control of the internal environment. Temperature and relative humidity are measured, displayed, and controlled. Rapid heat-up and recovery times and precise humidity control are achieved with a digitally controlled dual-element ducted system. Intelligent power distribution maximizes efficiency and assures that the desired temperature is held. Low-water sensors and low-temperature alarms assure that the cabinet is performing safely.

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www.botest.com
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The OLED Lifetime Test System (OLT) is a test system designed for advanced lifetime testing of OLEDs. Each device under test is controlled and monitored independently. This allows for the simultaneous operation of a large number of devices with maximum flexibility in test conditions. The OLT measures electrical and optical device characteristics. The most important OLED performance parameters are directly calculated. Fitting and extrapolation of the time dependence of the device characteristics is possible at any time during test. Furthermore, system calibration allows the measurment of absolute luminance and color coordinates. Each OLT is customized with respect to device size, device layout, system configuration, *etc.*, to best match the customers' testing needs.

BREAULT RESEARCH ORGANIZATION (BRO)
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www.breault.com
Booth 1000

Optical design program

BRO's ASAP(r) is the leading optical-design program combining geometrical and physical optics with full 3-D models of optical and mechanical systems. Over 20 years of continuous development allows ASAP to simulate the actual physics of more optical systems than any other program available. ASAP is the time-proven industry standard in optical software, offering optical-system designers unmatched capability, flexibility, speed, and accuracy. ASAP accurately predicts the real-world performance of automotive lighting, bio-optic systems, coherent systems, displays, imaging systems, lightpipes, luminaires, medical devices, and other systems.

BRITEVIEW TECHNOLOGIES
Holland, OH 419/868-7290
www.briteview.com
Booth 244

Dual-mode backlight

BriteView's backlight system uses a beam expander and a light guide to achieve dual-mode illumination using LEDs as the light source. In this backlight, only two LEDs are used for NVIS-mode operation. With this novel backlight system, a uniform illumination is maintained even when one of the two LEDs for the NVIS-mode failed. This backlight can also provide a reasonably uniform illumination even when some of the LEDs for the day mode failed. With a single light guide to provide the dual-mode operation, this backlight is compact and highly efficient.

CALIFORNIA MICRO DEVICES CORP.
Milpitas, CA 408/934-3108
www.cmd.com
Booth 359

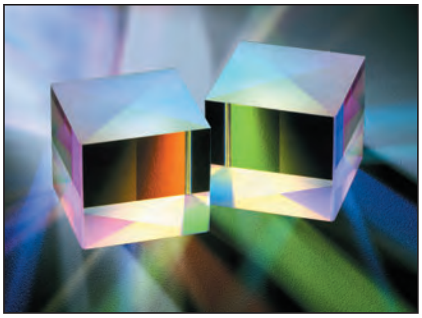
Dual display and auto controller

CMD's dual display and audio controller for wireless handsets incorporates the VESA Standard Mobile Display Digital Interface link, fully compatible with Qualcomm's MSM™ chipset solution. The CM5100 features a fully compliant, MDDI-based serial client, an integrated display controller with embedded memory that supports primary TFT-LCDs with resolutions up to QVGA, and secondary displays with up to QCIF+ resolution. Its unique architecture is optimized for use with today's most advanced TFT-LCD modules that feature drivers integrated directly on the display glass, and also allows the use of low-cost RAM-less drivers for non-integrated display modules.

CASIX
Atherton, CA 650/575-9650
www.casixca.com
Booth 828

Polarizing beamsplitters

Casix will feature its polarizong beamsplitters, in addition to light pipes and a variety of other optical components for display-system applications. The beamsplitters are available in BK7, SF1, SF2, SF6, SF57HHT, and PBH56, or the equivalent in sizes up to 40 mm. The beamsplitters are available in a dimension tolerance of ±0.2 mm, with a surface quality of 60–40 scratch and dig. Custom prisms, optics, and glass components are also available.



CHI MEI OPTOELECTRONICS CORP.
Tainan, Taiwan +886-2-2545-7290 x213
www.cmo.com.tw
Booth 619

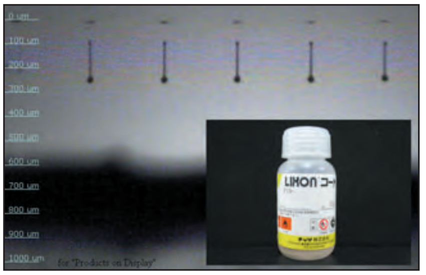
Image-quality solution

CMO's HyperChameleon technology provides the optimal solution for the image quality of LCD TV. This novel design, which combines the signal processing and a locally dimming backlight, can achieve an ultra-high dynamic contrast (100,000:1) and extremely low power consumption (30–70% of the conventional one). By controlling the RGB color individually, the HyperChameleon can greatly enlarge the dynamic color gamut (160% of NTSC) and obviously improve the viewing-angle characteristics (omniview contrast and omniview color). The application of this technology will definitely be the most important trend in LCD technology.

CHISSO CORP.
Tokyo, Japan +81-3-3243-6090
www.chisso.co.jp
Booth 268

Ink-jet inks

Chisso Corp. will introduce functional ink-jet inks. Chisso provides thermal curable polyimide ink used for printed-circuit board and semiconductor packaging. Chisso's polyimide ink, "PIN series," has a high concentration 25–60%, and excellent dielectric properties. The dielectric strength is more than 100 V/µm. Chisso also provides UV-curable ink-jet inks for etching resist, protective coat, insulating film, LCD spacers, *etc*. Chisso's UV-curable ink, "PMA series," is solvent-free, and features high sensitivity and high thermal resistance.



CHROMA ATE
Irvine, CA 949/421-0355
www.chromaus.com
Booth 552

Programmable video pattern generator

Chroma's 22293 video pattern generator (VPG) provides a total solution for multimedia tests on digital and analog displays, such as LCM monitors, LCD TVs, PDPs, and projectors. Considering product quality and cost to meet demands, the 22293 VPG was built to cover the most complete multimedia test interfaces for all standard signals output and can meet the requirements for various video tests in the industry. The 22293 supports full-HD 1080p, HDMI 1.3, HDTV, CEC, 36-bit True Color, xvYCC, and much more. It is a reliable, flexible, and a powerful solution for the users in the field of RD, production, and product inspection.

Submit Your News Releases
Please send all press releases and new product announcements to:

Michael Morgenthal
Information Display Magazine
411 Lafayette Street, Suite 201
New York, NY 10003
Fax: 212.460.5460
e-mail: press@sid.org

CI LUMEN INDUSTRIES
Hauppauge, NY 631/231-1246
www.ci-lumen.com
Booth 712

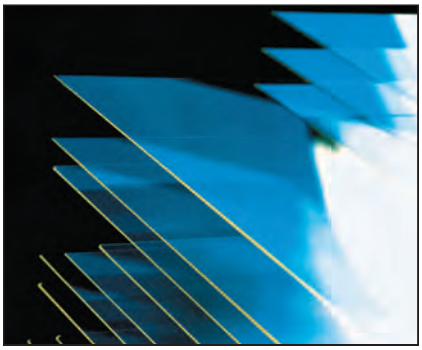
Signage system

CI Lumen is introducing the Touch-Enabled All-In-One™, the latest in digital sign technology. The All-In-One™ provides a slim-line large-format design that is only 4 in. deep, has a powerful built-in computing platform, and MicroTouch™ DST touch from 3M. This ultra-intelligent signage system includes an Intel dual-core processor, the Intel 945GM graphics chipset, 20-GB RAM, SATA hard drive, and XP Pro O/S. The MicroTouch™ DST technology enables touch performance unaffected by on-screen contaminants and moderate surface damage. The response is faster, more accurate, and far more reliable than other touch technologies and ignores static objects on the screen.

CORNING INCORPORATED
Corning, NY 607/974-4345
www.corning.com
Booth 635

Specialty glass and ceramics

Corning will feature specialty glass and ceramics. From large-sized glass to the industry's first environmentally friendly glass substrates, Corning's contributions have been essential to the growth of the display industry. The company continues to be at the forefront of new product development for emerging technologies, such as silicon-on-glass, a low-temperature polysilicon glass composition, a hermetic sealing solution to improve OLED lifetime, strengthened cover glass for touch-screen devices and high-end portable applications, and green lasers for micro-projection devices.



CreaPHYS GmbH
Reinhardtsgrimma, Germany +49-35-0461-0263
www.creaphys.com
Booth 101-3

Organic molecular evaporators

CreaPhys's organic molecular evaporators are designed for use in R&D or small-series production and may be applied in high- and ultra-high-vacuum assemblies to deposit organic molecular compounds by thermal physical vapor deposition. The temperature- and rate-controlled power supplies are available and allow, in combination with the high-grade crucibles, a highly stable and reproducible deposition process which meets the demands of advanced co-evaporation technologies. Various options such as integrated shutter or multiple-source assembly and the availability of different crucibles designed for quick and easy replacement make them a flexible tool for OLED manufacturing.

DARK FIELD TECHNOLOGIES
Orange, CT 203/925-8581
www.darkfield.com
Booth 501

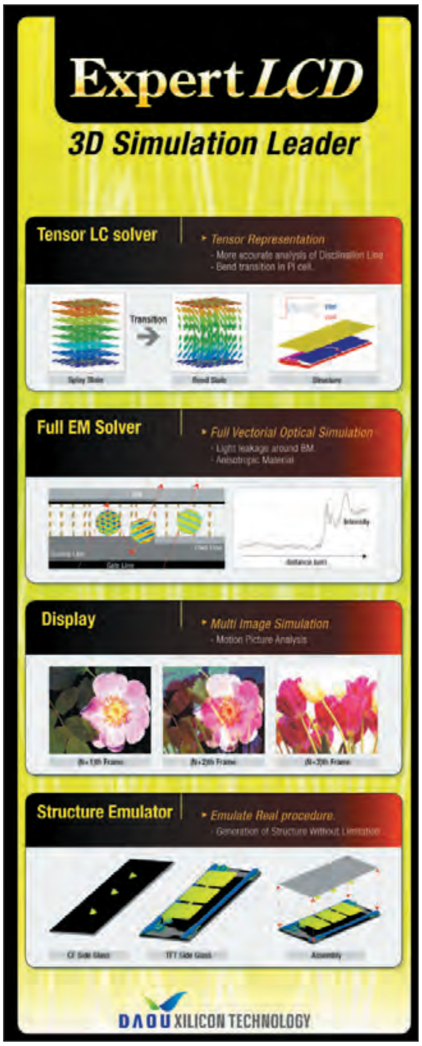
High-resolution laser inspection system

Dark Field/Jenoptik have developed and proven telecentric laser inspection systems, which deliver multiple optical channels in an optically elegant system. A single-laser scanner provides a spot of laser light that scans the film or glass, at a constant angle (telecentric scanning). All critical optical information is extracted from the transmitted and reflected beams concurrently. This means that all information extracted from the product is spatially coincident; no other system can deliver this performance. This technology has been proven in a wide array of inspection applications including brightness-enhancement films, polarizing films, *etc.*

DAOU XILICON TECHNOLOGY CO.
Gyeonggi-do, Korea +82-19-9159-7966
www.dauxilicon.com
Booth 1002

LCD simulation

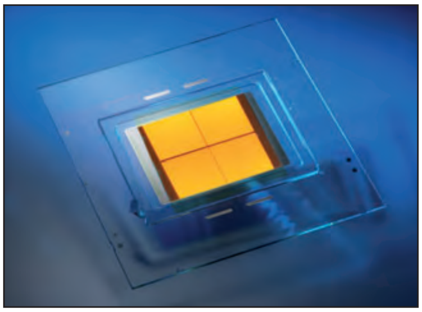
ExpertLCD provides a complete physically based simulation environment. It can estimate not only liquid-crystal dynamics and optics but also electrical properties of liquid-crystal displays. Commercial liquid-crystal modes such as TN, IPS, FFS, MVA, ASV, PVA, and OCB can be analyzed and modeled. Recently, several functions have been developed, such as full electromagnetic solver for analyzing light such as around a black matrix, a tensor solver for OCB, full-screen simulation for multi-image, and structure emulator for real LCD fabrication.



DELO INDUSTRIAL ADHESIVES
Windach, Germany +49-8193-9900-0
www.delo.de
Booth 148

Adhesives for the sealing of OLED displays

DELO Industrial Adhesives has recently developed highly efficient OLED sealants. OLEDs consist of a self-lighting array of semiconducting layers, which in turn consist of organic substances reacting sensitively to humidity and oxygen. Therefore, the component is encapsulated between two glass plates. For this purpose, light- or UV-curing adhesives with an extremely low permeation for oxygen and humidity are used. Furthermore, the adhesive adheres to glass and is suitable for fast and automated high-volume processes. The reason is that OLED encapsulation compounds do not require thermal postbaking but are cured by light, resulting in short processes and cost savings.



DELTA
Hoersholm, Denmark +45-20-90-53-37
www.delta.dk/icam
Booth 1035

2-D colorimeter

Delta's ICAM is a filter-based high-accuracy 2-D colorimeter that measures absolute color and luminance on both still images and moving images. Parameters such as uniformity in color and luminance, contrast ratio, color gamut, and mura effects are measured at a glance. Apart from flat-panel displays, the ICAM is useful in many display-related industries such as CCFFL, FFL, LED backlight, front and rear projection, LED-sign calibration, *etc.* DELTA has specialized in the design and manufacture of optical thin-film coatings. The complex filters consist of different thin layers (down to 6 nm) in one coating.

DIALOG SEMICONDUCTOR
Swindon, U.K. +44-7788-104-624
www.diasemi.com
Booth 1004

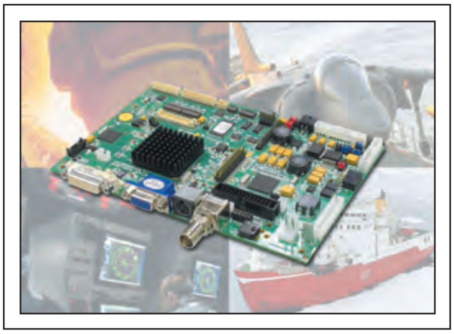
Series display drivers

Dialog Semiconductor will demonstrate the capabilities of its new SmartXtend™ technology that enables QVGA/WQVGA resolutions using passive-matrix OLEDs in the primary displays of mobile devices. In addition to its innovative design techniques, this new technology provides significant benefits over active-matrix OLEDs and LCDs in terms of cost, power consumption, video quality, and performance. Also on show are its driver ICs for advanced displays in ultra-low-power mobile applications. These highly integrated mixed-signal high-voltage CMOS solutions include the DA852x series, optimized for delivering high performance in a small package to support E Ink electronic-paper displays.

DIGITAL VIEW
Morgan Hill, CA 408/779-5804
www.digitalview.com
Booth 737

Harsh-environment LCD Controller

Digital View's new HE-1920 is a fully buffered multi-sync interface controller that provides analog and digital connections for large-format high-definition TFT-LCDs plus wide operating temperature and voltage ranges, heightened shock and vibration tolerance, and conformal coating for extreme environment applications. The latest in Digital View's new HE Series of COTS LCD controllers designed to comply with the strict standards required for the harsh environments encountered in military and rugged industrial applications, the HE-1920 is designed to aid manufacturers building hardened panel display systems requiring advanced capabilities such as high resolution and high definition.



DOLBY LABORATORIES
San Francisco, CA 415/645-5000
www.dolby.com
Booth 753

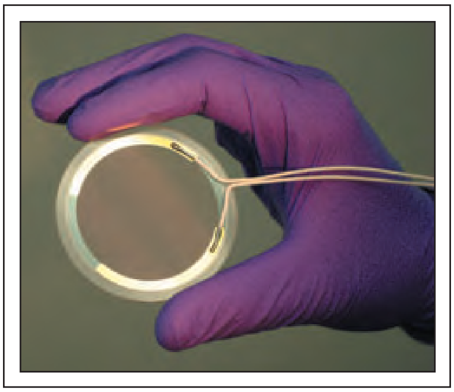
HDR-enabled LCD

Dolby Laboratories and SIM2 Multimedia have developed a prototype high-dynamic-range (HDR) enabled LCD flat-screen display using Dolby's new light-emitting diode (LED) local-dimming technology. Dolby's HDR technologies utilize the capabilities of LED-based backlight units (BLUs) to provide outstanding contrast combined with crisp brightness to deliver picture quality that matches real-world visual perception of depth, detail, and color. SIM2 designed and developed the BLU, which drives the electronics of the LCD plus the BLU and BLU thermal management system.

DONTECH
Doylestown, PA 215/348-5010
www.dontechinc.com
Booth 259

Transparent heaters

Dontech Therma Klear™ transparent heaters provide the warmth necessary to extend the operating temperature of LCDs in cold environments (*e.g.*, from 0° to below -40°C) and for the anti-fog, anti-icing, and de-icing of optics and optical displays. A Therma Klear heater is composed of an electrically conductive thin-film coating on a visually transparent substrate. When current flows across the coating, it generates heat. Dontech manufactures heaters using different types of crystalline materials (*e.g.*, zinc sulfide or germanium), glass, acrylic, and polycarbonate substrates. Applications include avionic displays, vehicle displays, mobile computers, kiosks, and handheld devices. Custom shapes are available in sizes up to 42 in. on the diagonal.



DR. SCHENK OF AMERICA
Woodbury, MN 651/730-4090
www.drschenk.com
Booth 201-5

Flat-panel inspection system

Dr. Schenk's Flat Panel Inspection System "Chess" is a high-resolution modular optical system designed for the inspection of sheet-to-sheet panels, including glass substrates, PDP glass, coated glass, color filters, OLEDs, array structures, and rear-projection screens. Chess is used worldwide in a wide range of applications for the information-display, medical, and architectural industries. A variety of resolution ranges is available to respond to customer-specific manufacturing and inspection requirements. Chess systems can be used either in-line, fully integrated into automated production lines, or off-line as stand-alone systems with integrated handling. Chess systems are accurate, highly reliable, and maintenance-free with repeatable defect detection, fast cycle time, and real-time data processing.

DUPONT MICROCIRCUIT MATERIALS
Research Triangle Park, NC 1-800-284-3382
www.mcm.dupont.com
Booth 119

Thick-film metallization advancements

DuPont Microcircuit Materials will showcase the new DuPont™ Fodel® 8th generation (8G) photo-imageable thick-film paste that is used in the metallization of PDP front bus electrodes to achieve enhanced image quality in large-sized full-HDTVs. Made without costly ruthenium (Ru) metals, Fodel® 8G enables PDP manufacturers to compete more cost effectively with LCDs. DuPont™ Transfer Materials Technology (TMT) is a high-precision photolithographic patterning technology for the metallization of PDP substrates. This process allows imaging of conductor lines and spaces down to a breakthrough resolution of 20 µm.

DYOPTYKA
Dublin, Ireland +353-87-298-3418
Wwwdyoptyka.com
Booth 108

Reduction of laser speckle in projection displays

Dyoptyka has developed a groundbreaking solution for the reduction of laser speckle in projection displays. The technology can achieve speckle contrast ratios close to 0% with minimal light losses and very low power consumption. At SID 2008, a comprehensive evaluation kit containing all control electronics, optomechanical components, characterization data, and documentation will be introduced. The kit also contains reference designs for a variety of illumination systems (fly's eye, integrator tunnel/rod, and holographic beam shaping) for common microdisplay technologies (DMD/DLP, LCOS, and HTPS/3LCD).

eGALAX_eMPIA TECHNOLOGY (EETI)
Taipei, Taiwan +886-2-2698-0110
www.eeti.com
Booth 1010

Touch-screen controllers

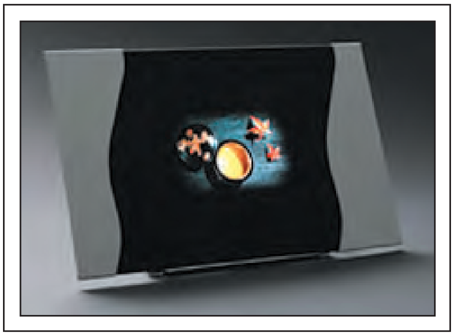
EETI specializes in touch-related solutions since 2000 and provides the most completed spectrum of product lines from a hardware and software perspective, including resistive touch-screen controllers, capacitive touch-screen controllers, surface-acoustic-wave touch-screen controllers, surface-acoustic-wave touch screens (8.4–21 in., customized), infrared touch screens, projected capacitive touch-screen controller ICs. The OS includes Windows, Linux, Mac, DOS, and QNX.

Submit Your News Releases
Please send all press releases and new product announcements to:
Michael Morgenthal
Information Display Magazine
411 Lafayette Street, Suite 201
New York, NY 10003
Fax: 212.460.5460 e-mail: press@sid.org

EPSON ELECTRONICS AMERICA
San Jose, CA 408/576-4457
www.eea.epson.com
Booth 819

OLED display system

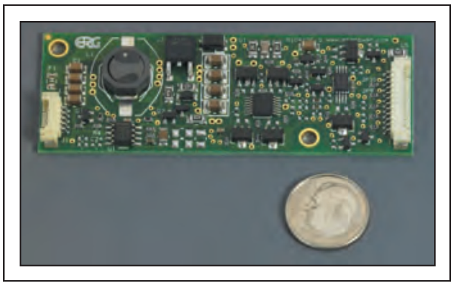
Seiko Epson Corp. (Epson) is showing its new OLED display system for the first time in the U.S. at SID 2008. The new OLED display system is capable of producing "the ultimate black," and makes effective use of advanced image representation not possible with conventional flat-panel displays. Having resolved the longstanding problem of achieving long life for OLEDs, Epson has now put into operation a manufacturing line for small-scale production of the technology for practical application.



ENDICOTT RESEARCH GROUP
Endicott, NY 607/754-9187
www.ergpower.com
Booth 343

Economical low-profile LED driver

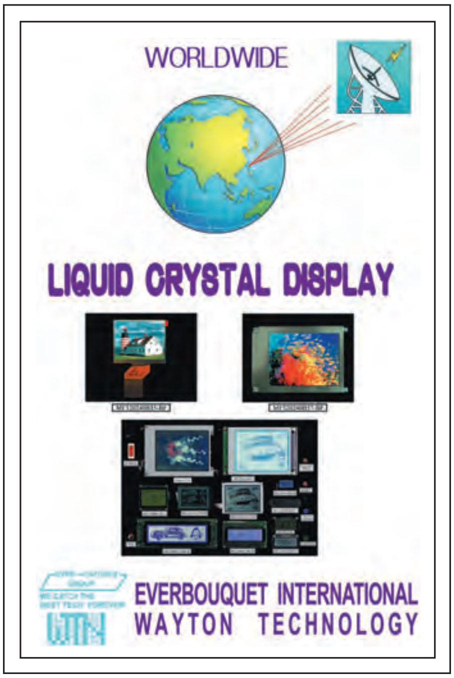
The new Smart Force™ SFDE LED backlight driver from ERG is a high-efficiency driver board with an extremely low profile (< 5 mm high). It provides brightness stability over a wide input voltage (8–18 V), with external PWM dimming to 500:1. The SFDE driver board provides a plug-and-play solution with an outstanding cost/performance ratio for powering LED BLUs in LCDs up to 15 in. on the diagonal. It is compatible with virtually all OEM LED-backlit panels and can also be used with ERG's Smart Force™ LED rails, which utilize a proprietary ERG design to provide thermal management superior to any other technology on the market.



EVERBOUQUET INTERNATIONAL CO.
Taipei, Taiwan +866-2-2633-1253
www.everbouquet.com.tw
Booth 1005

LCDs

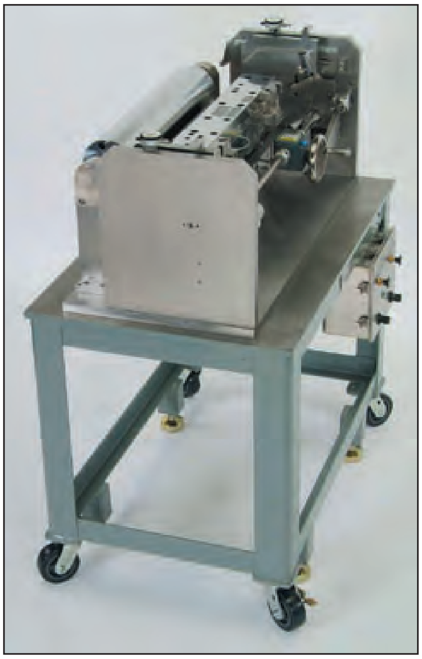
Everbouquet/Wayton has been a leading worldwide supplier of medium- and small-sized standard, custom, and semicustom LCDs, including TFT, STN, FSTN, TN, HTN, *etc.*, for 16 years and is ISO certified. Everbouquet/Wayton's TFT-LCD module range includes a wide variety of options, with diagonal screen sizes between 1.5 and 5.7 in. Devices are available with three color depths: 65,000, 262,000, and 1.67 million. All of the modules boast high contrast (typically 200:1, but in some cases up to 250:1) and brightness levels (up to 380 cd/m^2 for the 5.7 in module).



EXTRUSION DIES INDUSTRIES
Chppewa Falls, WI 715/726-1201
www.extrusiondies.com
Booth 142

Coating system

A Liberty coating system typically includes a slot die, positioning support, and fluid-delivery pump. While the lips of the die are integral with the die bodies and thus fixed, operators can vary product thickness and width by means of shims that change the dimensions of the slot gap. Liberty's WetWare™ system combines die, positioner, pump, and ancillary components into a module that can be shipped to a customer or prospect for on-site slot-die coating trials on actual production lines.



FIVE STAR TECHNOLOGIES
Independence, OH 216/447-8498
www.fivestartech.com
Booth 661

Inks and pastes

ElectroSperse™ inks and pastes from Five Star Technologies feature exceptional printability, low firing temperatures, high levels of conductivity, strong adhesion to a variety of substrates, and RoHS compliance. D-120 series grades offer exceptionally low firing temperatures (380–400°C), enabling users to achieve better ITO resistance stability and extend product life cycles. D-130 series pastes offer similar advantages in a lead-free RoHS-compliant system. ElectroSperse grades can be tailored for a range of processing techniques, including screen, gravure, extrusion, and ink-jet printing. Targeted applications include electrodes, interconnects, and linearization patterns for displays, photovoltaic front-side contacts, and hybrid microcircuits.

FUJI ELECTRIC ADVANCED TECHNOLOGY COMPANY
Nagano, Japan +81-2-6326-6415
www.fujielectric.co.jp
Booth 272

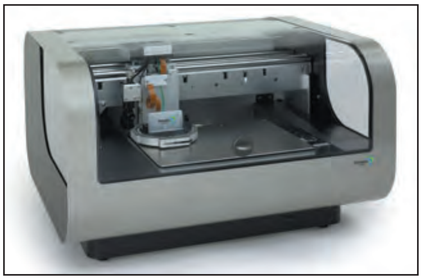
OLED panels

Fuji Electric Advanced Technology Co. is a research and development company of Fuji Electric Group. OLED panels made by a simple method applicable to medium- and large-sized substrates of a top-emission-type TFT substrate, on which organic layers are evaporated without the use of metal masks, and an ink-jet printed Advanced Color Conversion Materials substrate are connected to each other. Full-color 2.8-in. QVGA (240 × 320) AMOLEDs, which employ pure-blue-emitting OLEDs driven by a-Si TFTs to achieve an NTSC gamut ratio of 100 % and a wide viewing angle of 120°, will be demonstrated.

FUJIFILM DIMATIX
Santa Clara, CA 408/565-0670
www.dimatix.com
Booth 268

Materials printer

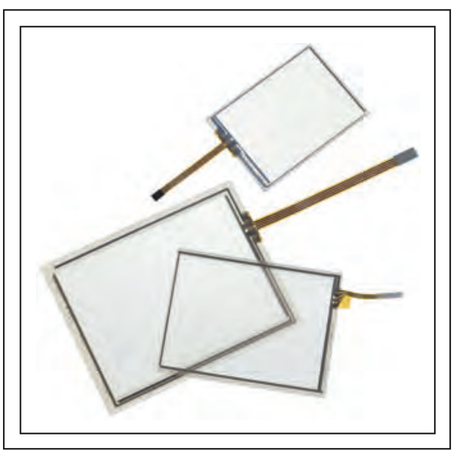
The FUJIFILM Dimatix Materials Printer (DMP) has been accepted as the industry standard for the accelerated development of ink-jet solutions in electronics, displays, life sciences, and other industries. It is a cost-effective easy-to-use tool that can be utilized for the development of test processes, from materials used in flexible circuits, RFID tags and displays to materials used in bioarrays and wearable electronics. This printer enables the precise deposition of fluids with a disposable piezoelectric ink-jet 1- or 10-pl cartridge. New materials and products are brought to market faster and at a significantly lower cost because of the DMP.



FUJITSU COMPONENTS AMERICA
Sunnyvale, CA 408/745-4924
www.us.fujitsu.com
Booth 701

Resistive touch panel

Fujitsu's new FID-533 is a rugged Film-Film-Plastic resistive touch-panel series designed for use with typical LCDs in a variety of mobile applications. These panels feature a durable and rigid plastic support sheet in place of a glass substrate. The Film-Film-Plastic touch panels provide reliable operation down to –20°C and up to 60°C and are sealable to the IP67 level, making them ideal for devices that must withstand a wide range of environmental use. With Fujitsu's proprietary coatings applied, the 2-mm-thick Film-Film-Plastic touch panels offer 85% typical transmissivity and are rated at 1,000,000 operations.



G2D TECHNOLOGIES
Owasso, OK 918/272-4710
www.g2dtech.com
Booth 1109

Direct optical bonding

G2D Technologies teaches manufacturers to bring the Direct Optical Bond process in-house. The G2D Direct Bond process is currently in use in North America and Asia. Customers are typically at full production in 6 months or less. The soft bond process is guaranteed to never crystallize or yellow and can be used with a LCD-to-glass gap as small as 0.5 mm. The G2D process is re-workable to eliminate scrap.

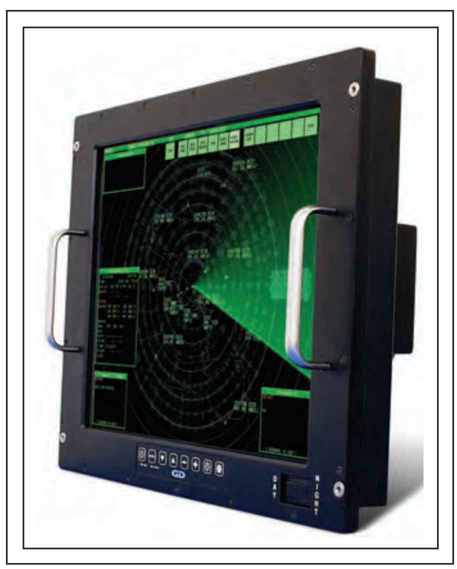
For daily display industry news, visit

www.informationdisplay.org

GENERAL DIGITAL CORP.
South Windsor, CT 860/282-2900
www.generaldigital.com
Booth 801

Chassis monitor panel mount

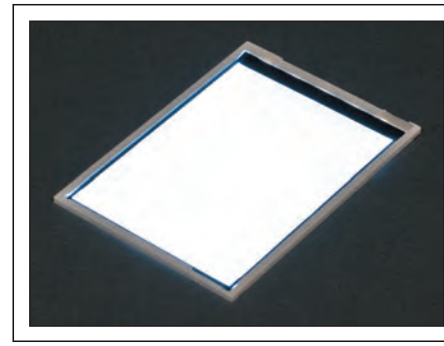
General Digital's innovative thinking takes a standard LCD monitor to new heights in two ways. First, to achieve sunlight readability, a revolutionary technology was incorporated: a mercury-free all-LED backlight, which puts out 700+ nits of luminance and reduces power consumption. Second, in addition to a beefy 0.59-in. front bezel and a military-grade power connector, the night-vision-goggle compatibility meets MIL-STD-3009 requirements. Also, this unit is designed with the intent to meet MIL-STD-901D, as well as numerous other military requirements.



GLOBAL LIGHTING TECHNOLOGIES
Brecksville, OH 440/922-4584
www.glthome.com
Booth 449

New ultra-thin LED-based backlight

Global Lighting Technologies (GLT) has introduced new LED-based high-brightness backlights that offer exceptional thinness (to 0.4 mm), providing the slimmest molded light-guide BLUs available for backlighting the LCDs and keypads/keyboards used in mobile phones and laptop and desktop PCs. GLT's patented MicroLens™ light-extraction technology and improved manufacturing processes are making light-guide packages less than 0.5 mm high a reality for OEMs who need to meet the increasing consumer demand for smaller, thinner size with no sacrifice in performance.



GRAFTECH INTERNATIONAL
Lakewood, OH 216/529-3714
www.graftech.com
Booth 1022

Thermal-management solution

eGRAF® thermal solutions offer a unique combination of flexibility, weight savings, and performance improvement to the electronic thermal-management industry. Made from natural graphite, SPREADERSHIELD™ products distribute heat evenly while providing thermal insulation through the thickness. Engineered thermal conductivity up to 500 W/m-K. This unique combination of spreading and shielding properties make natural graphite an excellent material choice for PDPs, LCDs, or OLED display thermal solutions.

H. C. STARCK GmbH & CO. KG
Leverkusen, Germany +49-21-4307-2626
www.hcstarck.com
Booth 201-3

Conductive polymers

H. C. Starck will present PEDOT:PSS materials, sold under the name of CLEVIOS™ (formerly known as Baytron®) for use in printed electronics and OLED applications. New touch screens can use formulations based on high-conductive CLEVIOS PH500 rather than using conventional materials such as ITO. Backplanes for flexible electronics can also use CLEVIOS as an electrode. H. C. Starck will also introduce new HIL materials for use in OLED applications.

HITACHI ELECTRONIC DEVICES USA
Lawrenceville, GA 770/409-3020
www.hedus.com
Booth 1009

WVGA TFT display

Hitachi Electronic Devices USA is pleased to introduce a new 8-in. WVGA (800 × 480) TFT display with In Plane Switching (IPS) technology, high-brightness LED backlighting (625 nits), and a superior contrast ratio of 1000:1. The panel is rated for a wide temperature range of -40–85°C. Market focus for this panel will be the automotive and industrial markets.

INSTEC
Boulder, CO 303/444-4608
www.instec.com
Booth 150

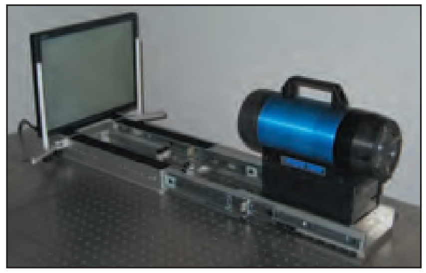
Automated LC parameter testing

Instec will feature its line of Automated Liquid Crystal Test Equipment highlighted by the new ALCT4. Built for industry, the ALCT4's easy to use software allows for the quick and accurate measurement of critical liquid-crystal material parameters. These include the dielectric constants, elastic constants, and threshold voltage for both positive and negative dielectric nematic liquid crystals. In addition, the rotational viscosity, gamma 1, of positive nematics can also be measured. As with all Instec's full line of industrial and academic LC measurement equipment, the ALCT4 interfaces easily to a PC *via* the USB port.

INTEGRAL VISION
Wixom, MI 248/668-9230
www.iv-usa.com
Booth 112

Texture Mura inspection system

Integral Vision's Texture Mura Inspection System is used to quantify the visual perception of small-scale luminance non-uniformities observed on a flat-panel display. The system takes into account both size and magnitude visibility factors of the non-uniformity over a large area of the display. The automatic optical inspection system is portable and can accommodate displays of different sizes. The output is a single number that represents the amount of texture Mura in a display and allows ranking the displays based on their texture Mura content.



IRTOUCH SYSTEMS CO.
Santa Clata, CA 408/656-4955
www.irtouch.com
Booth 1100

IR touch screens

Continued innovation has enabled infrared touch technology to be the interactive solution for rugged environments from public kiosks, indoors and outdoors; point-of-sales terminals; and in-vehicle displays to industrial control monitors, as well as marine and avionics displays. Sunlight operability, enhanced optical performance with high transparency, slim integrated mechanical profile, low maintenance with no drift and no wearing are all among the benefits an IRTOUCH touch screen brings to rugged interactive applications. Continued design innovation together with quality manufacturing cost control has enabled quality infrared touch-screen solutions to enter the mainstream mid-range market segments.

ITO AMERICA
Tempe, AZ 480/998-2250
www.itousa.com
Booth 845

Conductive-polymer products

Ito America is now a U.S. distributor of Orgacon™, the trade name for Agfa Materials' conductive-polymer product line. The Orgacon™ line covers a wide range of products designed for different applications such as EL lamps, touch pads, touch screens, displays, dashboard panels, *etc.* ITO America produces coating solutions, printing inks, as well as highly transparent conductive films. The six key properties of Orgacon™ products are conductivity, transparency, printability, flexibility, formability (cold and thermo), and patternability.

JACO ELECTRONICS
Hauppauge, NY 631/273-5500
www.jacodisplays.com
Booth 813

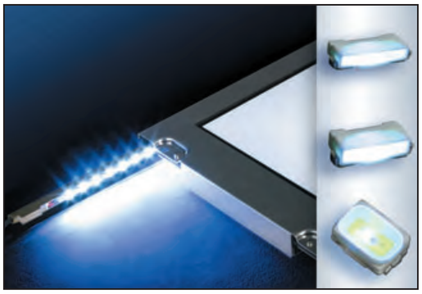
Signage system

Jaco will feature the WebDT Signage System, consisting of player-integrated displays, content and device management software, and optional IR touch for interactive signage. The WebDT family of products is based on thin computing platforms for secure, reliable, and cost-effective computing. WebDT products also include mobile tablets, compact information appliances, and display-integrated information systems. Powered by Windows® operating systems, WebDT devices offer durability and ease in integration, and emphasize mobility, wireless connectivity and touch displays. All WebDT systems can be remotely managed with the user-friendly WebDT Device Manager software.

JKL COMPONENTS CORP.
Pacoima, CA 1-800-421-7244
www,jkllamps.com
Booth 907

Surface-mount white LEDs

JKL Components Corp. will introduce new SMD LEDs. The LEDs yield up to 1900 mcd, offer a 120° viewing angle, and offer crisp, clear bright white output, ideal for display backlighting. LEDs are offered in reels for automatic placement or pre-mounted on a PC board to meet specific display requirements or on an existing LCD rail. Several binding options are available to meet unique requirements. The LEDs are reliable and dependable in extreme environments and offer an excellent low-cost long-life solution to designers seeking LCD enhancement or CCFL replacement options.



KONICA MINOLTA SENSING AMERICAS
Ramsey, NJ 201/785-2436
www.se,konicaminolta.us
Booth 400

Spectroradiometers

Konica Minolta will feature CS-2000 spectroradiometers. The CS-2000 features faster, accurate, repeatable measurements down to an ultra-low luminance of 0.003 cd/m^2; selectable measurement angles of – 1, 0.1, and 0.2°; additional calculations include CRI, L*a*b*, CIE Assessment of Daylight Simulation Metamerism Index; low polarization error; easy operation with a color LCD screen and simple keypad arrangement; USB compatible; and illuminance capable.

KOPIN CORP.
Westborough, MA 508/870-5959
www.kopin.com
Booth 807

Smallest color SVGA display

Kopin's new CyberDisplay® SVGA LVS display with a 0.44-in.-diagonal image area is the smallest color SVGA display (800 × 600 resolution) in the LCD industry. Compared with Kopin's commercially available SVGA display (0.59-in. diagonal and consuming ~100 mW), the new SVGA display has a 45% smaller area and consumes 30% less power. The CyberDisplay SVGA LVS exhibits remarkably sharp color images and is targeted for PC- and HD-related video eyewear applications.

KYOCERA INDUSTRIAL CERAMICS CORP.
Vancouver, WA 360/750-6121
www.kyocera.com
Booth 1008

TFT-LCDs

Kyocera will exhibit their new Thin & Light series TFT-LCDs. In 5.7-in.-diagonal size, the TL-series has VGA and QVGA models at a thickness of only 5.7 mm, excluding the touch screen. The width and height are also reduced compared to prior generations. The new series has a single 40-pin interface connector that gives the customer direct control of over three strings of backlight LEDs. The TL-series will soon include new 6.2-in. TFT-LCDs in HVGA format with an integrated constant-current backlight driver.

LIYITEC
Taoyuan County, Taiwan +886-3-359-1055
www.liyitec.com
Booth 1115

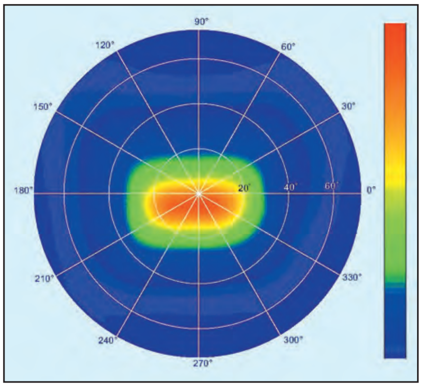
Surface-acoustic-wave touch panels

Based on surface-acoustic-wave (SAW) technology, SonicTouch™ is composed of a pure-glass construction that delivers unsurpassed durability, reliability, and clarity. With no plastic or metallic coatings on the surface, it offers over 90% light transmission and superior image clarity and color purity. Featuring a surface hardness as high as 7H, SonicTouch is scratch and chemical resistant. With its drift-free and stable controller design, the SonicTouch requires no recalibration once installed.

LUMETRIX CORP./WESTBORO PHOTONICS
Ottawa, Ontario, Canada 613/729-0614
www.lumetrix.com
Booth 800

Low-cost viewing-angle measurement system

It used to be the case that industrial instruments for measuring the viewing-angle-dependent luminance and contrast of displays required a very sizable capital investment. At SID 2008, Lumetrix will be changing this equation with the introduction of the ConoMeter. Leveraging many years of experience in the development of a successful line of imaging photometers and imaging spectrometers, the system boasts unrivaled measurement fidelity and productive software for analysis. A rigorous and extensive system calibration together with electronic bracketing produces an ultra-wide measurement dynamic range.



MATRIX ORBITAL
Calgary, Alberto, Canada 403/229-2737
www.matrixorbital.com
Booth 756

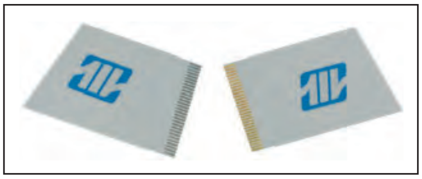
Graphic LCD

Matrix Orbital's new graphic LCD, GLK19264-7T-1U, has a 1U form factor. It also fits a 5.25-in. drive bay. It features a backlit seven-button embedded tactile keypad and three bi-color LED Indicator lights (red, green, and yellow). It is easy to use and comes with a RS232/I2C or USB interface. An optional black mounting bracket is available.

MERITEC
Painesville, OH 440/354-3148
www.meritec.com
Booth 901

Cable assemblies

Tin-bismuth-plated ZIF cable assemblies have been Meritec's RoHS plating of choice. ZIF board receptacle manufacturers are looking to gold-plating options. Available by the third quarter of 2008, Meritec will offer a high-quality industrial-grade electrolytic gold-plating option for application-specific requirements. Regardless of the application, Meritec will offer both tin- and gold-plated options. Meritec offers FPDI-I compatible cables in stock and a variety of flat flex cabling solutions that can easily be modified to solve the most intricate flat flex cabling needs.



METAVAC
Holtsville, NY 631/447-7700
www.metavac.com
Booth 903

Bulletproof coatings

Metavac, a part of Thermo Fisher Scientific, introduces a new line of environmentally bulletproof coatings. These coatings are engineered for the real world. They will not fail even under the most inhospitable environments including repeated touch.

MICROEMISSIVE DISPLAYS
Edinburgh, Scotland +44-131-650-7753
www.microemissive.com
Booth 540

QVGA microdisplay

MicroEmissive Displays will feature eyescreen™ ME3204, a QVGA resolution microdisplay with a 0.24-in.-diagonal pixel array. Vivid colors, high pixel fill factor, and really black blacks produce high-contrast video images (contrast ratio > 500:1), while rapid-switching speeds enable video frame rates of 50–120 fps, eliminating flicker and blurring. Energy-efficient BT.656 and serial RGB digital interfaces, a fully digital signal pathway, and elimination of a backlight all contribute to the ultra-low power consumption (typically 50 mW), and with built-in display drivers, eyescreen™ saves space, power, and cost of additional components for product design engineers.

MICROSEMI CORP.
Irvine, CA 949/221-7112
www.microsemi.com
Booth 229

Chipsets for LED backlighting of LCD TVs

Microsemi's new DAZL!™ Digital Advanced Zone Lighting chipset provides a breakthrough system-level solution for accelerating large-screen LCD-TV backlight designs. DAZL! chipsets feature advanced power management, unprecedented uniformity of color, brightness, contrast, blur-free performance, and energy savings. The new chipsets substantially reduce the number of components needed to build LED backlights, saving board space and cutting total system cost by as much as 30%. Uniquely, DAZL! drivers support both high- and low-power LED backlights, an advantage in speeding new display designs into production – especially those using the latest high-brightness LEDs.

MICROVISION
Auburn, CA 530/888-8344
www.microvsn.com
Booth 611

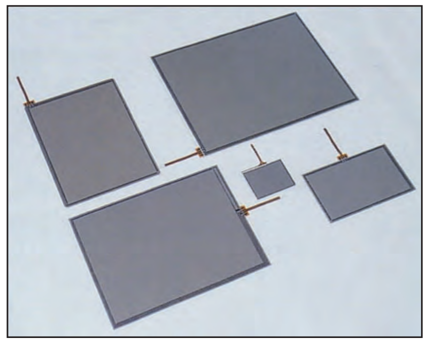
Display-measurement systems

Microvision will demonstrate its latest innovation in automated display testing systems, the SS400 series. The SS400 series will include several hardware advancements such as USB-controlled 16-bit spectrometers and 12-bit CCD cameras. New software includes improved response-time measurements (RTM) and ISO 300 test suites. The response-time software includes motion-blur measurements such as MPRT, blur-edge time, moving edge response time, and blur-edge width. Also included is improved filtering and improved user interface. The ISO 300 suite tests in full accordance to the latest draft of the ISO 9241-307 Ergonomics Standard.

NAGASE AMERICA CORP.
Santa Clara, CA 408/567-9728
www.nagase.co.jp
Booth 134

Glass touch panels

Compared to previous glass touch panels, Nagase's panels excel in reliability and are capable of various uses. It has an environmental resistance, including resistance to heat, moisture, and shock and has an extremely long keystroke lifespan. Moreover, due to its transparency and non-fading screen, it is outstanding in terms of picture quality. The glass touch panel can be produced by either using Touch Switch™ or Pen Input™, depending on the customer requirement.



NAKAN CORP
Tokyo, Japan +81-3-6222-5022
www.triphol.co.jp
Booth 957

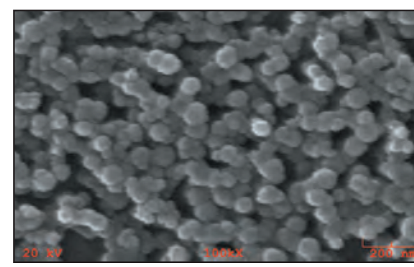
G8 alignment-layer coating system

Nakan is introducing the latest design in alignment-layer printing machines with a moving plate cylinder and flexographic plate transfer capability. This is an off-set print system designed for coating thin films. Adopted by many liquid-crystal makers because of its durability, excellent moving stability, and equalized coating quality.

NANOGRAM
Milpitas, CA 408/719-5345
www.nanogram.com
Booth 922

Optical materials

NanaGram Corp. will feature high (>1.7) and low (<1.3) refractive-index optical materials. NanoGram creates customized application-specific advanced materials solutions for its customers in the display, lighting, electronics, and energy markets. NanoGram's complete licensing package includes proven materials production tools and processes, surface modification and dispersion technologies, process transfer expertise, and ongoing support.



NEC ELECTRONICS AMERICA
Santa Clara, CA 408/588-6243
www.am.necel.com
Booth 235

7-in. WVGA a-Si TFT-LCD module

NEC Electronics America's 7.0-in. WVGA a-Si TFT-LCD module, part number NL8048BC19-02, features 160º horizontal and vertical viewing angles, a high contrast ratio of 1000:1, and fast response time of 25 msec, enabling information to be reproduced on screen quickly, precisely, and without stress. The 7.0-in. LCD module is equipped with a long-life (approximately 50,000 hours) white LED backlight system and provides lower power consumption compared with that of CCFL-based modules. The lightweight, slim-line package is highly resistant to shock and vibration, and an operating temperature range of –20 to +70ºC guarantees operation even in the most extreme conditions.

NEMOPTIC
Magny Les Hameaux, France +33-6-60-60-21-42
www.nemoptic.com
Booth 935

E-paper module

Nemoptic's e-paper display, based on the truly bistable zero-power BiNem® technology, is a perfect fit for retail tag applications in fresh-food counters or deli counters and is also suitable for logistics applications. It offers a 61×81-mm^2 viewing area (4:3 aspect ratio); the highest contrast ratio in the e-paper market (CR > 15:1, typical); high brightness in reflective mode (> 35%, typical); excellent readability at all angles; and a working temperature range of 0°– 40°C.

NEXTWINDOW
La Grange, IL 708/482-0004
www.nextwindow.com
Booth 1036

Touch-screen sensor

NextWindow's 1900 touch-screen sensor offers multi-touch and full mouse functionality – click, drag, double-click, and right-click, in a low-cost design that's easy to integrate and simple to use. Perfect for applications requiring superior optics, responsiveness, and multi-touch capabilities including consumer electronics, voting terminals, ticket kiosks, and much more. The NextWindow 1900 Touch Sensor offers the following benefits: multi-touch ready; accurate, low-cost, high reliability, superior optics; simple integration; HID-compliant USB interface for power and communications; once-only factory calibration, with no drift; light touch, no pressure required.

NOVACEL
Palmer, MA 413/283-3468
www.chargeurs-protective.com
Booth 741

Self-adhesive protective films

Novacel will be featuring 9003, 9016, 9841, and 9842 self-adhesive surface protective films, specifically designed to protect the critical surfaces of specialty films such as light-management films used in the manufacture of electronic displays. Novacel's 9003 and 9016 are clear and green low adhesion films, designed to protect smooth surfaces. Novacel's 9841 and 9842 are both clear films, designed for application to textured substrates. These products are easy to laminate to specialty films, with stable adhesion regardless of fabrication and processing. They protect sensitive surfaces during manufacturing, handling, shipping, and assembly. They are easy to peel-off without residue or contamination at the end of the process.

NOVALED AG
Dresden, Germany +49-351-79658-0
www.novaled.com
Booth 201-4

OLED materials

Novaled specializes in high-efficiency long-lifetime OLED structures and synthetic and analytical chemistry. Novaled is offering complete solutions to the organic electronic markets and is commercializing their PIN OLED™ technology along with their proprietary OLED materials.

N-TRIG
Kfar Saba, Israel +972-9-799616
www.n-trig.com
Booth 465

Digitizers

N-trig is the provider of DuoSense™ digitizer technology, the only combined pen, touch, and multi-touch interface for advanced computers. By offering the most technologically advanced digitizer on the market, N-trig sets the stage for OEMs to introduce computer products which offer an intuitive Hands-on™ and interactive experience. DuoSense digitizers are easily integratable, on top of any type of LCD, and keep devices slim, light, and bright. N-trig technology can be implemented in a broad range of products from small notebooks to large-format LCDs and can support a variety of applications including mobile computing, gaming, entertainment, all-in-one, and multimedia.

OPTICAL FILTERS
Thame Oxon, U.K. +44-1844-260-377
www.opticalfilters.co.uk
Booth 949

Resistive touch screens

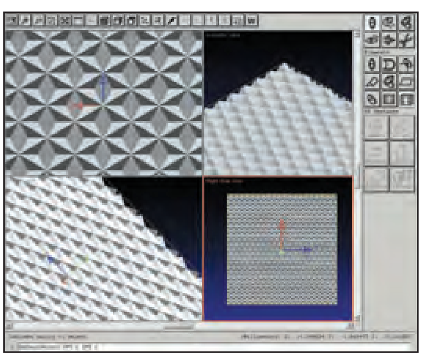
Optical Filters will feature a range of all-glass COTS resistive touch screens featuring sunlight readability and durability to match the most demanding applications such as military, marine, avionics, and industrial displays where the tough finish and wide temperature stability are required. With integrated enhancement options including EmiClare MicroMesh or ITO coating for optimum EMI-shielding and excellent light transmission, this is a proven off-the-shelf solution.

Submit Your News Releases
Please send all press releases and new product announcements to:
Michael Morgenthal
Information Display Magazine
411 Lafayette Street, Suite 201
New York, NY 10003
Fax: 212.460.5460   e-mail: press@sid.org

OPTICAL RESEARCH ASSOCIATES
Pasadena, CA 626/795-9101
www.opticalres.com
Booth 905

Illumination design and analysis software

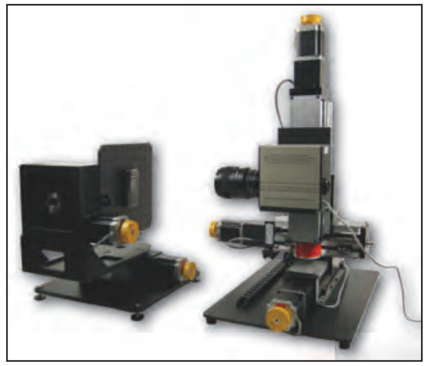
LightTools™ from Optical Research Associates is a complete illumination design and analysis software package featuring virtual prototyping, simulation, optimization, and photorealistic rendering of illumination systems such as backlights and rear-projector systems. LightTools models sources, waveguides, 2-D and 3-D extraction features, enhancement and recycling films, and the many performance aspects of display systems. This includes fully user-defined 3-D textures that can efficiently model an infinite variety of complex textures for the extraction of light from a waveguide, and the Backlight Pattern Optimization utility that automatically optimizes backlight extraction texture size or placement for optimal performance.



OPTRONIC LABORATORIES
Orlando, FL 407/422-3171
www.olinet.com
Booth 953

VESA display test workstation

Optronic Laboratories is excited to introduce a brand new motion control and modular platform suitable for, amongst other things, VESA display testing. The VESA Display Test Workstation is used in conjunction with the OL 770-DMS Display Measurement System for a complete, robust, and flexible tool for most display applications. The motion system is expandable up to 5 axes (x, y, z, theta, and phi). Powerful software allows users to create scripted automation and even the integration of other measurement tools for fully automated multi-parameter testing.



OPTREX
Duluth, GA 770/622-2146
www.optrexusa.com
Booth 558

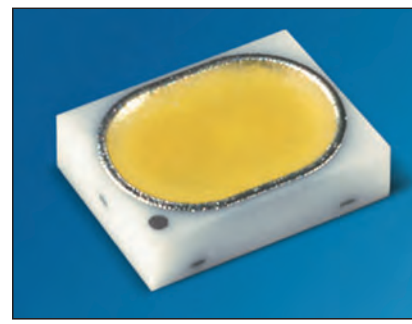
WVGA TFTs

Optrex will feature, for the first time, IPS displays that achieve a viewing angle of 85/85/85/85, thickness of 3.5 mm, luminance of 300 cd/m^2, contrast ratio of 600:1, wide-temperature range of from –20 to 70ºC, a CMOS TTL interface, and LED backlights. The displays are also available with a four-wire touch screen. A TN-mode cost-effective version is also available, featuring a viewing angle of 65/65/45/65, CR = 500:1, and luminance of 400 cd/m^2. Other wide-format modules shown will include 4.3-in. WVGA, 9-in. WVGA, 12.1-in. WXGA, 14.1-in. WXGA, and 17.5-in. WXGA. Touch-screen options are available on the entire TFT lineup from Optrex.

OSRAM OPTO SEMICONDUCTORS
Santa Clara, CA 1-888-446-7726
www.osram-os.com
Booth 435

Reflector LEDs

OSRAM will be demonstrating a 7-in. LCD backlit using new CERAMOS™ Reflector LEDs. The CERAMOS™ Reflector LED provides unprecedented high brightness and power in a very small package for backlighting mid-sized (5–20 in.) LCDs that need to operate in high-ambient-light conditions, such as those found in automotive dashboards or aircraft cockpits. The SMD ceramic package also enables robust operation under extreme temperature and humidity conditions. The Reflector LED is powered by OSRAM's patented ThinGaN® LED technology, which provides a high level of optical efficiency of over 50 lum/W.



OTSUKA ELECTRONICS CO.
Osaka, Japan +81-7-2855-8500
www.photal.co.jp
Booth 827

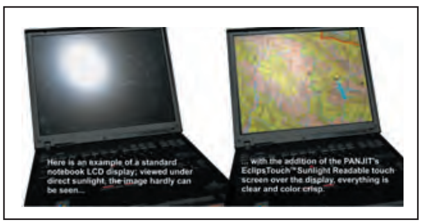
Total-luminous-flux measurement system

Otsuka Electronics will feature the HM series measurement system that measures the total luminous flux by using an integrating hemisphere and a flat mirror for backlight-like surface illuminants. Backlight-like surface illuminants can also be accurately measured.

PANJIT AMERICAS
Tempe, AZ 480/222-1040
www.panjit.com
Booth 1114

Sunlight-readable touch screen

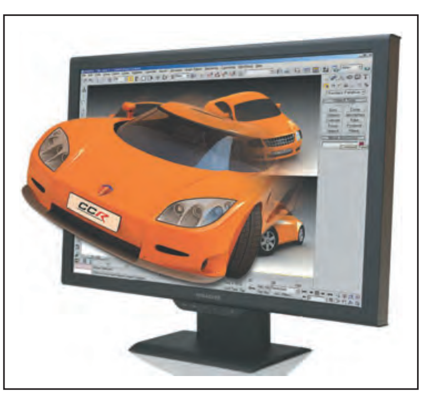
PanJit will feature EclipsTouch™, a state-of-the-art sunlight-readable touch screen. The optical characteristics of the touch screen are optimized by enhancing the polarized light transmission, color, saturation, and contrast, reducing the natural reflection. The battery power is enhanced and the LCD lifetime is extended. EclipsTouch™ is ideal for applications such as military and/or automotive displays, GPS, or rugged notebooks where they can be easily installed and maintained.



PAVONINE
Incheon, Korea +82-32-851-6060
www.hanafos.com
Booth 653

32-in. stereoscopic LCD

Pavonine will exhibit a 32-in. stereoscopic LCD that features a color TFT-LCD; 3-D glasses; a 2-D resolution of 1920 × 1200; a 3-D resolution of 1920 × 600; a brightness of 145 cd/m^2; an interfaced stereo format; a frame-sequential sub-field and side-field; 16.7 million colors; VGA, DVI, and HD component input signals; PAL and NTSC broadcasting signals; and CE and RoHS compliance.



PLANAR SYSTEMS
Beaverton, OR 503/748-5886
www.planar.com
Booth 1037

Mariner displays

The Planar LX1501PRI and LX1201PRTI Mariner displays are designed with innovative features to meet the challenges of unpredictable marine environments. As an open-architecture weather-proofed display, the LX Mariner displays integrate touch-screen technology to enable users to better interact with screen data for improved functionality, including future plans to support multi-touch capability. Additional features, including optical bonding from Planar's recently announced facility, and an ultra-wide vertical viewing angle for optimal viewing, make the LX Mariner displays ideal for use in marine environments in which sun, moisture, and salt create challenges for standard commodity displays.

POLYMER VISION
Eindhoven, The Netherlands +31-40-27-74200
www.polymervision.com
Booth 1029

Rollable mobile displays

Polymer Vision, the inventor of rollable displays, has pioneered a whole new generation of mobile devices with the announcement of the Readius® in January 2008. The device exploits the versatility of rollable displays to merge the "reading friendly" strengths of e-readers with the "high mobility" features of mobile phones. The Readius® offers a large 5-in. display without sacrificing the small size of the device. When not in use, the display can simply be rolled up so the Readius® will fit easily in a pocket. The Readius® will be commercially launched by mid-2008.

POWERTIP TECHNOLOGY
Lake Forrest, CA 949/859-8168
www.powertipusa.com
Booth 761

LCD modules

Powertip is fully equipped to handle the market needs for active-matrix OLED, TFT, color STN, chip-on-glass (COG), chip-on-film (COF), tape-automated-bonding (TAB), chip-on board (COB), and surface-mount-technology (SMT) LCD module designs. With over 79 series (comprising over 1000 configurations) of standard LCD modules, Powertip is uniquely positioned in the marketplace today. Very few manufacturers of LCD modules can affirm this diversity of standard product.

PUREDEPTH
Redwood City, CA
www.puredepth.com
Booth 1104

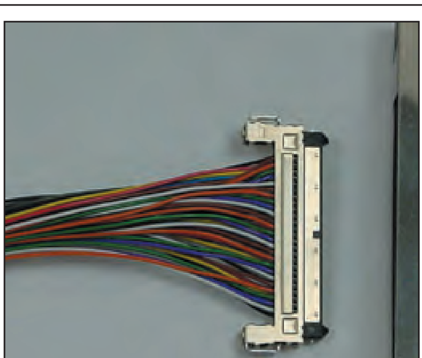
Public-information displays

Using PureDepth's proprietary Multi-Layer Display (MLD™) technology, this public display monitor is for use in public-information display locations (point-of-sales advertising, public transportation, electronic menu boards, *etc*.). Imagine any 3-D content being played in real depth, or a menu board with menu items on one side and a sponsored advertisement on the other, or having text displayed on the front LCD while promotional placements are displayed on the background. Because MLD technology uses actual depth, there are no visual impairments as in 3-D stereoscopic displays. PureDepth licenses both the technology and manufacturing processes for strategic partners.

QUADRANGLE PRODUCTS
Englishtown, NJ 732/792-1234
www.quadrangleproducts.com
Booth 855

Series connectors

Quadrangle Products is supporting a new component – Hirose's FX15 series connectors – in the development of custom LVDS cables. The FX15 is a cable-to-board connector that supports LVDS signals. The FX15 series connector features flexibility in design, enhanced shielding effectiveness, equal-length transmission lines, self-alignment and self-guiding, secure and complete mating/un-mating, and RoHS compliant. Quadrangle Products can help design a complete custom cable assembly using the FX15 connector for prototype and production purposes.



QUALCOMM
San Diego, CA 858/651-6276
www.qualcomm.com
Booth 427

Mirasol displays

The Hisense C108 mobile phone, which is the world's first handset to feature Qualcomm's mirasol™ display technology, is a lightweight low-power candy-bar-style handset that weighs less than a quarter pound (80 grams). The C108, based on Qualcomm's QSC6010™ chipset, uses the 1.2-in. mirasol display that features a resolution of 130 ppi (128 × 96 pixels). The mirasol display functions as the main display of the phone, showing such things as text messaging, phone-book entries, time, date, and other important information. The phone also supports multiple languages and has 32-Mbyte ROM and 8-Mbyte RAM.

Q-VIO
San Diego, CA 858/692-3706
www.q-vio.com
Booth 505

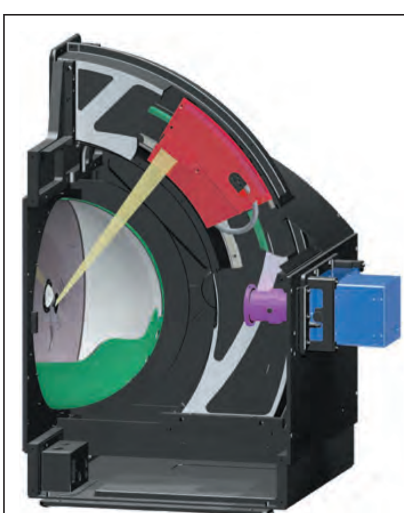
Sunlight-readable displays

Q-Vio is introducing Q-Solar™ sunlight-readable displays. They beat the daylight out of the sunlight with the brightest, easiest-to-read displays ever! The Q-Solar 7-in. model is a 1024 × 600 700-nit color active-matrix TFT-LCD that uses a-Si TFT as a switching device. The ultra-high-brightness display consists of a TFT-LCD panel, a driver circuit, and a backlight system. At 700 nits and the highest resolution in its class (1024 × 600 pixels), this dynamic 7-in. display offers up to 262,144 colors. And at a thin, 4.9-mm thickness and weighing in at only 100 grams, this low-power (2.4 W) display is perfect for a wide range of products where size, weight, power, and sharp readability in bright sunlight are essential.

RADIANT IMAGING
Duvall, WA 425/844-0152
www.radiantimaging.com
Booth 349

BRDF/BTDF measurement

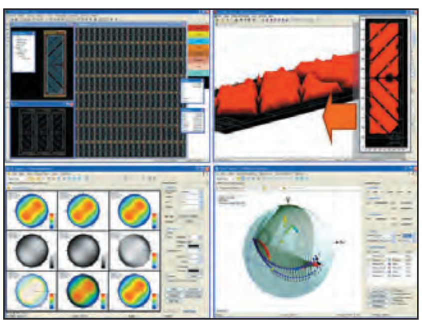
Radiant Imaging will be featuring their Scatter & Appearance Imaging Sphere (IS-SA) that enables rapid, high-resolution measurements of BRDF, BTDF, and TIS. It is useful for characterizing the light appearance of a wide range of reflective surfaces and transmissive films, including FPDs, display components, BEFs (brightness-enhanced films), painted surfaces, holographic foils, and plastic and metal parts.



SANAYI SYSTEM CO.
Incheon, Korea +82-32-254-2520
www.sanayisystem.com
Booth 706

LCD simulation software

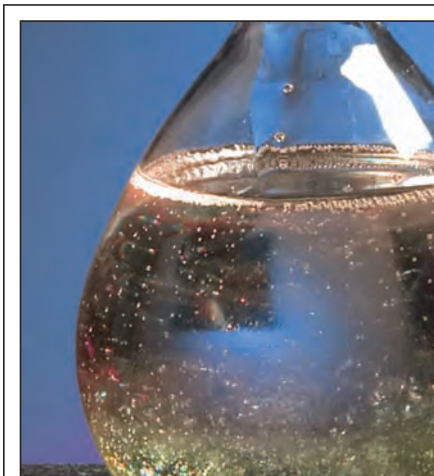
Sanayi System Co., Ltd., is a maker of LCD simulation software. 3-D simulation software for LCDs, TechWiz LCD 3D, is used by major LCD panel makers to develop novel LCD designs. A new simulation software, TechWiz LCD 1D, has been released for the optical design and characterization of LCDs.



SARTOMER CO.
Exton, PA 610/363-4100
www.sartomer.com
Booth 144

Acrylated oligomer

Sartomer Co. is the manufacturer of CN4000, a fluorinated acrylate oligomer featuring low surface energy, low viscosity, and low refractive index. It is used in UV/EB-cured coatings, electronics, and inks applications. CN4000 is effective in anti-reflective coatings and anti-graffiti resins for plastics and monitors.



SENCORE
Sioux Falls, SD 605/339-0100
www.sencore.com
Booth 1006

Optical tri-stimulus colorimeter

Sencore's OTC1000 is their newest ColorPro Color Analyzer designed specifically for highly accurate and convenient projection-system calibration. The OTC1000 is a lensed point-and-shoot color measurement system designed to be highly accurate and easy to use with all projection technologies. It is equipped with patent-pending Ambi-Block™ technology, which allows both the luminance and chromaticity effects of ambient light to be automatically excluded from projection measurements for accurate projection system calibration, even under less than ideal measurement conditions.

SHELDAH TECHNICAL MATERIALS
Northfield, MN 507/663-8564
www.sheldahl.com
Booth 708

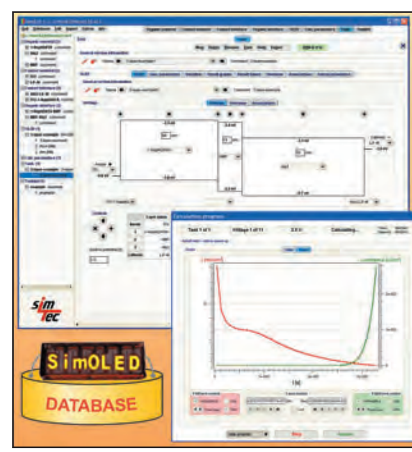
Specialty materials

Sheldah will feature specialty materials solutions to support resistive and capacitive touch sensor, smart windows, and electroluminescent product applications. Products include coated and patterned ITO, screen printing, and specialized tooling on thin plastic films manufactured roll to roll in a new state-of-the-art manufacturing plant. Custom prototype and volume touch-sensor assembly services are available.

sim4tec GmbH
Dresden, Germany +49-(0)-35-0533-1478
www.sim4tec.com
Booth 101-4

OLED simulation software

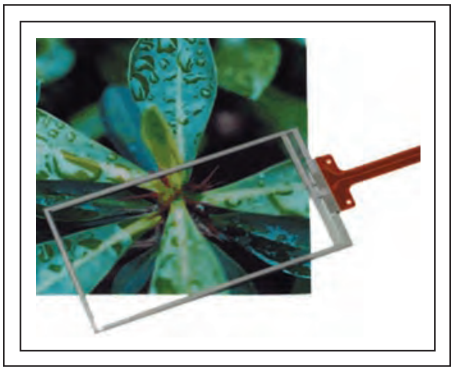
sim4tec GmbH, a provider of numerical simulation software for organic electronics, will introduce the new version 1.1 of its OLED simulation software SimOLED®. The device simulator SimOLED® can model the complete optoelectrical characteristics of multilayer OLEDs (*e.g.*, current density, luminance, and efficiency), including special effects such as carrier and emitter doping, exciplex states, and exciton quenching. Version 1.1. comes with enhanced calculation speeds and the possibility of performing automatic parameter variations. The user can take advantage of the graphical user interface and the database concept of SimOLED® where input parameters and output results are automatically stored, managed, and conveniently displayed.



SMK ELECTRONICS CORP.
Chula Vista, CA 619/216-6477
www/smkusa.com
Booth 100

Highly transparent film

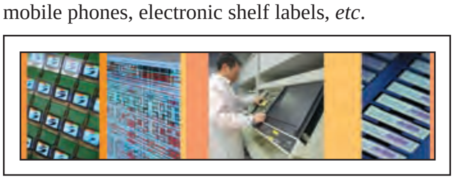
SMK has joined with a film manufacturer to develop a highly transparent film to solve the problem of reduced visibility caused by light reflecting on the surface and on the inside of the touch screen. By combining our film with a highly transparent glass, 93% transparency, and 5% reflectance was achieved, which is the highest in the industry. Our highly transparent resistive touch screen is available in film-on-film and film-on-glass. This product is being marketed for use in information terminals, notebook PCs, UMPCs, and photo printers to suppress light reflection.



SOLOMON SYSTECH
Pak Shek Kok NT, Hong Kong +852-2207-1560
www.solomon-systech.com
Booth 549

Bistable display driver

Solomon Systech is a world leader in bistable display driver technology. These ICs are the world's first commercialized single-chip integrated drivers with a controller. The SSD1623, a 96-segment direct segment drive bistable display driver, offers flexible driving waveforms, allowing the output waveform to be set to drive different displays such as cholesteric, electrophoretic, and other new display technologies. With a highly compact and competitive design, the bistable IC can be used in portable devices such as smart cards, memory cards, mobile phones, electronic shelf labels, *etc*.



STELLARNET
Tampa, FL 813/855-8687
www.StellarNet.us
Booth 941

Portable LED and display measurements

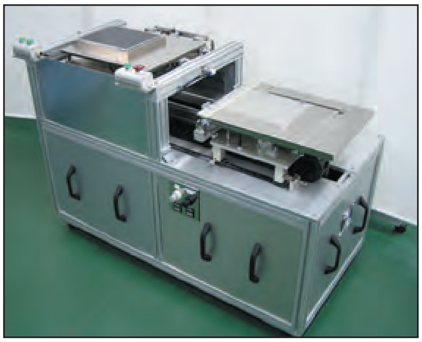
The low-cost StellarNet SpectroRadiometers use aberration-corrected concave grating optics to provide research-quality imaging and top spectral efficiency with a unique dual blaze technology. The research-grade spectrograph contains no mirrors to minimize stray light while the flat field grating delivers a uniform focus on the detector for < 2-nm spectral resolution. The instrument is ruggedized for portability (it can be dropped without harm) and connects directly to a PC's USB-2 port. The system includes the SpectraWiz software for LED xy chromaticity and intensity measurements.

SUN-TEC AMERICA

Scottsdale, AZ 480/922-5344
www.sun-tec.net
Booth 1019

Film lamination equipment

Sun-Tec America will feature the TMS-47SA film-lamination machine for laminating films to other film, glass, or plastic substrates up to 47 in. on the diagonal. The TMS-SA series of lamination machines are designed to be affordably priced for R&D, low-to-medium volume production, and repair work without sacrificing the performance of more-expensive models. These machines maintain Sun-Tec's high production standards and are capable of bubble-free lamination with a high placement accuracy of 0.2 mm. The basic TMS-SA series are manually operated, but with available options can be configured as a fully automated machine. Other options include tables for laminating assembled displays with bezels, de-ionizers, and a hood with an Hepa filter.



SYNOVA

Fremont, CA 727/504-1127
www.synova-usa.com
Booth 155

Laser MicroJet®-Powered Stencil Cutter

Fast and clean manufacturing of thin metal masks has improved even further when using the Laser Stencil System (LSS 800/1000/1200) from Synova, featuring the unique Laser MicroJet® technology. Almost any aperture shape can be created with very small beam diameters down to 28 µm. The LSS offers high mechanical precision with a tolerance of less than 5 µm. An unsurpassed cutting quality is achieved at rates of up to 30,000 apertures per hour without any heat damage, deposition, burrs, or oxidation. There are no gas emissions and all waste products are removed in the water flow.

TANNAS ELECTRONIC DISPLAYS

Orange, CA 714/633-7874
www.tannas.com
Booth 502

Resized LCDs

New larger-sized LCDs (27-in. on the diagonal) are being resized to 5.8 × 23 in. for avionics applications to replace out-of-production plasma panels. Tactical Displays, Inc., (TDI), Irvine, CA, is ruggedizing the resized LCD with front AR glass and rear-heater glass and qualifying it for military-aircraft applications. Tannas Electronic Displays is resizing large LCDs to odd sizes to replace other technologies.

TIANMA MICROELECTRONICS

City of Industry, CA 646/336-8188
www.tianma.com
Booth 1043

Thin-film transistors

Ideal for portable media players and medical/industrial products, Tianma's new TFTs also feature higher brightness and wider viewing angle and are supported by their new state-of-the-art TFT FAB in Shanghai, China.

TLC INTERNATIONAL

Phoenix, AZ 602/296-1886
www.tlcinternational.com
Booth 729

Computerized Gen-3 mechanical glass cutter

TLC International will feature the Gen-3 TLC Phoenix-600® (24 × 24 in. / 600 × 600 mm) computerized mechanical glass cutter for thin, flat glass singulation of FPD/photonics/optics parts, especially X-Y/circular/curvilinear flat-panel displays. The rotating cutting head incorporates a CCD camera. Features include AutoCAD® interface O/S; exact onstage measurement/inspection; quick, repeatable targeting system for precise alignment of single sheet/laminate parts; unobstructed surface for easy integration in automated lines; fast, clean, and dry (no contaminating oil/water) processing; pristine afterbreak edge quality; nesting software maximizes utilization of expensive coated/plain substrates. It compliments TLC's Summit Gen-5® (46 × 58 in./1160 × 1460 mm) which provides multifunctionality never before possible in technical glass singulation, replacing bulky, complex, outdated-technology machines.

TOSHIBA AMERICA ELECTRONICS COMPONENTS
Irvine, CA 949/623-3098
www.toshiba.com/taec
Booth 135

Industrial LED-backlit TFT-LCDs

Toshiba will exhibit their new 70,000-hour long-life LED-backlit TFT-LCDs for industrial applications at SID 2008. Toshiba's new line-up includes LCDs ranging in diagonal-size from 5.7 to 10.4 in. and resolutions from QVGA (320 × 240) to XGA (1024 × 768). These modules each feature an on-board LED-driving circuit to facilitate customer design-in. Today's common industrial-use TFT-LCDs use cold-cathode fluorescent lamps (CCFLs) as their backlight source. An LED-backlit TFT-LCD provides many benefits: low electromagnetic interference (EMI), low power consumption, wide backlight dimming range, and light weight. LED backlights are also mercury-free and therefore support industry environmental initiatives.

TYCO ELECTRONICS ELO TOUCH SYSTEMS
Menlo Park, CA 650/361-4948
www.elotouch.com
Booth 900

Wide-aspect-ratio touch monitors

Elo Touch Systems, a Tyco Electronics business, announces the stylish 1900L 19 in. and 2200L 22-in. wide-aspect-ratio touch monitors. The sleek integrated design is attractive for public venues and the adjustable height stand provides flexibility to meet a variety of height requirements. The base can also be removed and with VESA compliance wall or arm mounting is possible. Available in both IntelliTouch surface acoustic wave and acoustic pulse recognition (APR) touch technologies, the pure-glass construction of the touch monitors is sealed to resist water, dust, and grease and delivers high-quality optical performance.

UNIDYM CORP.
Menlo Park, CA 512/567-3763
www.unidym.com
Booth 504

Carbon nanotubes

Unidym leads in the development and manufacture of carbon nanotubes (CNTs), specifically for applications in electronics. Unidym's first CNT electronics product, already recognized as a true innovation, is a transparent, conductive film based on its conductive CNT inks that are designed to improve performance and processing of touch screens and displays. When compared to current transparent electrode materials (ITO, IZO), Unidym's films offer greater reliability, uniform transmission across the entire visible light spectrum, true mechanical flexibility, reduced reflectivity, and are more-cost effective to manufacture.

UNIVERSAL DISPLAY CORP.
Ewing, NJ 609/671-0980
www.universaldisplay.com
Booth 260

Phosphorescent OLED materials and technology

Universal Display's award-winning PHOLED™ phosphorescent OLED materials and technology enable manufacturers to produce OLEDs with dramatically higher power efficiency compared to conventional OLEDs and LCDs. Available in many colors, PHOLEDs offer excellent performance for use in full-color and white OLEDs. UDC will also exhibit prototypes showcasing other proprietary technologies, including FOLED® Flexible OLED, TOLED® Transparent OLED, and WOLED™ White OLED technologies.

VERTEX LCD
Placentia, CA 714/646-1105
www.vertexlcd.com
Booth 110

Active-matrix TFT-LCDs

Vertex LCD will introduce two active-matrix TFT-LCDs: 10.4-in. night-vision model NVIS Mil-3009 Type I or Type II compatible NVIS displays featuring (day) 800 cd/m^2, (night) 200 cd/m^2, and XGA resolution. Designed for high brightness in high ambient conditions and low-light NVIS filtered applications, it can be dimmed from full brightness to zero for rugged flat-panel hand-held systems, transportation, office, or daylight industrial automation systems. Options include EMI/heater/touch available with optical bonding and dual-mode LED drivers. Custom BLU designs available on all Vertex LCD sizes and models.

VP DYNAMICS LABS
Sha Tin NT, Hong Kong +852-2607-4238
www.vp-dynamics.com
Booth 267

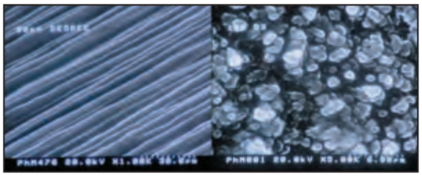
RGBW display technology

VPW™ technology adds white (transparent) subpixels to form a proprietary four-color RGBW display of square subpixels. Higher brightness can be obtained from the backlight through the white subpixels for LCDs and CF-OLED displays or from the reflection of the ambient light on the white subpixels area for electronic-paper displays. The VPW™ engine, embedded in a display driver, further enhances the perceived resolution, colors, and contrast, which provides a much better user experience with the image contents. In addition, VPW™ technology's duo resolution driving mode further reduces power consumption in mobile devices.

WAVEFRONT TECHNOLOGY
Paramount, CA 562/634-0434
www.wft.bz
Booth 254

Ultra-thin tailored microdiffusers

WaveFront Technology (WFT) is introducing ultra-thin high-performance tailored microdiffusers (TMD®) for mobile LCD applications. The TMD® is ~25 µm in thickness offering up to a 15% increase in brightness and 25% improvement in contrast ratio. As with all WFT TMDs, the Ultra Thin also offers improved viewing angle and better uniformity. This ultra-thin high-performance diffuser will be available in the second half of 2008. WFT also offers roll-to-roll or large-flat-panel replication of micro-structured optical films containing prismatic, diffractive, or microlens features.



WESTAR DISPLAY TECHNOLOGIES
Saint Charles, MO 636/300-5112
www.displayquality.com
Booth 419

TFT-panel universal tester

T-Drive™ Model II is a universal tester for TFT panels with resolutions up to WQXGA. Dual-channel LVDS, TMDS, and analog outputs are standard, with optional quad-channel LVDS and DisplayPort outputs. Model II has three programmable power supplies; two range from 2.5 to 24 VDC/3 A and one ranges from 9 to 24 VDC/6 A. An optional negative supply is available. Companion T-Link software maintains profiles, images, and pattern lists stored on the tester. T-Link™ can read and write a panel's EDID. T-Drive™ Model II's built-in test patterns, bitmap display feature, and moving patterns offer broad content for displays under test.

ZBD DISPLAYS
Malvern, Worcestershire, U.K.
+44-(0)-1344-887691
www.ZBD.co.uk
Booth 842

Bistable displays

The Zenithal Bistable Display (ZBD®) is the first commercially available LCD that uses surface bi-stability. It has the same basic construction as the conventional twisted-nematic (TN) displays used in watches. However, instead of the usual rubbed polymer alignment layer used for the TN displays, one of the surfaces of the ZBD has a patterned or profiled surface designed to induce two or more alignment states. These states have either a low-pre-tilt (planar) or a high-pre-tilt (homeotropic) and are retained indefinitely after being latched with an appropriate electrical signal.

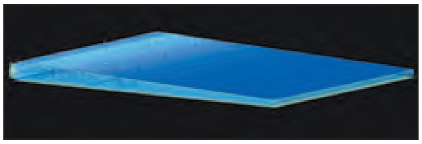
ZEMAX DEVELOPMENT CORP.
Bellevue, WA 425/822-3406
www.zemax.com
Booth 664

LCD backlight

ZEMAX optical design software has the capability to model, analyze, and optimize backlight structures for liquid-crystal displays. The ability to model and ray-trace array structures efficiently is critical to this application. From brightness-enhancement films to micropatterned arrays, ZEMAX has significant flexibility to model any repeating geometry.

trade-show preview

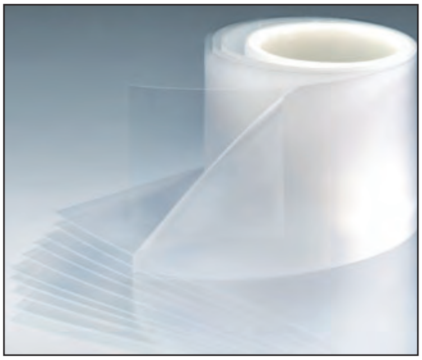
Very complicated structures may be created by either importing CAD objects or creating boolean objects from several parents. Non-linear array spacings along optionally non-orthogonal axes further enhance this variability. By adding the ability to optimize parameters of these objects, a very powerful tool for designing LCD backlights is available.



ZEONEX CHEMICALS/OPTES
Louisville, KY 502/775-2134
www.zeonchemicals.com
Booth 157

Isotropic and retardation optical films

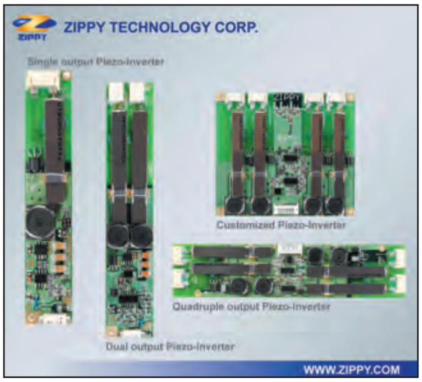
Optes, Inc., and Zeon Chemicals will showcase its ZeonorFilm® isotropic and retardation optical films at SID 2008. ZeonorFilm has 92% superior transparency, excellent dimensional stability – even in hot and humid environments – and enables wider viewing angles than conventional optical films based on PET, PEN, and TAC. Common applications for ZeonorFilm include polarizers and support films for LCDs, touch-panel displays, and bio-diagnostic devices. Optes will be showing samples of its 45° retardation film at the show.



ZIPPY TECHNOLOGY CORP.
Taipei, Taiwan +886-2-2918-8512
www.zippy.com.tw
Booth 450

Pizeo inverters

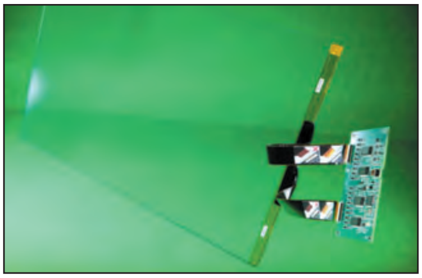
Zippy Technology is the leader in Piezo-Inverter and green power for CCFL, EEFL, and HCFL solutions. Zippy Technology has been ISO 9001 certified since 1994 and own more than 400 worldwide patents in various key technology segments. Zippy's piezo inverter for LCD backlights has numerous outstanding advantages over conventional inverters for mission-critical applications. Among them are no EMI, 90% ultra-high efficiency, more safety with patented Arc-Protection, balanced sine-wave output and mercury-migration-free to secure the lamp life, –40 to +85°C operating temperature, wide-range flicker-free dimming, and robust open and short protections are most notable and welcome by customers such as Boeing, Barco, FAA (U.S.), and many system integrators.



ZYTRONIX
Blaydon, U.K. +44-1914-145511
www.zytronic.co.uk
Booth No. 654

Wide-screen projected capacitive touch sensors

Zytronic's recently launched large-format XY controller for its Projected Capacitive Technology (PCT™) touch sensor products offers greater flexibility for a range of LCD types, including popular wide-screen displays. The new controller includes additional functionality such as palm rejection, and enables accurate touch detection through up to 10 mm of protective cover glass for 4:3 and now 16:9 format screen sizes up to 65 in. on the diagonal. This controller supports a larger range of operating systems, including Vista and Linux, and coupled with the unique durability of PCT™ touch sensors, offers designers a robust solution for outdoor and public-access digital-signage applications. ■



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Journal of the

SOCIETY FOR INFORMATION DISPLAY

A preview of some of the most interesting papers appearing in the May 2008 issue of the *Journal of the SID*.
To obtain access to these articles on-line, please go to www.sid.org

Edited by Aris Silzars

Motion-blur characterization on liquid-crystal displays

Wen Song
Xiaohua Li
Yuning Zhang
Yike Qi
Xiaowei Yang

Southeast University

Abstract — In this paper, several methods to characterize motion blur on liquid-crystal displays are reviewed. Based on the assumptions of smooth-pursuit eye tracking and one-frame temporal luminance integration, a simple algorithm has been proposed to calculate the normalized blurred edge width (N-BEW) and motion-picture response time (MPRT) with a one-frame-time moving-window function to LC temporal step response curves. A custom measurement system with a fast-eye-sensitivity-compensated photodiode has been developed to characterize motion blur based on LC response curves (LCRCs). MPRT values obtained by using the algorithm mentioned above and those from the smooth-pursuit-camera methods agree. Perception experiments were conducted to validate the correspondence between the simulated results and actual perceived images by the human eyes. In addition, the insufficiency of MPRT to evaluate motion blur on impulse-type light-generation LCDs, by analyzing the measurement results of a scanning backlight LCD, is discussed.

In order to make use of the LCRC, a theoretical explanation of the relationship between LCRC and motion blur needs to be developed and validated. Considering the normal three-frame LCRC, a white block represented by one horizontal line, scrolling at a speed of one pixel per frame on the screen, is given as a simple example, which is illustrated in Figs. 3(a) and 3(b), respectively. The above analysis indicates that the perceived moving picture is determined by the sum of the pixel's intensity along the motion trajectory within one frame period.

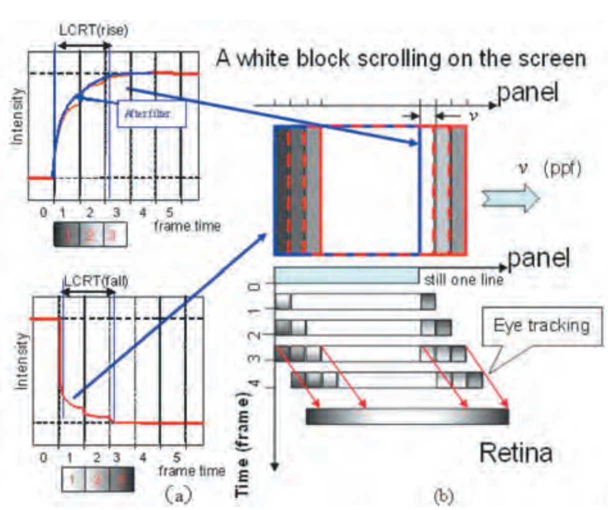

FIGURE 3 — (a) The LC response curve and (b) the illustration of a white block scrolling and eye tracking.

0362-0972/05/2008-088$1.00 + .00 © SID 2008

Transient-current asymmetry in CSTN-LCD panels

Xiaofei She
Jun Tang
Rong Chen

TPO Displays Shanghai, Ltd.

Abstract — Optical flicker is one of the artifacts of color STN-LCDs and is related to the electrical asymmetry in LCD panels. The transient-current asymmetry was observed to have a linear correlation with the internal DC offset of LC panels. The asymmetric cell structure of LC panels with a single topcoat layer leads to the asymmetry. The interface effect between different layers in an LC panel plays an important role in this phenomenon. Based on experiments, an improved RC network model was introduced to describe the mechanism.

According to previous studies, the panel asymmetry can be related to the work function of ITO electrodes, polyimide (PI) and topcoat (TC) layer structure, and the ions trapping behavior on PI layers. Therefore, the experiments were performed on three different types of test panels, which have no TC layer, a TC layer on one substrate, and a TC layer on both substrates in the cell; while the PI layers, the ITO electrodes, the process settings, and other cell configurations are the same.

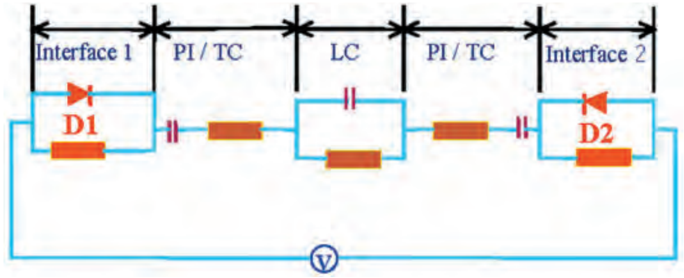

FIGURE 9 — Improved RC network model of a LC panel.

Self-bank metal conductor fabricated with silver nanoparticles

Jun Xu
Chun Fu
Yanchuan Li

Fudan University

Abstract — A novel self-bank method for fabricating a thin-film metal conductor was studied by drying silver-nanoparticle dispersion droplets. The bank of the thin-film metal conductor was created spontaneously utilizing the self-bank method. A uniform film of polymethyl methacrylate (PMMA) used as a barrier layer was formed on a glass substrate. Silver nanoparticles were dispersed in a suitable solvent for which PMMA is soluable and a silver nanoparticle fluid suspension was formed. When the silver-nanoparticle fluid suspension was injected into the PMMA film of the substrate, the solvent dissolved the PMMA film, creating a restricted area for silver-nanoparticle material defining the bank of the conductive area which improves the uniformity and conductivity of metal film. The metal conductor with a self-defined bank is formed when the PMMA film was removed after sintering. This self-bank method would be helpful in improving the deposition process of the functional materials in the fabrication of organic light-emitting diodes, organic thin-film transistors, color filters, metal electrodes, and biosensors.

One of the current problems for the ink-jet printing of thin films is related to the so-called coffee-ring effect, a ring-like film formed on the substrate. The coffee-ring effect usually refers to the non-uniform surface pattern of film due to the fluid flow of the liquid drop within the deposited area. Because the coffee-ring phenomenon strongly affects the deposited film, preventing it from achieving better physical and electrical properties, we studied a novel fabricating method of thin metal film which could improve the uniformity and electrical property of the metal conductor. This method utilizes the self-bank effect which greatly eliminates the coffee ring by forming a uniform surface.

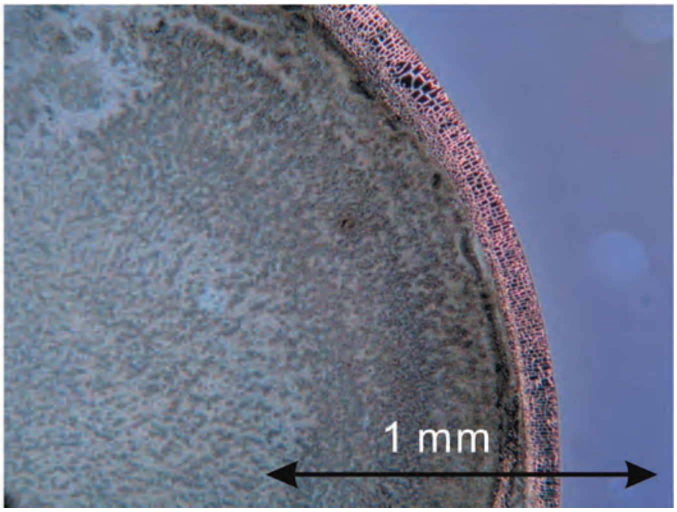

FIGURE 3 — Microphotograph of the silver thin film prepared by the self-bank effect. The bank formed on the boundary of the droplet.

Improved performance of organic light-emitting devices with ultra-thin hole-blocking layers

B. J. Chen
Y. Divayana
X. W. Sun
K. R. Sarma

Nanyang Technological University

Abstract — Tris-(8-hydroxyqunoline) aluminum (Alq_3)-based organic light-emitting devices (OLEDs) using different thickness of 2,9-Dimethyl-4,7-diphenyl-1,110-phenanthorline (BCP) as a hole-blocking layer inserted both in the electron- and hole-transport layers have been fabricated. The devices have a configuration of indium tin oxide (ITO)/*m*-MTDATA (80 nm)/BCP (X nm)/NPB (20 nm)/Alq_3 (40 nm)/BCP (X nm)/Alq_3 (60 nm)/Mg:Ag (200 nm), where *m*-MTDATA is 4, 4′,4″-Tris(N-3-methylphenyl-N-phenyl-amino) triphenylamine, which is used to improve hole injection and NPB is N,N′-Di(naphth-2-yl)-N,N′-diphenyl-benzidine. X varies between 0 and 2 nm. For a device with an optimal thickness of 1-nm BCP, the current and power efficiencies were significantly improved by 47% and 43%, respectively, compared to that of a standard device without a BCP layer. The improved efficiencies are due to a good balance between the electron and hole injection, exciton formation, and confinement within the luminescent region. Based on the optimal device mentioned above, the NPB layer thickness influences the properties of the OLEDs.

Organic multi-layered structures are necessary for lower operating voltage, higher efficiency, and practical devices. Because multi-layer-structured devices can balance hole and electron injection/transport, the light-emitting layer is far away from the metal electrode, and the mismatch of energy levels between the organic materials and the electrodes can be reduced.

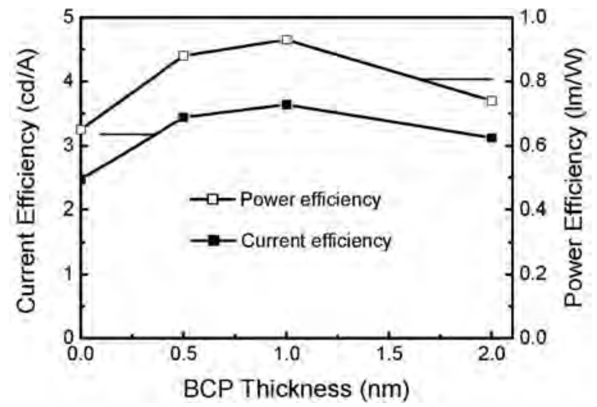

FIGURE 4 — Maximal current efficiency and power efficiency of the devices vs. the thicknesses of BCP layer.

ZnO nanowires for LED and field-emission displays

R. Könenkamp
A. Nadarajah
R. C. Word
J. Meiss
R. Engelhardt

Portland State University

Abstract — The use of ZnO nanostructures in various display applications is reported. Single-crystal-line vertically oriented nanowires with typical diameters of 100 nm and a length of 1–2 µm were grown at deposition temperatures below 100°C. Homogeneous growth over areas up to 50 cm^2 on Si as well as on various metallic, transparent, and flexible substrates were obtained. Visible electroluminescence in the region between 400 and 900 nm and narrow-line near-ultraviolet (UV) electroluminescence is demonstrated. The physical conditions leading to single-crystalline growth at low temperature, the role of defects, and the possibility of doping are discussed. These issues present the main challenges on the road towards high emission rates in LED operation. Under certain conditions, sharply tipped wires can be grown that hold promise for field-emission applications.

ZnO has long been considered a strong candidate for lighting and display applications. Its bandgap of 3.37 eV allows for the generation of photons over the entire visible spectral range, and the large exciton binding energy of 60 meV promises high excitonic transition probabilities. Various defect transitions involving impurities as well as vacancies are known to produce light emission at distinct colors in the visible. Generation of white and colored light therefore appears feasible. ZnO nanowires can be fabricated by a variety of methods, including CVD, MOCVD, PVD, solution growth, and electrodeposition. Our own work has focused on electrodeposition from aqueous solutions because this method produces single-crystalline wires at comparatively low temperatures on practically any conductive substrate.

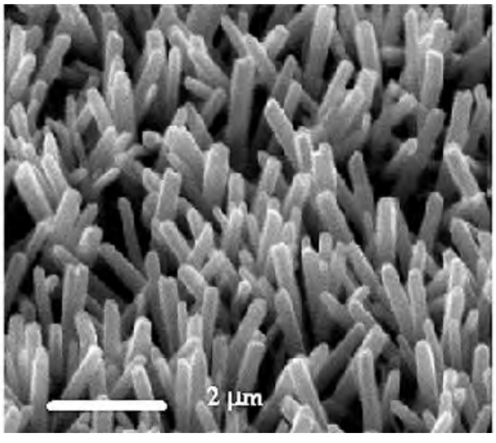

FIGURE 1 — Single-crystalline ZnO nanowires deposited on SnO_2-coated glass at 85°C in electrodeposition.

Design of carbon nanotubes for large-area electron field-emission cathodes

Richard C. Smith
S. R. P. Silva

University of Surrey

Abstract — Electron-field-emission displays offer a viable option for the next generation of flat-panel screens. Boasting high-quality images in terms of good color saturation, fast refresh rate, and high brightness, these displays have the potential to offer above and beyond what the current market leaders, LCD and plasma. However, for the realization of such a new display disrupting the incumbent LCD and plasma displays, not only does the image quality need to be better, but fabrication costs and suitable manufacturing processes need to be in place at reduced cost. Many viable cathode materials have been proposed in recent years, one of which being the use of carbon nanotubes (CNTs) in various forms (aligned growth, screen printing, and polymer matrix). In this review, a series of recent experiments investigating the field-emission characteristics of carbon-nanotube systems for possible use in the display industry is presented.

Following an introduction into the phenomenon of field emission, some computational simulations investigating the geometric field-enhancement factor were examined. This effect is first discussed in terms of a single, isolated CNT, then secondly for an array of CNTs. To expand on these findings, the use of nano-manipulators in order to accurately determine the FE characteristics of CNT experimentally is reported. The third and fourth sections of this review involve reporting on incorporating CNTs within a polymer matrix, and also that of room-temperature-grown CNTs for large-area applications.

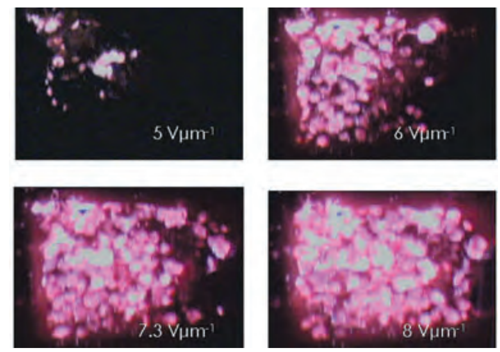

FIGURE 9 — Emission-site density maps made over a 3-mm^2 area from a 20% B-doped MWNT-PS composite at different applied fields. The maps are taken over the same area with applied fields of 5, 6, 7, and 8 V/μm.

Characteristics of an electron source of a surface-conduction electron-emitter display

Chuanxing Wu
Weijun Xu
Xin Lei
Chunliang Liu
Shengli Wu
Wenbo Hu
Zhihu Liang

Xi'an Jiaotong University

Abstract — The electron source is an essential part of a surface-conduction electron-emitter display (SED). An electron source for an SED was obtained after certain procedures were performed. By introducing a carbon atmosphere, the electron-emission characteristics of an SED were studied experimentally. The electron-emission characteristic curves were drawn after comparing the experimental data of the electron source obtained in a vacuum environment with the data obtained in a carbon atmosphere, from which it had proved that a carbon atmosphere could significantly improve the electron-emission characteristics of an SED. As a result, both the device current and the emission current had become stronger and the efficiency of surface-conduction electron emission had been improved significantly. The possible reasons were analyzed: more carbon, which could possibly form the electron-emission region of an SED, was produced from the carbon atmosphere during the electrical activation process.

When forming the conductive film, three types of Pd organic solutions were adopted with a Pd concentration of 0.25, 0.5, and 1%, respectively. Here, a triangular wave was applied as the device voltage U_f with a peak value of 30 V. Meanwhile, no anode voltage was applied. However, the activation time needed for the three kinds of conductive film were different. It took a relatively long time – about 2 hours – for the formation of condutive film and activation of the 0.25%-Pd film as a result of its relatively high resistance. When dealing with the 0.5%-Pd film, it took only less than 1 minute before the device current I_f dropped dramatically from 1 A to 0.008 mA with its resistance increasing from 266 Ω to 10.2 kΩ. The device current I_f ranged from 0 to 11 mA, and the emission current I_e ranged from0 to 4.5 μA.

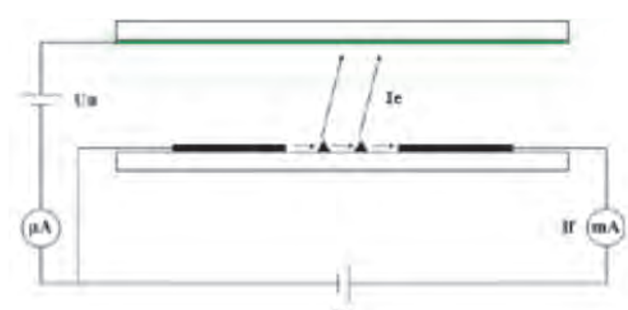

FIGURE 4 — The circuit.

FIGURE 5 — A photograph of SED luminous spots (U_a = 750 V).

Dynamic studies on the charging of spacers for high-voltage field-emission displays

Hao Li
Dirk C. Jordan
Bernard F. Coll
Emmett Howard
Scott V. Johnson
Michael R. Johnson
Kenneth A. Dean
James E. Jaskie

Motorola, Inc.

Abstract — In this article, a systematic study on the relationship between the rate of spacer surface-charge accumulation and the anode voltages in a dynamic setting is presented. The spacers are placed in a test package simulating a field-emission panel where electron trajectories are recorded along a preset timeline. True secondary emission of spacers under the influence of an anode field is then deduced and the factors affecting the rate of charge accumulation on the spacer surface are discussed. The results of invisible spacers under different operating conditions of anode voltage, emission current, and pulse width will also be given.

Figure 3 shows actual anode images at different stages of the charging process in the spacer test fixture. The vertical lines are rows formed by individual subpixels. A spacer was placed in between the two rows in the center. The anode voltage was set at 10 kV. The primary beam was pulsed with a pulse width of 15 μsec and the emission current was set at 1.5 μA per subpixel.

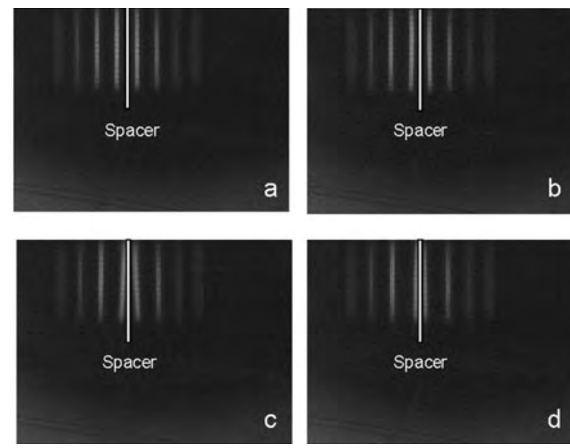

FIGURE 3 — Spacer-charging process in FED operating at 10 kV. Primary electron dosage per subpixel are: (a) 22.5, (b) 157.5, (c) 180, and (d) 202.5 pC, respectively.

Film surface morphology and field-emission characteristics of a carbon-nanotube array pattern fabricated under a magnetic field

I.-S. Tsai
C.-W. Huang
H.-K. Huang
J.-M. Jehng
T.-C. Pan

Feng Chia University

Abstract — This study focuses on the influence of sodium metasilicate binder on CNT paste and the arrangement of Mg–Ni alloy multi-walled carbon nanotubes on the surface of CNT film under the influence of a magnetic field. The CNT paste was prepared by mixing CNTs with silver epoxy resin and sodium metasilicate solution and coating them onto the surface of indium tin oxide (ITO) glass. The impact of sodium metasilicate solution and magnetic strength on the morphology of the paste film's surface and on the field-emission (FE) characteristics of the cathode was examined. The experimental results showed that the CNT paste provided good adhesion between the CNT array and silver epoxy resin when sodium metasilicate solution was presented. CNT paste containing sodium metasilicate showed a better dispersion with silver epoxy resin and a better CNT-array pattern, and better vertical alignment of the CNT was obtained when the magnetic field and grid were both applied. An optimal condition for a better CNT-array pattern for both the morphology and FE characteristics had a magnetic strength of 189 mT, magnetization time of 30 min, and a grid above the cathode.

In this study, we tried to solve the problem of covering CNTs with CNT paste by using two approaches. One approach was to add an inorganic binder as filler and to dilute the viscosity of the CNT paste so as to let the CNTs protrude out of the film's surface without being covered by silver epoxy resin. Another approach was to use a magnetic force to pull on one end of each magnetized CNT while the other end of the CNT was fixed by the paste. Under a magnetic field, one end of the CNT will be pulled by the magnetic force and bent upward toward a position parallel to the magnetic field (and perpendicular to the ITO glass) as shown in Fig. 3.

FIGURE 3 — Schematic diagram shows that the one end of the CNT is pulled by a magnetic force and bent upward.

Growth of uniform carbon-nanotube arrays with sandwich technology

Zexiang Chen
Qiang Zhang
Bingjin Zhu
Daniel den Engelsen
Peter K. Bachmann
Astrid Lewalter

University of Electronic Science and Technology of China

Abstract — In this work, a novel approach to grow structured, highly oriented carbon nanotubes (CNTs), which are vertically aligned to the substrate and show large field emission, is reported. Growth is performed on lithographically defined dots of catalysts, which can be deposited on metallic, semi-conducting, and glass substrates. A sandwiched catalyst structure and microwave plasma chemical vapor deposition enables the formation of uniform CNT arrays of 1.6 × 1.6 μm^2. The method is easily scalable to large areas. The CNT arrays exhibit a stable field emission of 20 mA and a macroscopic current density of 50 mA/cm^2 at a rather low electric field of 5.33 V/μm. Modeling of space charge indicates that space charge reduces the magnitude of the CNT emission at high field strength: this agrees satisfactorily with the measurements.

Figure 1(a) illustrates a standard lithographic method to pattern a Fe-catalyst layer for CNT growth on a silicon wafer. Figure 1(b) shows the final structure of the CNT bundles or arrays having a diameter of 1.6 μm and separated from each other at a pitch of 15 μm. First, a layer of titanium nitride (TiN) was sputtered on a silicon substrate covered with a photoresist pattern, then a thin layer of aluminum was deposited on top of the TiN layer by evaporation, and finally a layer of iron was evaporated to act as a source for the catalyst particles. By stripping the photoresist layer, the structure as shown in Fig. 1(a) was obtained.

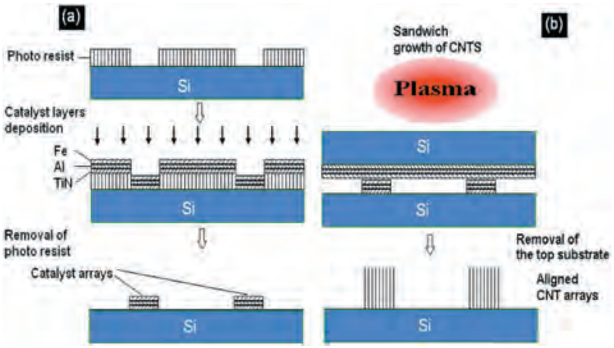

FIGURE 1 — (a) Sketch of fabrication of catalyst arrays. (b) Sketch of sandwich growth of CNTs.

Suspension-deposited carbon-nanotube networks for flexible active-matrix displays

Axel Schindler
Stefan Spiessberger
Steffen Hergert
Norbert Fruehauf
James P. Novak
Zvi Yaniv

University of Stuttgart

Abstract — The unique properties of carbon nanotubes (CNTs) promise innovative solutions for a variety of display applications. The CNTs can be deposited from suspension. These simple and low-cost techniques will replace time-consuming and costly vacuum processes and can be applied to large-area glass and flexible substrates. Single-walled carbon nanotubes (SWNTs) have been used as conducting and transparent layers, replacing the brittle ITO, and as the semiconducting layer in thin-film transistors (TFTs). There is no need for alignment because a CNT network is used instead of single CNTs. Both processes can be applied to glass and to flexible plastic substrates. The transparent and conductive nanotube layers can be produced with a sheet resistance of 400 Ω/□ at 80% transmittance. Such layers have been used to produce directly addressed liquid-crystal displays and organic light-emitting diodes (OLEDs). The CNT-TFTs reach on/off ratios of more than 10^5 and effective charge-carrier mobilities of 1 cm^2/V-sec and above.

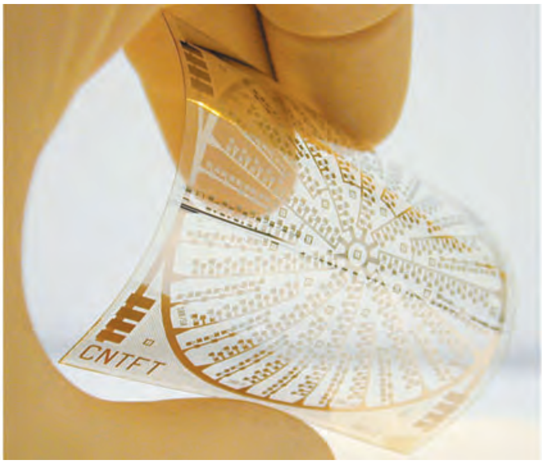

FIGURE 3 — Fully processed CNT-network TFTs on a 50 × 50 mm^2 PES substrate.

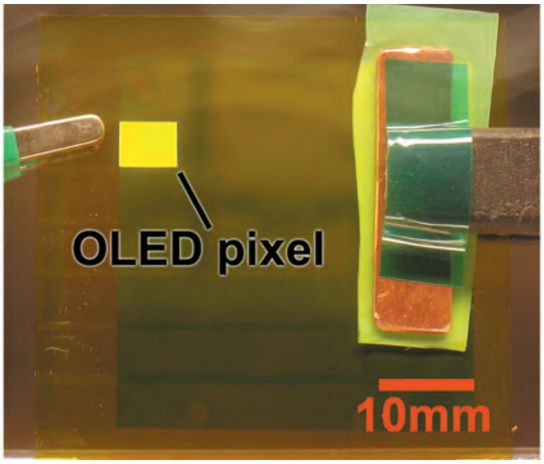

FIGURE 6 — A 5 × 6-mm^2 OLED with a CNT-network anode at 5-V driving voltage under illumination of a fluorescent tube.


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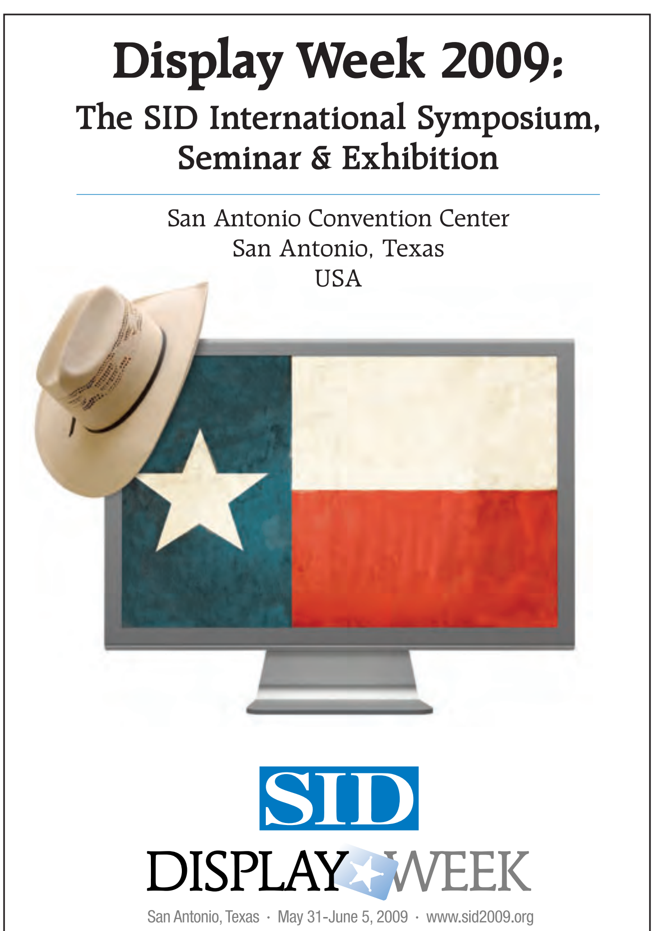
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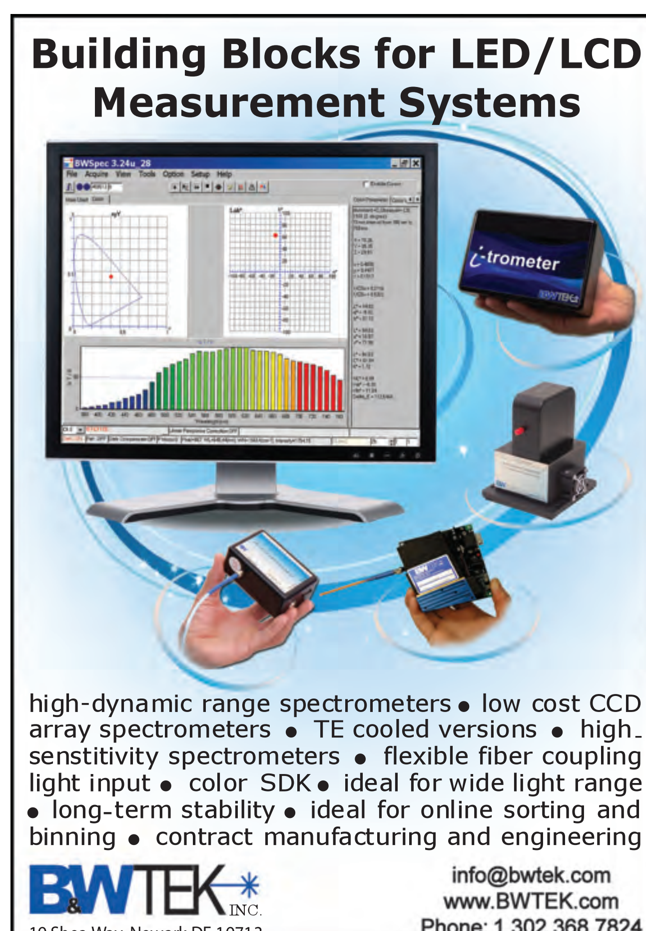
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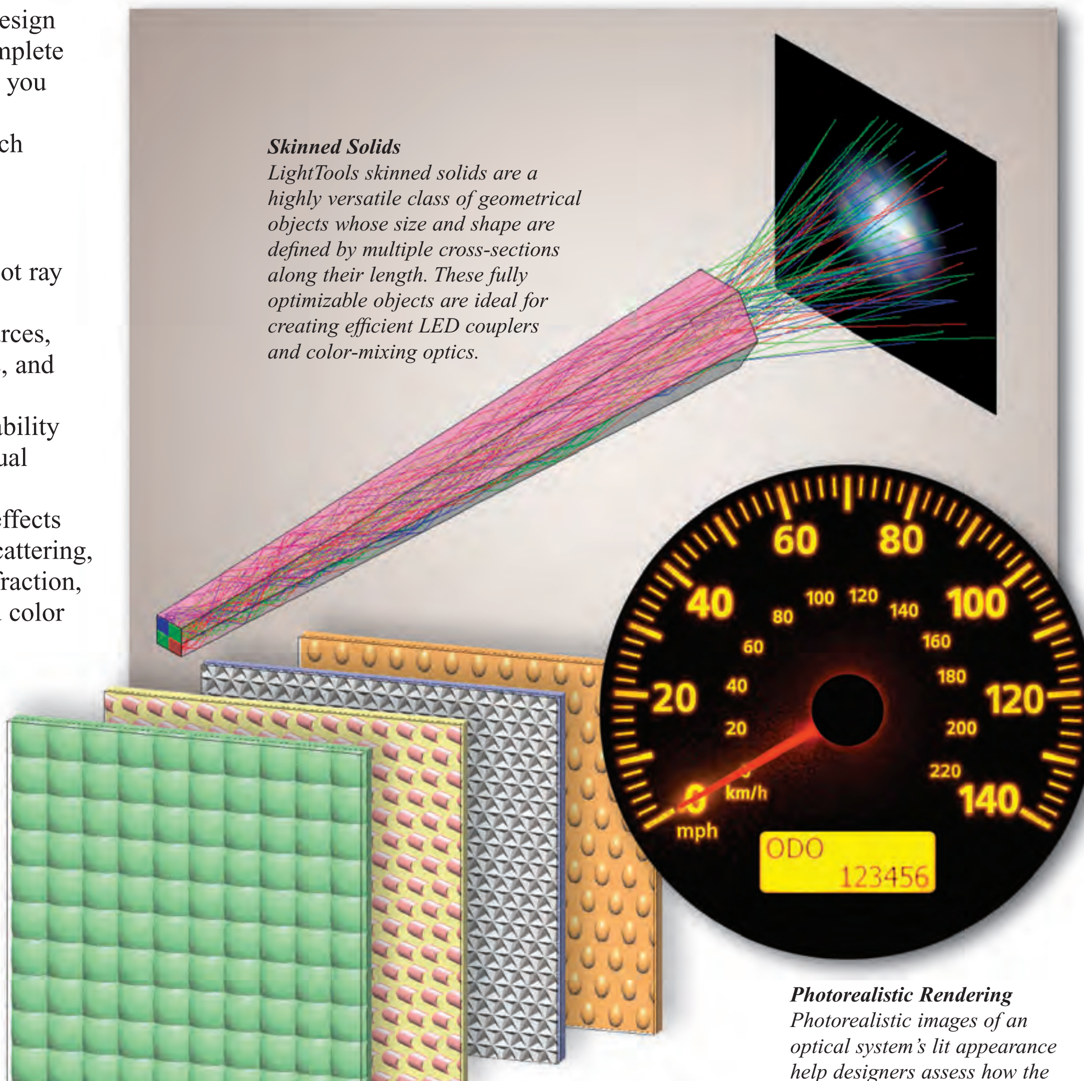

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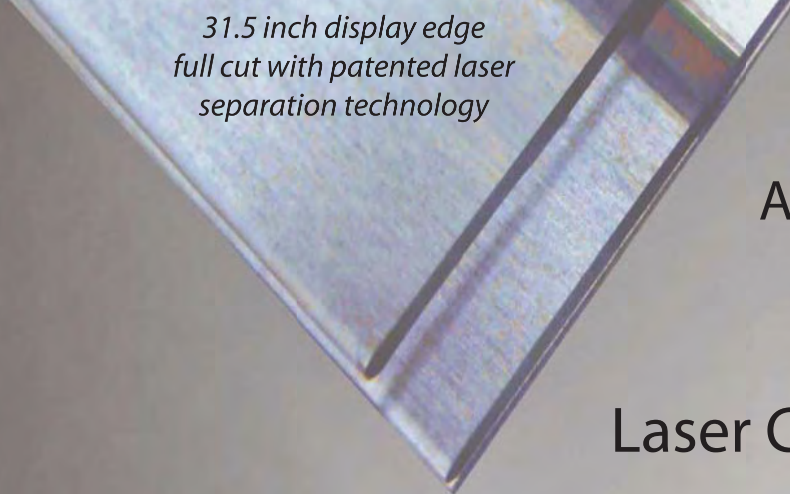
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However, some of the most important Society activities are those taking place regularly on a local and regional level in each of SID's 30-plus chapters worldwide. It's hard to find any industrialized part of the world that doesn't have some SID chapter activities going on. And if all that isn't enough, SID's publications such as this magazine, online resources, and network make it a truly indispensable tool to a successful display-industry career. In particular, *Information Display* magazine publishes 11 issues per year full of important and timely narratives about the technology of displays, from applications to new innovations to the business of displays. We also have a Web site that is updated daily with breaking news from around the display industry and has other valuable features that complement what you see in print each month – be sure to visit www.informationdisplay.org daily. In this particular issue, you can read about the most important new display products from 2007, which are being honored during Display Week with SID's coveted Display of the Year awards. Another article examines the value of different types of LCD glass. We also have the privilege of presenting the first of a two-part series on the evolution of projection technology. I was surprised to learn about the many different schemes used throughout the last century to create projected display images. I thought it was all done with CRTs and film – I was wrong.

This month, we begin what I hope will be a continuing series of columns titled "President's Corner" written by incoming SID President Paul Drzaic. Paul will be discussing a variety of topics concerning the Society, it's membership, and strategic directions for the future. I have known Paul for many years and I have the highest regard for his vision and insight into the industry. I hope you will enjoy his writing, and through this feature we will enhance the communication between the President's office and the membership at large.

So, if you are new to SID, I hope you find it a truly enriching experience. If you are a regular member and ID reader, welcome back and thank you for your generous support of SID.

– Stephen P. Atwood


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Just when you're starting to feel full, be sure to save some room for the Display Week Exhibition, which is sure to tempt you with the stunning collection of flavors cooked up by over 250 companies that will showcase their latest technology and product offerings in 2008. The exhibit floor shows display technology a bit further along in the product cycle, demonstrating the refinement in recipes that have evolved in the past few years. It is universally understood that the display technology that debuts in this forum will be unveiled as products at events like CES in 2–3 years time.

What's a fine meal without great conversation? Here, SID also provides the networking opportunities to meet with collaborators, assess where your competitors are, and make new connections that will prove valuable later in the year. Part of Display Week's popularity derives from the recognition that this is the premier event in the display industry for experts to come together to compare notes, and take this information back to their companies and laboratories to invent the future.

The future of displays is, in large part, invented during Display Week, and serves as the main ingredients for next year's forum and subsequent events. How many restaurants rely on the skill and tastes of the patrons as much as on the chefs behind the scenes? This vibrancy keeps Display Week as a critical component to the future success of the global display industry.

So, I hope you are hungry. Be sure to bring your appetite to Display Week as I promise that there will be plenty to go around. And you don't even need to tip the waiters – though a word of thanks to the SID sponsors and volunteers who serve up this event would of course be welcome! Did anyone say seconds?

Bon Appétit!
Paul Drzaic
President
Society for Information Display

continued from page 8

Printing the different colors is another approach to create a cost-effective way to create full-color displays. When successful, this technology is very well suited for up-scaling but obviously requires solution-processable materials. This approach was pioneered by Seiko-Epson and CDT using polymer materials. Plextronics has developed a process using polymer hole-injection layers called Plexcore® HIL, which offer tunability of the work function and offer greatly improved lifetimes for polymer OLEDs (5,000–10,000 hours at 50,000 nits). DuPont has developed solution-processable small molecules and is making tremendous progress with improving lifetimes (25,000–50,000 hours at 200 nits).

The ink-jet-printing approach requires high precision and reliable ink-jet heads. FujiFilm Dimatix has created a new MEMS-based piezoelectric head with 2-µm placement error and a 2% uniformity which has enabled Litrex and other companies to make large-scale (Gen 8) industrial machines for printing color filters, OLEDs, *etc.*

Active-Matrix OLEDs

AMOLED displays use higher currents than LCDs. This has necessitated the use of low-temperature polysilicon (LTPS). No companies in the U.S. are currently working on large-scale LTPS production. Kodak has made an important contribution to solve the problem of small non-uniformities in the LTPS-TFT performance showing up as a display non-uniformity (Mura). Their compensation algorithm will both increase performance and the AMOLED yield. Leadis Technologies has developed a compensation scheme and driving ICs for differential aging of pixels. The Flexible Display Center at Arizona State University develops AMOLED technology based on a-Si TFTs on flexible substrates for flexible displays.

New Materials: Higher Efficiency and Longer Lifetimes

A key element in the development of the OLED technology has been the creation of new materials with higher efficiency and longer lifetimes. Stephen Forrest from Princeton University and Mark Thompson from USC, together with UDC, created a big breakthrough with the invention of phosphorescent OLEDs (PHOLED™) for which virtually 100% of all the electron–hole recombinations result in the emission of light (compared to a maximum of 25% for fluorescent OLEDs). This has pushed up the efficiencies and lifetimes of displays. Efficiencies well in excess of 100 lm/W have now been reported for green emission. Even blue-emitting PHOLEDs now show high efficiency (21 cd/A) and respectable lifetimes (9000 hours at 500 nits), whereas red (27 cd/A; 200,000 hours) and green (67 cd/A; 250,000 hours) have reached lifetimes at 1000 nits (brightness) that a few years ago were deemed to be impossible for organic materials in such an application.

QDVision is approaching high efficiency and very stable materials in a different way by using inorganic quantum dots in an OLED-like structure to create pixels with a very narrow emission band. By changing the size of the quantum dots, a color gamut that is much wider than that of HDTV can be obtained.

***Fig. 1**: The world's thinnest display made by Samsung SDI. A Vitex Barix coating is used as encapsulation.*

Very Thin and Flexible Displays

OLED displays are notoriously sensitive to water and oxygen. Local oxidation of less than a monolayer of the low-work-function cathodes, which are highly reactive, results in so-called black spots, which render the display useless. Currently, OLED displays are protected on one side by a glass substrate and on the other side by a glass lid that, in most cases, contains a cavity filled with desiccant to absorb all the water that has passed through the glue line need to fix the cover lid.

Vitex Systems has developed a very thin, transparent, flexible barrier coating (Barix coating) with extremely low water-vapor transmission rates (WVTR) of 10^{-6} gr/m^2/day (10^7 better than a normal plastic film). The thin-film coating can be applied at temperatures in the range of 40°C, which are compatible with organic electronics.

This thin-film coating consists of a multilayer of polymer and inorganic layers. The polymer layers cover and planarize over particles, defects, and display structures; the inorganic layers form the barrier against water. The multiplayer provides redundancy against defects and decouples local defects in the oxide, providing a tortuous path for molecules from the outside to reach the display. While, in the beginning, 4–6 organic/inorganic pairs (dyads) were needed to ensure good and high-yield barrier performance, now 2 dyads suffice, with yields very close to 100%.

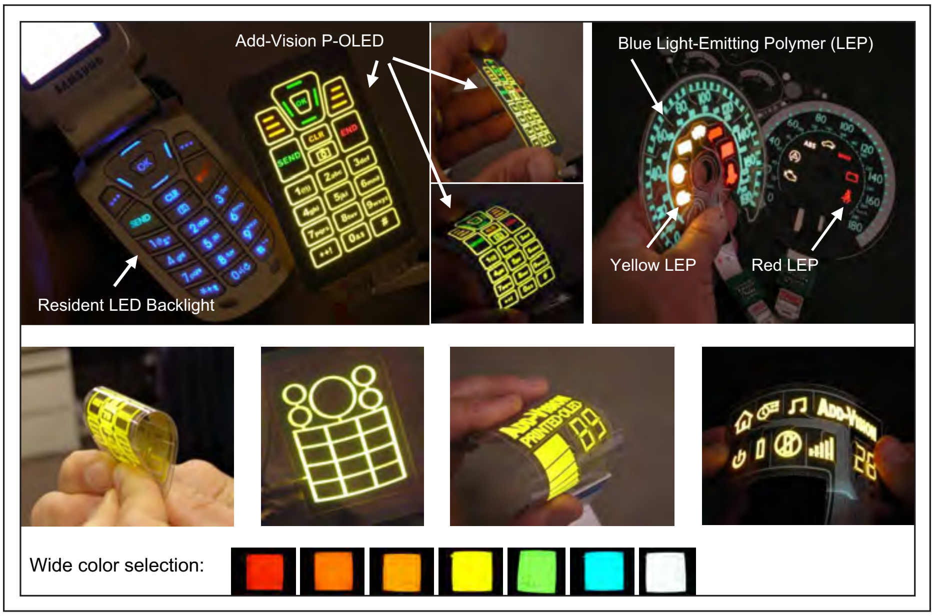

Fig. 2: *Add-Vision's flexible OLED displays. A Vitex barrier film is used as the substrate and encapsulation.*

This Barix coating can be applied directly on top of the OLED display, replacing the glass lid. Working with many different customers, Vitex has been able to show that the Barix coating can meet telecommunications and automotive applications. Using the Barix coating, Samsung SDI has recently created the world's thinnest display (Fig. 1).

The next step is to then replace the glass substrate by a thin film of plastic covered by a barrier layer and create a flexible display. Vitex has shown that these films covered by the multilayer barrier can meet the barrier performance of a WVTR of 10^{-6} $gr/m^2/day$, needed to successfully protect OLED displays.

The barrier films do not only enable flexible OLED displays but provide a basis for creating flexible solar cells, flexible batteries, and other non-electronic applications in thermal isolation and medical applications. Using a very similar approach but a different deposition technique, GE has recently obtained good results in using their technology for thin-film encapsulation and the creation of barrier films.

In order to create a flexible, high-resolution full-color OLED display, many more problems need to be solved: low-temperature deposition of the active matrix; lithography on a dimensionally much less stable substrate; handling of the plastic substrates, *etc.* These topics are being addressed at the Flexible Display Center. They have recently shown excellent capabilities in creating a flexible active-matrix display using an electrophoretic display (E Ink) for showing a first generation of demonstrators.

Add-Vision, a start-up company, is very close to commercializing what would be the first flexible OLED displays on the market. By using a completely printed OLED structure laminated between two of the Vitex barrier films, they have succeeded in making stable flexible segmented displays for cellphone touch pads, car dashboards, *etc.* (Fig. 2).

Conclusion

An OLED display is the almost ideal display: best picture quality; thin, fast response; no viewing angle issues; and low power. After years of struggle, OLED displays are now on the verge of a commercial breakthrough. Further reduction in cost, increase in throughput, and scaling to larger sizes will be needed to be price competitive with LCDs. Flexible OLED displays are around the corner and will create a new and unique market opportunity. ■

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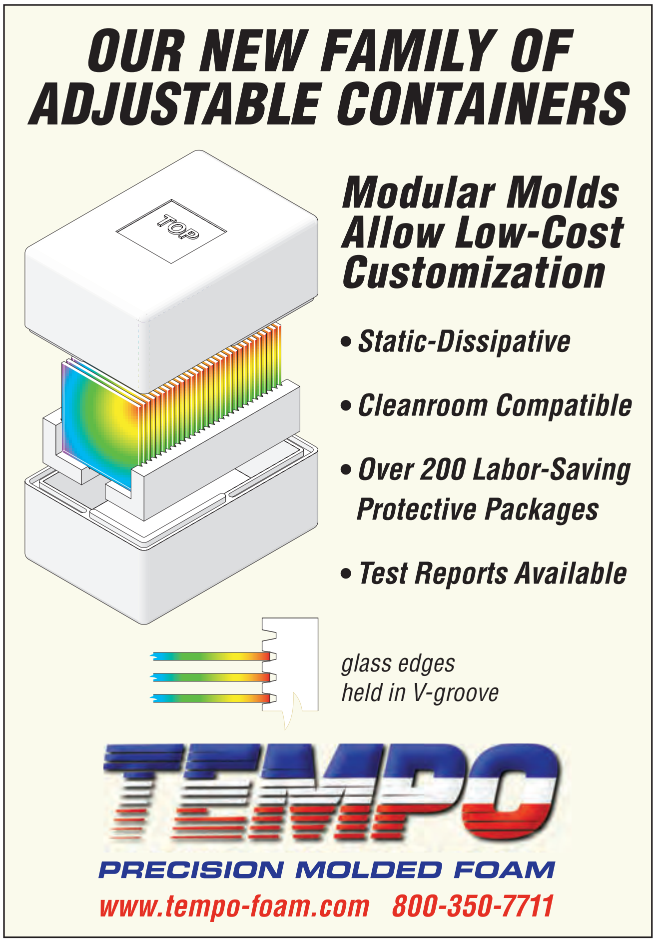

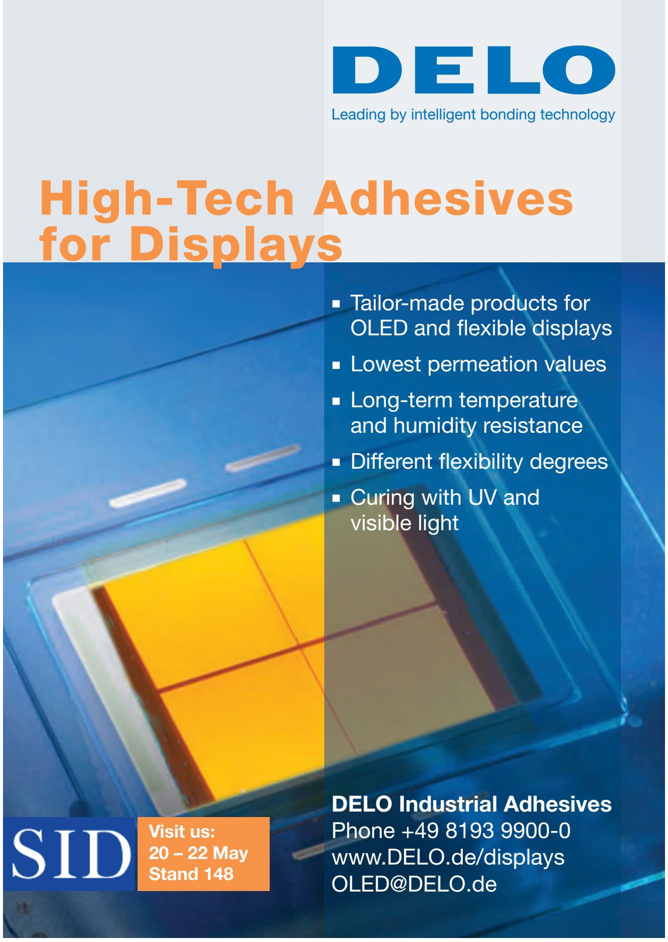

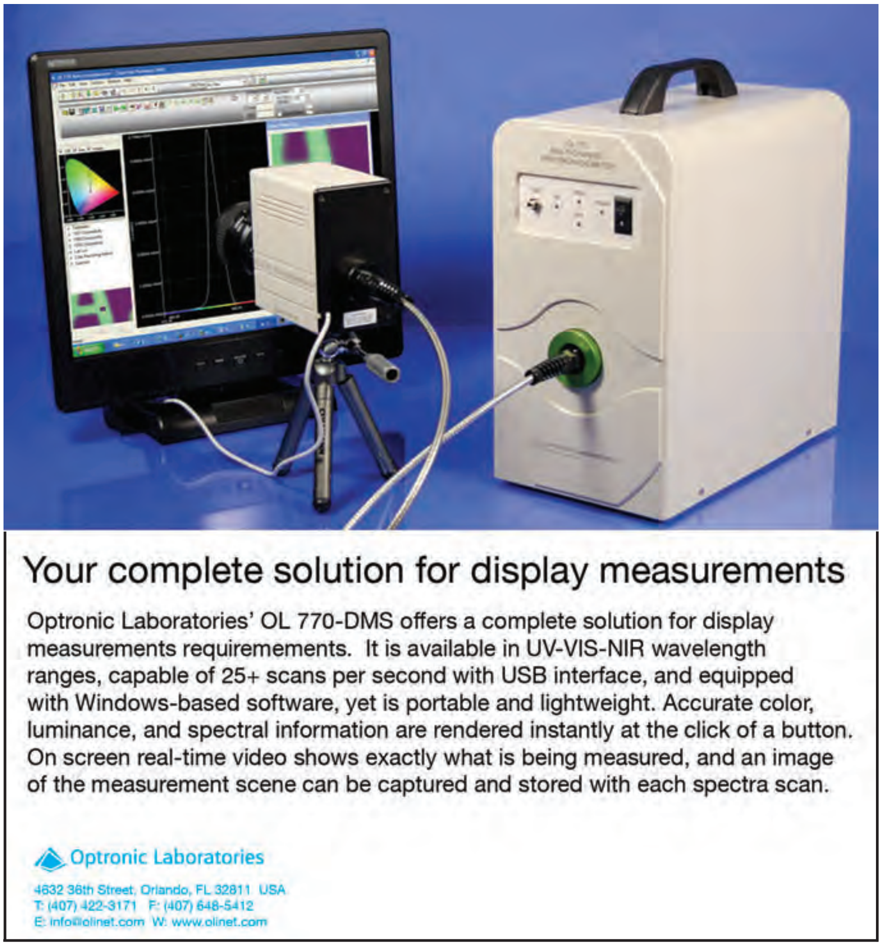

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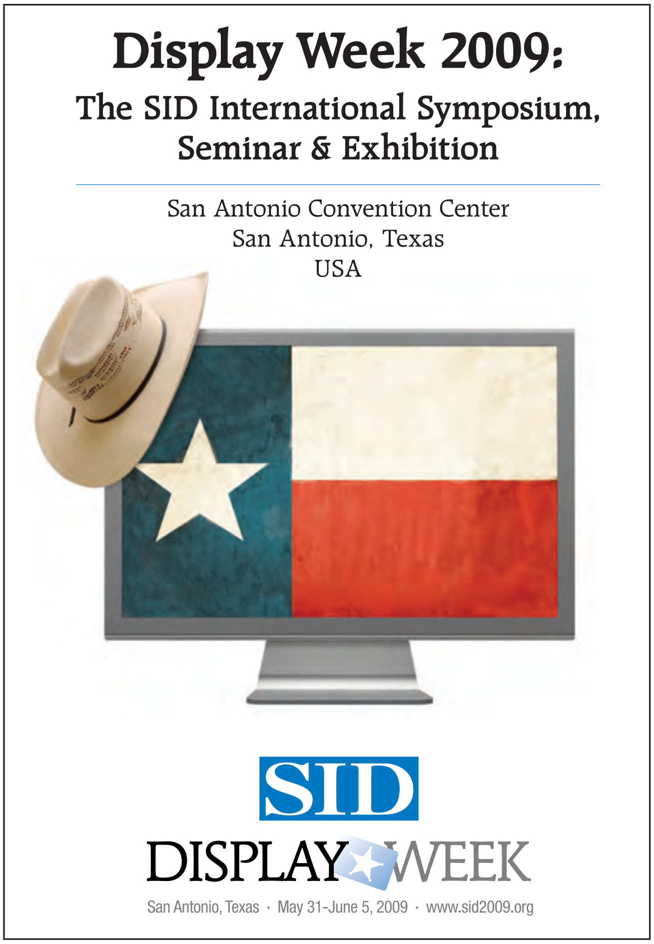
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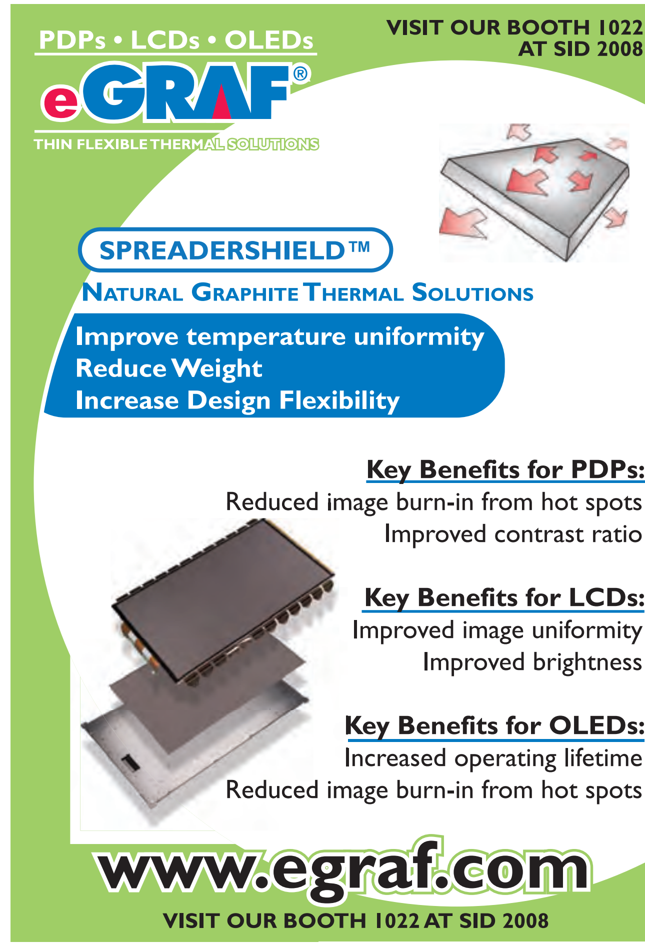
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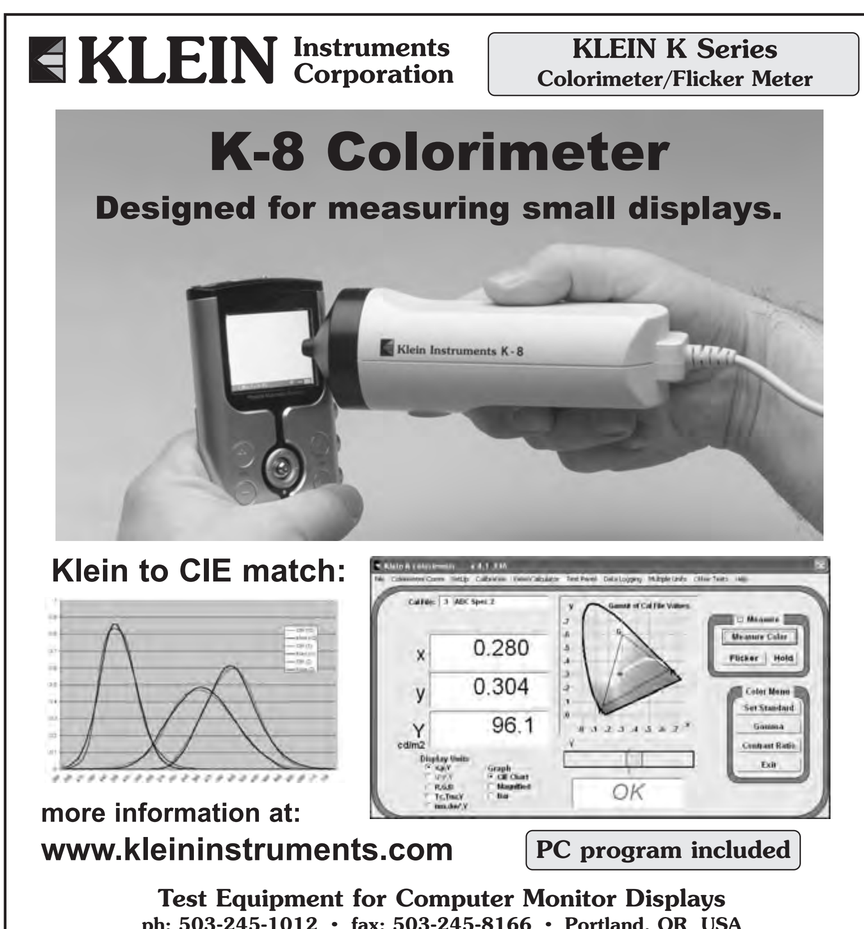
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