DISPLAY WEEK 2011 REVIEW ISSUE

Information DISPLAY

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SOCIETY FOR INFORMATION DISPLAY

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July/August 2011
Vol. 27, Nos. 7 & 8

The Stars Shone Bright at Display Week 2011 in LA

Plus

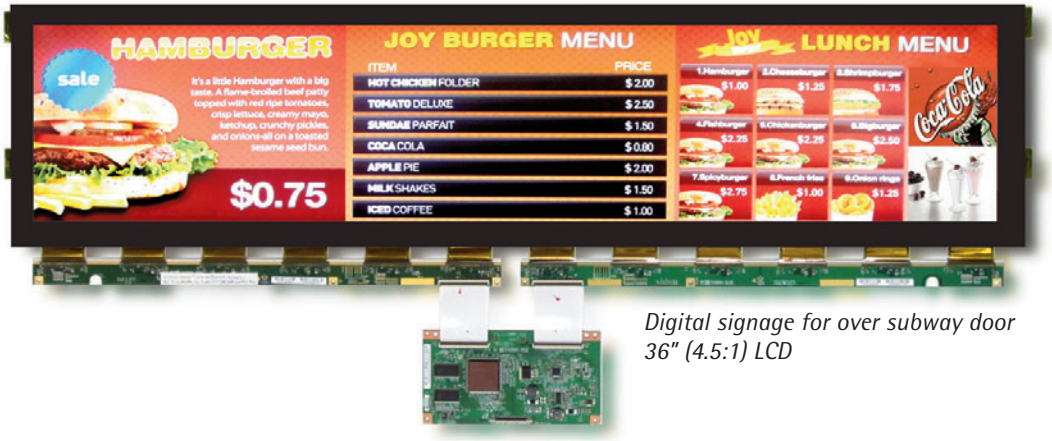
Photonic Crystals Enable Flexible Displays

Inaugural Best in Show Awards

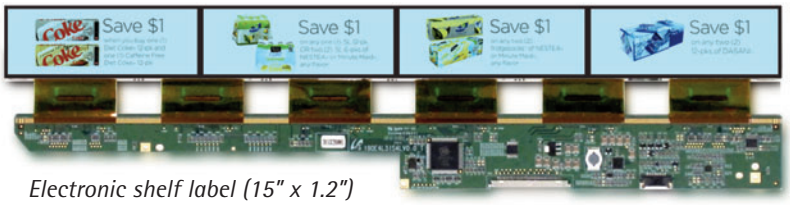
***Journal of the SID* August Contents**

RESIZING FOR CUSTOM SIZES

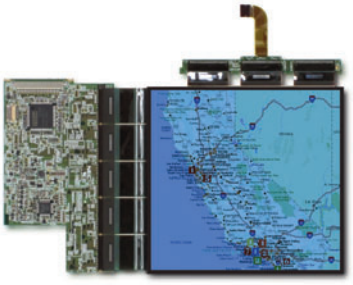
We Will Cut an LCD to Fit Almost Anywhere!



Digital signage for over subway door 36" (4.5:1) LCD



Electronic shelf label (15" x 1.2")



5 ATI aircraft instrument (4.2" x 4.2")

The resizing process has a high yield and is cost effective. Where possible, the resizing process preserves all of the LCD components, such as LC material, polarizers and attached electronics. Only the pixels remaining in contact with the row and column drivers continue to function. The performance and reliability of the original display is maintained.

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ON THE COVER: *Attendees at Display Week 2011 enjoyed many opportunities to see the latest in display technology, attend a variety of seminars and paper sessions, and catch-up with old friends. The first ever Best-in-Show awards were also presented this year to the most deserving exhibitors. Everyone enjoyed the setting at the LA Convention Center.*

Cover Design: Acapella Studios, Inc.

Next Month in *Information Display*

LCD Issue

- Future LC Technology and 3-D Displays
- 3-D Technologies for Home LCD TVs
- Large TFT-LCD Panels Shift into High Resolution
- Measuring Resolution: PR *vs.* TM Displays
- Advancing Science Education

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contents

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editorial

Optimism Prevails: A Look Back at Display Week Shows a Bright Future Ahead

by Stephen Atwood

We're looking back this month, as we do every year, to review the most noteworthy things from the SID Display Week event in May. This year, we were back in LA and we could not have picked a better place. Between the energy of that city and the renewed optimism among the many participants at the conference, it was exciting to be a part of the action again. The display industry, like every other area of our global economy, has endured some real challenges and lots of disappointments along multiple dimensions. Funding for R&D has been in short supply and so have been customers willing to place bets on unproven solutions. Many people I met this year were working at different companies than a few years before and some were still looking for their next positions. Yet despite this backdrop, Display Week was clearly about the future and provided a much-needed outlet for everyone's creative sides to emerge. From big companies to small start-ups, innovation and optimism were everywhere. If this event is a reflection of the face of the industry, then what I saw was an industry full of new ideas, constantly adapting to the marketplace, and looking way beyond 2011 with high hopes for the future.

I started my Display Week by attending the annual SID Business Conference organized by DisplaySearch. As usual, DisplaySearch did a great job organizing a program that highlighted some of the most dynamic areas of the marketplace, including infrastructure investment and emerging markets in China and 3-D technology expansion. What struck me was the sheer scale of new physical plant investment scheduled for China. Over the next few years, as many as nine new full-scale LCD fabrication facilities could be coming on line if all the current plans are realized. Similarly, several new OLED manufacturing plants are also in the plans. Now I'll concede that a large chunk of this investment is likely motivated by the growing domestic consumer market in China rather than a truly bullish view of the rest of the world. However, we are a global economy, and the China domestic consumer marketplace would not be so attractive if economic growth were not starting to return to the many international export markets that Chinese companies serve. If you did not make it to this year's Business Conference, please try to plan it into your agenda for next year. It's really a don't-miss piece of Display Week and I am very grateful for all the effort put in by the organizing team each year so we can have access to this valuable industry insight!

To give you a good picture of what Display Week 2011 was like, we asked a team of freelance writers, mostly names familiar to those of you who read *ID* regularly, to canvass the show and give us reviews of the most interesting things they saw and heard. These are in many cases their own opinions based on years of experience in their fields and very enlightening as a result. Our loyal and frequent contributor Alfred Poor covered the myriad of new innovations within the field of LCDs, of which there are too many to cover all in this issue. Naturally, one of the big attention getters was the RealD LC shutter implementation paired with a Samsung 46-in. LCD used to make a field-sequential 3-D display that can use passive glasses. (This one received one of the three inaugural Best-in-Show awards!) Behind the scenes all week was a frequent debate about the relative strengths of patterned-retarder *vs.* active-shutter glasses embodiments for 3-D, but with one demonstration Samsung and RealD essentially made that argument moot.

(continued on page 39)

Information DISPLAY

Executive Editor: Stephen P. Atwood
617/306-9729, satwood@azonix.com

Editor-in-Chief: Jay Morreale
212/460-9700, jmorreale@pcm411.com

Managing Editor: Jenny Donelan
603/924-9628, jdonelan@pcm411.com

Administrative Assistant: Ralph Nadell

Ad Coordinator: Michele Klein

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Two Industry Giants Based in Asia Unveil Technology at Display Week

by Jenny Donelan

The Beijing-based Hanwang is an extremely well-known name in China, where the company enjoys a 70% share in the e-reader market, the largest in that country. In fact, Hanvon (the company and brand name used outside of China) is the fourth largest e-reader company in the world, after Amazon, Barnes & Noble, and Sony. It also manufactured the first e-reader featuring E Ink's new color-imaging technology, Triton.

Hanvon would like to become very well-known in North America too, which is one reason why the company chose to exhibit at Display Week for the first time ever this year. Hanvon also had a new display technology to show – a dual-touch e-reader system that enables both finger and stylus input, shown at Display Week in combination with E Ink's electrophoretic technology. The company's approach utilizes electromagnetic resonance (EMR) technology. As DisplaySearch analyst Jennifer Colegrove noted in the DisplaySearch Blog covering Display Week, "What makes it unique is that the sensors are located beneath an e-paper display (from E Ink Holdings) – there is no touch sensor in front of the display. Hanvon developed the technology by adding several capacitors to a conventional digitizer touch sensor … it works by adding an antenna network just above the sensor board." This technology, adds Colegrove, can easily be added to any existing manufacturing process.

The company claims the dual-mode technology is able to outperform comparable capacitive, resistive, and acoustic-pulse-recognition technologies in precision, data report rate, and ease of use.

I had a chance to try a prototype e-reader at Display Week, and being able to use both finger touch and stylus is pretty neat. You can annotate text and write your own notes on a separate page and save the notes. You cannot, however, use both input "devices" at the same time. The prototype, at least, required you to switch between them. This is probably useful in terms of eliminating the potential for inadvertent touches when in stylus mode.

Hanvon is planning to commercialize the new technology in its e-readers in the second half of this year, starting with the Chinese market. It is currently commercially available to manufacturers in the U.S. and the rest of the world. For more about the Hanvon dual-mode technology, including a diagram, see the Touch Technology review from Display Week also in this issue.

Another powerhouse manufacturer that has been seeking increased North American visibility is Asahi Glass Company (AGC). The Japanese firm has been around since 1907, employs about 50,000 people around the world, and has annual global sales of approximately $US15 billion. It has the number-one global market share in architectural glass, automotive glass, and glass substrates for AMOLED displays, LTPS, PDPs, and projected-capacitive touch screens. It is number two for TFT glass substrates.

At Display Week, Asahi was showing Dragontrail, a chemically strengthened glass material designed for high-quality cover glass used in screens for electronic devices (Fig. 1). Dragontrail, which is being marketed as a competitor to Corning's Gorilla Glass, is, in the words of the company, "six times stronger than conventional soda-lime glass, highly resistant to scratches, and features a beautiful, pristine finish compared with resin." Dragontrail is also free of arsenic, lead, and antimony.

AGC uses a highly efficient float process to manufacture Dragontrail, utilizing the company's extensive background in producing specialized glass for electronics. AGC also says it is poised to respond to growing demand for cover glass used in televisions as well as mobile devices. (Gorilla Glass has also been used in Sony televisions, for example.)

At Display Week, AGC also announced that it has developed ultra-thin sheet glass (not yet named) that is also manufactured using the float process, and measures just 0.1 mm, roughly the thinness of a sheet of paper. Made from alkali-free glass, which is used as a glass substrate for TFT-LCDs, this extremely thin sheet float glass is designed for use in next-generation displays, lighting, touch screens, and high-tech applications such as medical devices.

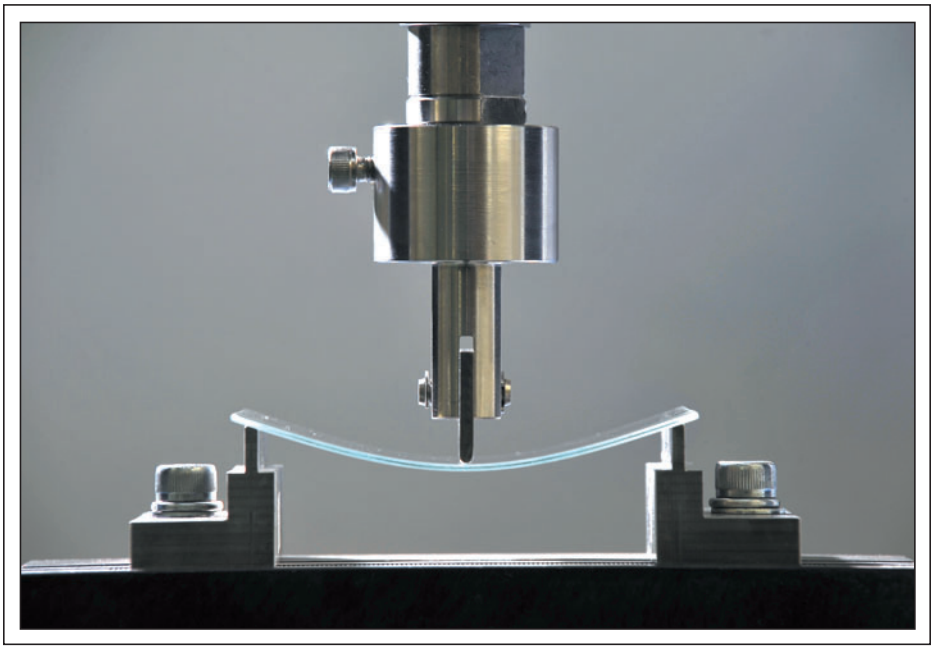

Fig. 1: *Dragontrail glass is extremely impact and scratch resistant and is being positioned as a competitor to Corning's Gorilla Glass.*

References

[1]http://www.displaysearchblog.com/2011/05/sid-display-week-2011-amoled-touch-and-3d-provide-excitement/. ■

president's note

SID Shines in Hollywood

by Munisamy Anandan
President, Society for Information Display

On March 11, 2011, at 16:46 JST, an earthquake of magnitude 9 occurred in Japan, resulting in a powerful tsunami that caused massive destruction. The entire world was in shock and our prayers went out to the people of Japan. At SID, we immediately communicated with our members in that country and received the good news that they were unharmed. We were then concerned that our Japanese members would not be able to make it to Display Week this year, but attendance from Japan in 2011 was at the same level that it was in 2010. We thank these members for participating and supporting SID despite their economic and logistical challenges, and we wish a speedy recovery to the nation of Japan and its people.

Display Week 2011 was a success, and SID maintained its leadership in all areas of display technology. We are known as the No. 1 society in the world on display technology. In that role, we serve the public by providing education on displays, we serve members by helping them gain knowledge and growth, and we serve display and display-related companies through the promotion of their businesses. The Society supports its own growth through increases in membership. In order to keep growing and providing all our services, we obtain some of our income through activities related to the business of displays. Each year, Display Week includes events – such as the Market Focus, Business, and Investors Conferences – that emphasize the business of displays.

Technology Highlights from Display Week 2011

Display Week 2011 kicked-off with keynote speeches from the University of Santa Barbara's Shuji Nakamura, who discussed the development and exciting future of high-brightness LEDs; Keio University's Yasuhiro Koike, who described the future of highly realistic face-to-face communications through the use of 3-D and super-high-resolution 4K real-time video imaging; and Phil "Captain 3D" McNally from DreamWorks Animation, who explained his personal vision for 3-D media. It was exciting to see the overflow of attendees in the ballroom, all wearing 3-D glasses to view the imagery of DreamWorks Animation.

Our very successful technical conference focused on many hot topics in the display industry. For example, several papers described the progress of blue phase in LC technology. OLED advances could be seen in a paper on a 31-in. OLED 3-D TV. The subject of 3-D continues to draw significant attention. There were exciting technical papers on active glasses, passive glasses, and "glassless" viewing of 3-D images. Many participants could be heard discussing the future of 3-D TV without glasses. Numerous member companies of SID are actively involved in solving the problems that exist in developing autostereoscopic 3-D TV.

On the substrate side, what were once thought to be rigid and breakable glass substrates are becoming flexible and nearly unbreakable! We heard papers on "roll-to-roll" manufacturing employing flexible glass. Flexible glass or even bendable glass will find applications in displays using both OLED and LCD technology. It is exciting to see this technology becoming a reality.

(continued on page 36)

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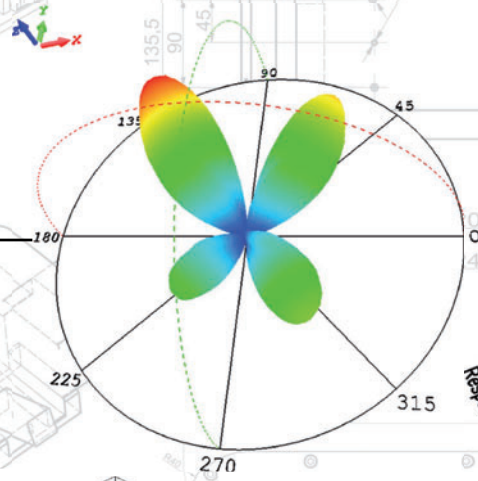

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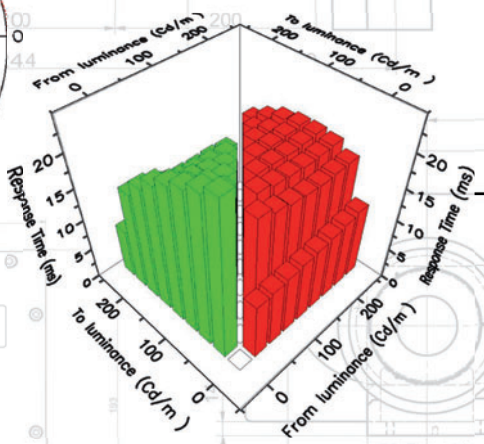

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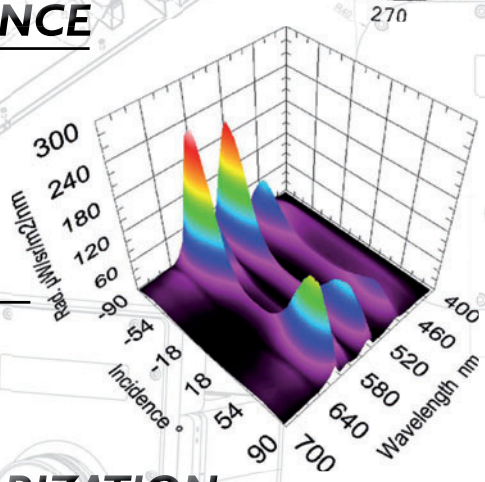

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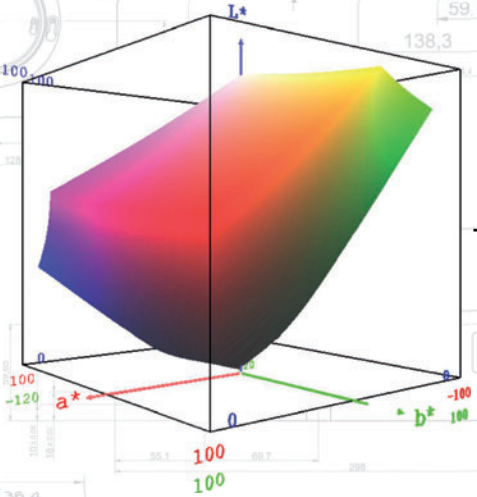

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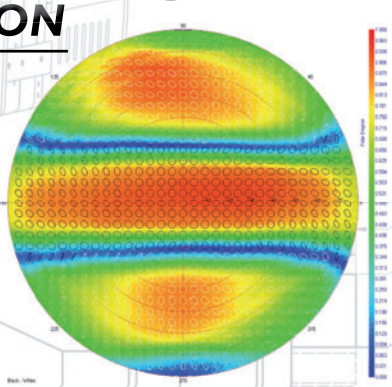

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DisplayWeek 2011 Review: LCDs

Liquid-crystal displays evolve in many directions.

by Alfred Poor

IF you stop and think about it, it is remarkable how the liquid-crystal-display (LCD) panel has come to dominate the world of information display. Not only has it displaced a variety of older technologies – most notably the cathode-ray tube (CRT) – it has also managed to enable a host of new applications that were not possible without it. Notebook computers, personal navigation devices, and even cell phones could not have been successful without thin, lightweight, and low-power LCD technology.

So it should be little surprise that LCDs dominated all aspects of Display Week 2011, from the exhibit hall floor to the Symposium sessions. And there seems to be plenty of life left in the technology, with new advances being explored in many different directions.

In the space allotted here for LCD coverage, it would be impossible even just to list all the 2011 Display Week papers, posters, and exhibits that related to LCDs. Instead, here is an overview of some of the highlights.

Display Week As a Materials Show

Materials are a good place to start because there was plenty of news on the subject at this year's show. These developments are likely to have a significant impact on the LCD industry going forward.

For example, LCD production remains a batch process using discrete sheets of mother-glass that are then cut into individual displays. There is some question as to whether or not we have reached the practical limits of this approach with Gen 10 production plants such as Sharp's Sakai facility. One possible avenue to lower production costs and higher efficiencies is through the use of roll-to-roll processing for some or all production steps. Substrates other than glass have the flexibility to make this possible, though these alternative materials have shortcomings compared to glass.

As a result, it was interesting that both Corning and Asahi Glass Company showed 0.1-mm-thick glass in their DisplayWeek exhibits (Fig. 1). While this glass has potential for several display technologies (such as serving as an encapsulation layer for OLED panels), it could have a particularly big impact on LCDs. It could eliminate a lot of weight, for example, which has advantages when multiplied times millions of units. And it could help lower production costs by increasing efficiency.

Fig. 1: *Corning's 0.1-mm-thick glass is so flexible that it can be moved in a continuous loop around rollers. Photo courtesy of Alfred Poor.*

Another group of materials that received lots of attention at Display Week were the metal oxides that are being used instead of a silicon layer for the active backplane in LCDs. Sharp has announced that it will convert about one-quarter of its Kameyama 2 Gen 8 plant to use indium gallium zinc oxide (IGZO) for its semiconductor layer. Samsung also demonstrated a 70-in. UD (3840 × 2160 pixel) LCD panel with a metal-oxide TFT backplane.

Another material that has drawn a lot of interest is "blue-phase" LC technology. This is a phase of liquid-crystal material that normally exists in a narrow range of conditions, but can be stabilized through the use of polymers. The result would be an LCD panel with extremely rapid refresh rates, with the potential for reduced motion blur. It is also possible that the panels could be fast enough to support field-sequential backlight illumination, which could eliminate the need for subpixels and color filters. There were three separate sessions devoted to blue phase alone in the Symposium, as well as a Monday seminar. (For earlier discussions of blue phase, see the November 2009 issue of *Information Display*.)

One of the most dramatic materials demonstrations was on display at the 3M booth. The company showed its "Collimating Multi-layer

Alfred Poor *is an editor and publisher of the HDTV Almanac and a freelance writer covering technology topics with special emphasis on displays. He is a Senior Member of SID and can be reached at apoor@verizon.net.*

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Optical Film" (CMOF), which makes possible a new light-mixing technology for LCD-panel backlights that it calls "Air Guide." The traditional approach to LED edge-lighting for LCD panels requires multiple layers of light guides, diffusers, collimators, and other materials. The new 3M approach combines all these functions into a single layer that is adhered to the back of an LCD panel. An air space behind this is then backed by a reflective layer at the back of the display.

The new film can eliminate as much as 3 kg of weight from a typical 52-in. LCD HDTV simply by eliminating the extra materials. It also is so effective at diffusing the edge light that the LEDs can be spaced as far apart as 60 mm instead of the standard 12 mm, which means that either display designers can use fewer LED parts or they can use the standard number with increased reliability because a failed LED will not be noticeable. There are other benefits to this more effective light mixing; for example, less-expensive white LEDs can be mixed to produce the same color temperature as more expensive pieces. As a result, this new Air Guide technology may have a big impact on large-LCD-panel design.

More Panels

Of course, there were plenty of LCD panels to see and hear about at Display Week. Samsung showed a number of displays using the Nouvoyance PenTile technology, including a tablet-sized panel with 300-ppi resolution and another with a 180-Hz refresh rate that had a field-sequential-color backlight. (Samsung also showed a 46-in. "active retarder" 3-D HDTV that uses passive glasses, employing a second LCD layer to actively switch the polarity of the image's light.)

LG had some impressive LCD panels, including a 4.5-in. display with 329-ppi resolution. A 47-in. panel with LED edge lighting along just on one side demonstrated low power consumption, demonstrating a power reading of 35–38 W.

Several companies showed LCD panels with narrow bezels designed for video-wall applications, either for control room or digital-signage installations. One of these, from Planar, had a display that used 46-in. panels and had a combined 6.7-mm-wide bezel when tiled (Fig. 2).

There were several LCD panels with integrated photosensors. Samsung showed a 40-in. panel with an IR sensor at every pixel in their high-definition 1920 × 1080 display. The sensors support input from more than 50 simultaneous points without relying on ambient lighting, a technology that Samsung has named "PixelSense." The panel is designed for use in the upcoming Microsoft Surface-2 touch display. Toshiba had a panel that integrated both a photosensor and a 1-bit memory per pixel. This 7-in. QVGA panel with "in-cell write-erasable" technology lets the user write on the screen, which then requires just 0.7 mW to maintain the image. The result is a display that can act much like an Etch-A-Sketch toy, in that you can write on the screen with a light pen and the image will be retained using very little power. You can then erase the image at any time (Fig. 3).

Industrial Applications

Many exhibitors showed LCD panels for industrial and other vertical applications. Unlike the typical consumer products that ship in the tens or hundreds of thousands, devices for medical, aviation, or industrial applications ship in much smaller quantities and a given model may need to have a lifetime that spans many years. Display manufacturers must be able to provide the customers that count on them with a steady and reliable supply.

This is not always easy to accomplish. For example, Sharp Microelectronics was informed not too long ago by its supplier of cold-cathode fluorescent (CCFL) backlights that the company was exiting the market. The Sharp engineers had to design LED-backlight equivalent displays that were plug-compatible

Fig. 2: Planar's LCD panels have thin bezels so that they can be tiled to create a video wall. Photo courtesy of Alfred Poor.

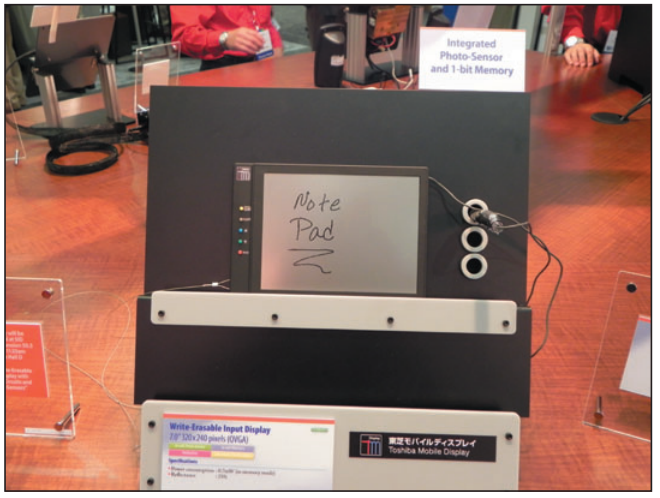

Fig. 3: Toshiba demonstrated an LCD panel that contained both light sensors and 1 bit of memory per pixel, which allows one to write on the screen with a light pen and the image to be retained using very little power. Photo courtesy of Alfred Poor.

with the original CCFL models. In most cases, they were able to incorporate the LED drivers onboard the panel. In a similar vein, Endicott Research Group (ERG) was showing LED backlight drivers at Display Week that were on circuit boards that have the same physical dimensions and mounting holes as the CCFL inverter boards that they are designed to replace (Fig. 4).

NEC LCD Technologies also provides panels for industrial applications. The company has developed a new "Color Xcell" technology that allows the color points to be reset by changing the drivers at the cell level. This provides additional color control and is a feature that will be available in all the company's products eventually. NEC also has seen growing demand for wide-format displays, as well as panels optimized for portrait orientation.

Many other companies exhibited a wide range of LCD panels intended for industrial and other applications. Rockwell Collins showed applications for its Direct Dry Film technology that allows the company to modify bare panels for everything from 3-D technologies to touch screens. Many companies also exhibited high-brightness LCD panels, including INSYNC Peripherals Corp. and Brightview Technologies. GemLight Technologies showed "Sapphire Star" displays that are rated at 2000 cd/m^2 or more, but that can also be dimmed to 100:1 as needed.

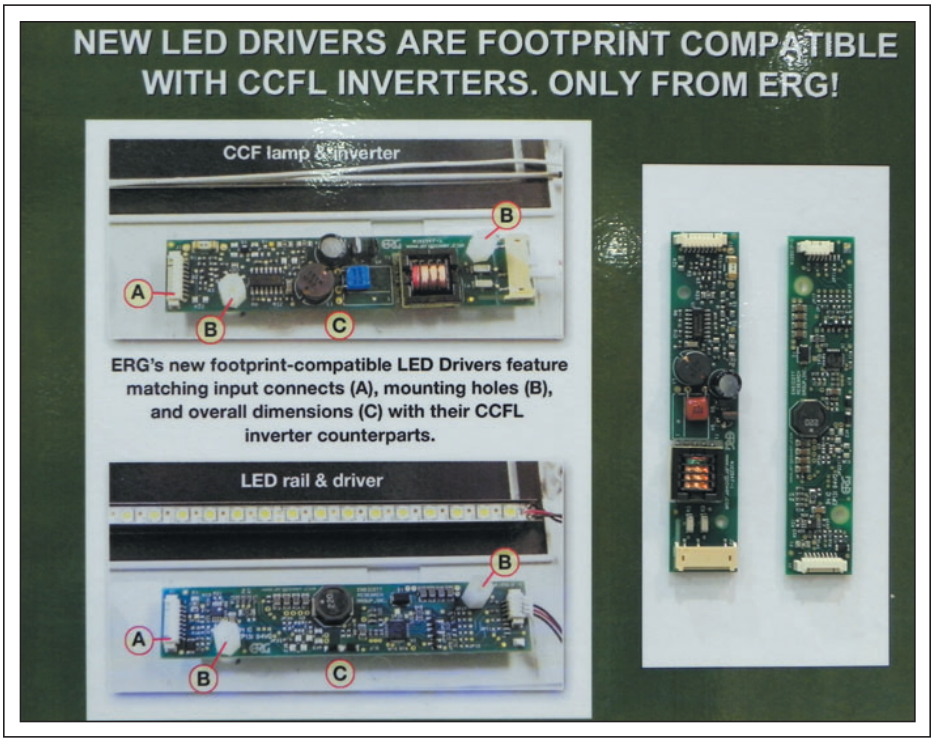

Fig. 4: LED driver boards from Endicott Research Group (ERG) are physical replacements for their CCFL inverters. Photo courtesy of Alfred Poor.

Different Shapes and Sizes

Some of the LCDs on display were not of the standard 4:3 or 16:9 aspect ratios. Tannas Electronics demonstrated its ability to cut LCD panels to just about any size or shape needed, showing a 5 × 35.5-in. panel that was cut from a 40-in. LCD panel (Fig. 5). FSN also had some novel-sized panels at its booth,

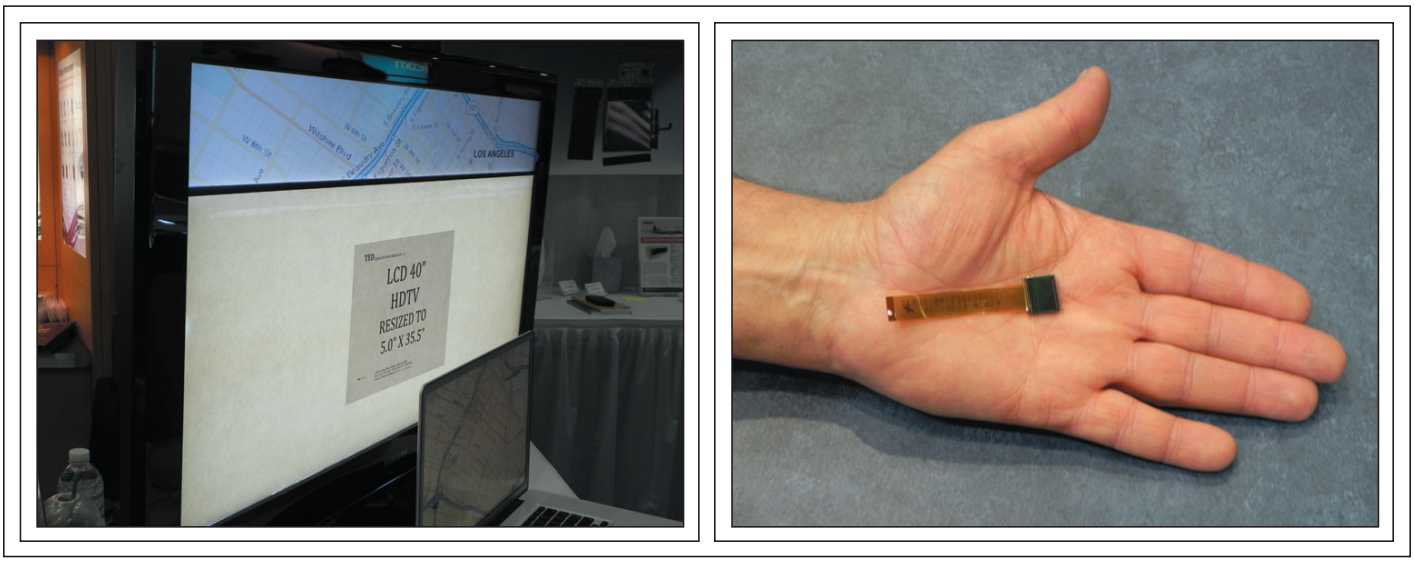

Fig. 5: Tannas Electronics can cut LCD panels to create displays with novel dimensions. Photo courtesy of Alfred Poor.

Fig. 6: Kopin's high-resolution LCD panels are less than 0.5 in. on the diagonal. Photo courtesy of Alfred Poor.

including a 1920 × 480-pixel "panoramic" display that it showed in both landscape and portrait modes .

There were even tiny LCD panels. Perhaps the smallest were the ones shown by Kopin. Their BDM-720P LCD panel has 1280 × 720 pixels – sufficient for HDTV images – in a panel that is just under 0.5 in. on the diagonal. At the same booth, they showed a new SXGA-R5 panel from Forth Dimension Displays (now owned by Kopin) that has 1280 × 1024 pixels on a panel that is just 0.88 in. on the diagonal. Designed for near-to-eye applications such as viewers and head-mounted displays, these panels use ferro-electric LCD technology. Forth Dimension plans to have a QXGA panel available in about a year, with 2048 × 1536 pixels (Fig. 6).

Still Growing

Despite of its dominant position in the information-display industry, LCD technology is not sitting still. Big and small, fine resolution and bright, standard or novel shaped, the LCD panel continues to evolve to meet the needs of new applications as they arise. While there are other technologies that show a great deal of promise, it will be increasingly difficult for them to unseat LCDs as the leading way to obtain information from our various electronic devices. ■

Display Week 2011 Review: e-Paper

A year of robust investment in more mature technologies also offers a few new surprises.

by Jason C. Heikenfeld

LAST YEAR was a breakthrough in visual terms for e-Paper at Display Week, as numerous color prototypes appeared throughout the 2010 exhibition and symposium. Sometime before the show, I wrote, with authors Paul Drzaic, Jong-Souk Yeo, and Tim Koch, a major overview of e-Paper (see Ref. 1). I was curious going into this year's Display Week about whether the rapid pace of e-Paper technology had already outdated our article.

While Display Week 2011 did not match the amount of new e-Paper technology shown at Display Week 2010, this year represented both increased product focus and firm investment from large display and electronics companies. What a great time to be involved in the technology or business of e-Paper. I find it absolutely amazing that there are so many unique horses (technologies) in the race. How long will they last? Maybe for a while, as the "perfect" color-video e-Paper has yet to be achieved, even in a laboratory setting.

It makes sense to start any e-Paper overview with E Ink Corp. At Display Week, the company showed a familiar array of excellent looking electrophoretic displays. Sony also showed a large 13.3-in. flexible module based on E Ink's Triton color technology (Fig. 1).

A couple of weeks before the conference, endgadget posted a blog (http://www.engadget.com/2011/05/04/e-ink-develops-flashing-displays-for-cloth-and-tyvek-experiment/) about possible full-motion video in the 2012 product update from E Ink. However, such a video module was not to be found at the E Ink booth – maybe next year… . To most of us, the resolution capability of E Ink at up to 300 ppi is completely satisfactory. E Ink continues to be on a roll, increasing production capacity, appearing in prototypes of numerous display companies, and, appropriately, winning the Society for Information Display's Gold Display Component of the Year Award for Triton film.

Comebacks

It was exciting to see a few of those companies that had previously exited e-Paper now back in the race and stronger than ever. Consider Samsung who just last August announced a halt to e-Paper production, and then this year strategically surprised many by acquiring Liquavista and therefore a global lead in electrowetting display technology. Samsung showed 6.3-in. color active-matrix electrowetting prototypes that appeared to have better gray scale and fewer defects than the Liquavista units displayed last year. One of the demo modules, and a symposium talk given by Liquavista engineer Andrea Giraldo, showed a low refresh rate of 1 Hz for power reduction (electrowetting displays are not bistable). Johan Feenstra, CEO of Liquavista, noted that with the acquisition by Samsung, electrowetting-display commercialization is

Fig. 1: *Sony's 13.3-in. flexible prototype uses E Ink's new color imaging technology, Triton.*

Jason C. Heikenfeld *is an Associate Professor in the School of Electronics and Computing Systems at the University of Cincinnati; telephone 1+513-556-4763, e-mail:heikenjc@ucmail.uc.edu.*

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now more focused than ever before, with a clear product and production facility in sight.

If you visited the Solutia (Flexview) booth, you might have seen Edzer Huitema, CTO of Polymer Vision, showing a defect-free 6-in. SVGA rollable display. The display used SiPix microcup front-plane technology and exhibited 40% reflection. The fact that it was defect free is important because the display came off Polymer Vision's new Gen 2.5 R&D line in Eindhoven. Polymer Vision appeared to exit the e-Paper race in 2009 when it declared bankruptcy, but was acquired in 2010 by Wistron Corp. and is now once again pushing its technology forward.

(a)

(b)

Fig. 2: *(a) External ambient illumination is used (as it would be for standard e-Paper) and (b) the display in a dark environment with the front light activated.*

New Offerings

So what was new? Actually quite a bit. There was a talk given by SiPix Imaging on its dual-mode display. It has now demonstrated prototypes with "dual color pixels," in which a single pixel can display a color or white or black. The big benefit is a possible boost in reflectance, but no strong supporting data were presented at this time. In the exhibit hall, you could find an HP electrokinetic active-matrix module (in the Corning booth), and if you were lucky enough to run into Tim Koch of HP, you were treated to a demo of a three-layered CMY prototype, which now nearly satisfies SNAP (Specifications for Newsprint Advertising Production; see Ref. 1) color standards such as reflectance and color gamut that we are all accustomed to from newsprint. This is a major advance for e-Paper.

A very interesting e-Paper adaptation was shown at the Qualcomm booth, where there were two mirasol demos that were front lit for nighttime readability. The image quality for the front-lit units was good [Figs. 2(a) and 2(b)].

This front-light concept is quite intriguing because a bright front light could possibly allow e-Readers to have a "saturated" color mode. For instance, with RGBW, if the red is turned on, the front light illuminates the red creating better color saturation than achieved with R&W pixels in the reflective-only mode. Qualcomm is not the only company working on advanced front lights, although it is the only one thus far to publicly disclose it. Regarding product launches of e-Reader/tablet-sized mirasol displays, the target date has been pushed back to late 2011. This seems to represent a strategic shift for Qualcomm, from mobile phones to larger-sized displays. Also based on optical interference, but not requiring micromechanical pixels, is the improved photonic-crystal electronic ink that Opalux CTO André Arsenault presented at the Symposium. This "P-Ink" has 60% reflection across the visible spectrum. Unlike mirasol, this technology currently can create any saturated color across the visible spectrum inside one pixel (see the article from Opalux, "Photonic Crystal Display Materials," in this month's issue of *Information Display*).

Arguably one of the most exciting presentations at the SID Symposium was Ricoh's three-layered CMY electrochromic display. In electrochromism, colorants undergo an oxidation change that shifts them between a clear or colored state. First, the white-state reflectance was 70% (although the black state was not fully black yet). Second, the color gamut was vastly improved through the use of CMY stacking as opposed to RGBW. Third, the stacked display used a common electrolyte that coupled all three layers to a single backplane. This eliminates many of the optical losses in CMY stacking. Only two substrates were used, a first ever for stacked e-Paper. Although slow (it took seconds to refresh), the gray scale was striking for a first demo (see Fig. 3).

I was impressed by how the three layers were stacked and addressed between just two substrates. Ricoh reported that each layer is only ~ 2 μm thick, and when questioned in the session, company representatives claimed 20,000 cycles of operation. Akira Suzuki of Ricoh has been seen at every display conference for as long as I can remember, assessing what technologies Ricoh should pursue. It looks like the company's first major bet may now be played.

Fig. 3: *Ricoh unveiled a three-layered (CMY) electrochromic display capable of 70% white-state reflectance and, amazingly, driven with a single backplane.*

ADT and Gamma Dynamics reported on the progress in their variations of displays using electrowetting, not to change surface wetting, but to move (transport) colored fluids inside microfluidic pixels. The ADT booth showed a first-ever medium-sized droplet-driven prototype (Fig. 4). ADT's Frank Bartels also noted the availability of evaluation kits late this year, with initial products in 2012.

Last but not least, a resurgence in traditional liquid-crystal displays (LCDs) was seen throughout the exhibit hall. Sharp displayed two polymer-network LCDs. Also, the new Chinese startup company Halation showed numerous smectic LC products (see Fig. 5).

I ran into display industry expert Mark Willner, who is knowledgable about smectic-A displays and Halation in particular. He was impressed by how far the company had come in just 2 years in developing both smectic-A liquid-crystal materials and displays for production in China. Mark said "If Halation is able to improve performance and meet ESL market requirements, they could become a significant player." None of these LC technologies look superior to E Ink or other more optically diffuse displays, but the infrastructure for LC technology is strong, so the costs for such displays could be quite low, even in the short term. Kent Displays did not exhibit, nor were there many cholesteric demos, except for several papers and demos presented by ITRI.

It is not possible to cover all the e-Paper seen at Display Week 2011 in this short review. Almost every major company has reflective technology in production or development. However, e-Paper is still only widely available in monochrome formats. After approximately 1 year, the major technologies reviewed in our *JSID* paper are still in play. None of us knows all the true challenges and benefits for all the competing technologies. Presentations, demos, and review articles such as this will soon give way to the ultimate judge of commercial success or failure – the marketplace. Looking forward to next year, will we have color E Ink (electrophoretic), Bridgestone (liquid powder), Qualcomm (mirasol), and Samsung (electrowetting) modules in the marketplace? The demos look ready to go. Some now already have video, which pushes e-Paper into closer competition with LCD and OLED tablets. Next year should be a critical one for accessing the ability of e-Paper to move beyond signage and e-Readers.

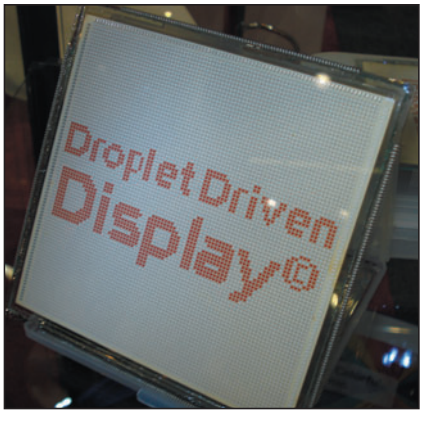

Fig. 4: *ADT showed, for the first time, a highly pixelated and bistable droplet-driven (electrowetting) display.*

Fig. 5: *Halation's smectic-A e-Paper displays exhibit good e-Paper performance with the potential for low-cost manufacturing.*

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Display Week 2011 Review: 3-D

Active-polarization switching may be the shape of things to come for home 3-D.

by Steve Sechrist

AT DISPLAY WEEK 2011 IN MAY, the experts on hand were publically shown prototypes of what may be the most significant technology for the next generation of 3-D TVs. What is known as active-polarization switching moves active-shutter technology from 3-D glasses onto the flat-panel LCD (eliminating the need for active LCD shutter glasses.) The result is a full-HD-resolution video image for each eye using passive (circular polarized) 3-D glasses.

Generating particular excitement at the show were full HD 3-D monitor and TV prototypes based on active-polarization switching technology. These prototypes, based on RealD TV Display Technology (formerly known as RDZ 3D Display Technology) were presented in the RealD booth. Working with consumer-electronics-giant Samsung, RealD has plans to develop a 55-in. 3-D TV and two monitors in 23- and 27-in. sizes. Panels incorporating the technology are scheduled to ship by early next year. (This technology won a 2011 Best-in-Show award from SID; see the article in this issue.)

To integrate the active shutter onto the screen, a second low-resolution non-TFT-LCD sheet is directly bonded to the LCD panel, which adds or subtracts a quarter-wave plate (circular rotation) to the already polarized light coming from the LCD. In the RealD TV approach, rows are scanned from top to bottom, in sync with eight horizontal bars of LC control electrodes that, when energized, switch the light for the left- and right-eye images to create the 3-D effect when the passive circular polarized glasses are worn (see Fig. 1.)

The RealD/Samsung approach replaces the existing film-patterned retarder (FPR) technology, which inserts a non-active sheet of micropolarizers over the LCD panel, with alternating odd and even rows of orthogonally oriented quarter-wave plates to create left and right circular polarized light (Fig. 2). The down side to this simpler FPR method is that it is achieved by presenting 540 lines per eye rather than the full 1080 in normal 2-D full HD. The active-polarization switching breakthrough that was recently announced and demonstrated finally overcomes this issue, which had prevented many television makers from adopting the 3-D FPR approach.

Background: Passive *vs.* Active

Even with concerns over the resolution tradeoffs associated with the FPR approach, LG has said it is compelled to deliver this technology, as consumer studies show that passive glasses are preferred over the heavier active glasses. Ever since the Consumer Electronics Show in January 2011, and the decision by LG to standardize its 3-D TV product offering on the FPR approach with passive glasses, the company has been at odds with the bulk of the consumer-electronics establishment, which

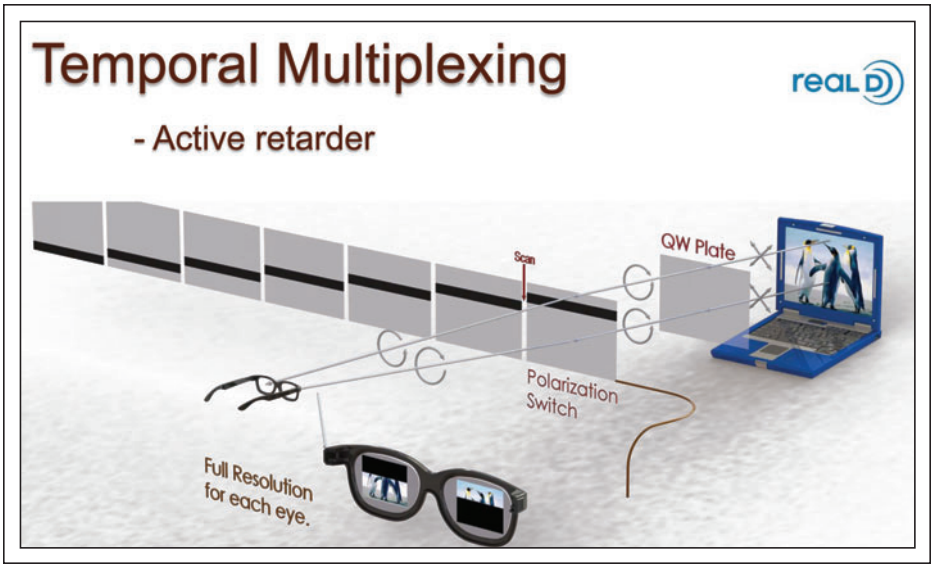

Fig. 1: *RealD's active-retarder approach was demonstrated at Display Week. Source: RealD.*

Steve Sechrist *is an 18-year technology and display-industry veteran who has held positions as a Sr. Analyst and Editor for Insight Media for the past 6 years. He serves on both national and local SID committees as well as the local Pacific Northwest SID Chapter. He can be reached at sechrist@q.com.*

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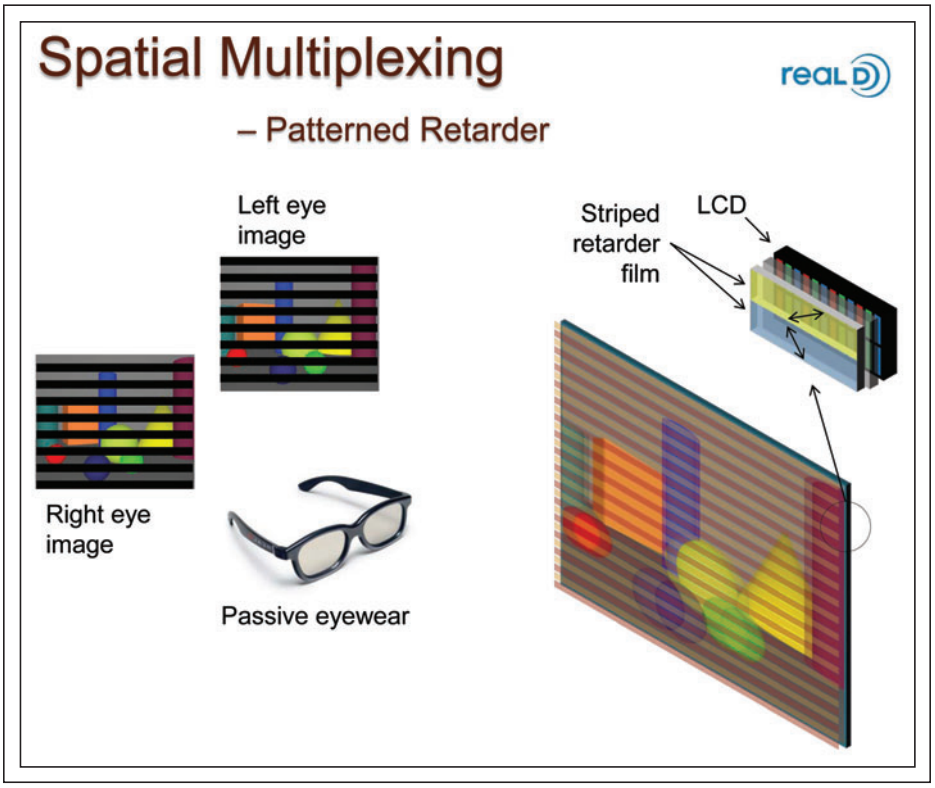

Fig. 2: *Patterned-retarder technology allows the use of passive glasses but at decreased resolution. Source: RealD.*

initially turned to active glasses to bring 3-D images to the living room.

Passive 3-D, which includes the RealD approach used in most U.S. cinemas, does offer a string of compelling benefits that go well beyond consumer preferences for low cost, comfort, and simplicity, including the promise of flicker-free viewing with low cross-talk, enhanced brightness, fast frame rate, and freedom of motion with support for head tilt. Environment permitting, getting cozy (cuddling on the couch) or lying down to view a 3-D program is possible with passive glasses.

But resolution concerns have been one of the big turn-offs for most 3-D TV makers, and to Samsung's credit, they never seemed to want to compromise a high-resolution image, particularly in delivering 3-D to the living room. The company opted for the costlier active-shutter glasses, using individual LCDs in the left and right lens of the glasses to do the shuttering, a methodology that offers a full-HD-resolution image. In fact, most manufacturers characterized the higher-cost, higher-specification, active-shutter-glasses solution as the "step-up" technology for 3-D in the home. "Pay a bit more and get a superior HD-resolution 3-D image" was the rallying cry for the 3-D active-shutter-glasses technology. This still holds true today, except for the RealD TV approach, which delivers full-resolution HD 3-D utilizing passive glasses.

Active glasses come at a high price for consumers, a price that goes beyond just the pocketbook. The cost is up to $250 retail for the glasses, yes – but the active technology also reduces brightness in the TV by 15–20%, even for 2-D viewing. Lack of standards is keeping the technology price high, and one set of glasses from one TV maker may not work on a different maker's set.

The Next Wave?

The RealD TV technology is endorsed by James Cameron, who sits on the RealD board of Directors. In a press release at SID, the iconic 3-D film director described the new technology as "… the next step in 3-D home entertainment." He emphasized the importance of resolution, stating "Full-resolution viewing is key to experiencing 3-D as a filmmaker intended, and when combined with the comfort and practicality of RealD 3-D cinema glasses, this display technology will set a new standard for 3-D in the home" (Fig. 3).

It is important to note that the active polarization approach is not new and does not come without some challenges. LG introduced the technology at SID 2009, in a paper on active-retarder technology, before switching its attention to FPR technology. Concerns with the approach include switching speed and sourcing the STN panels in large quantities. There are no fabs in the Gen 8 process that are making the kinds of panels needed to ramp quantities to the point where the active polarized 3-D approach would be reasonably affordable. So speculation is that we will not see high-volume 3-D sets in this range until sometime in 2013. RealD has been known to be working on a fast-switching active retarder as a separate optical element added to an LCD panel. The company has stated it will have this technology available in 3-D LCD panels by the end of 2011.

Another example of this approach comes from Sweden-based LC-Tec and Seiko Instruments, Inc., which have been working together on providing high-speed liquid-crystal devices since January 2011. The two companies signed a letter of intent at that time with plans to leverage LC-Tec's fast-switching technology with the high-yield manufacturing prowess of Seiko. Among other initiatives, they are targeting active retarders for

Fig. 3: *At SID, Samsung teamed with RealD to show passive 3-D with full HD to each eye.*

direct-view displays that can switch polarization state at 120 Hz.

For the time being, consumers must choose between a lower-resolution, albeit simpler, passive 3-D technology based on FPR, or perhaps a step-up high-resolution 3-D TV display that uses active-shutter glasses without compromising the full-HD image delivered to both the right and left eye. At SID, we had a peek at what may come to be the 3-D standard that eventually replaces both these mainstream technologies. ■

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Display Week 2011 Review: Touch Technology

2011 was the year that projected capacitive became the dominant touch technology in terms of revenue, and this was evidenced by its overwhelming dominance on the show floor.

by Geoff Walker

TOUCH continued to take an increasingly important role at Display Week 2011, with almost 40% of the approximately 200 exhibitors being directly or indirectly related to touch. There were 37 companies showing touch modules or controllers (compared with 33 last year) and 38 (*vs*. 34) companies showing related products such as adhesives, transparent conductors, glass, films, coatings, filters, bonding services, haptics, styli, touch monitors, touch-integration services, market-research reports, manufacturing start-up support, IP sales, and newsletters.

Projected capacitive (pro-cap) was by far the most frequently shown touch technology, as shown in Table 1. Twelve touch technologies were shown by the 37 exhibitors, with analog resistive and multi-touch resistive taking the second and third spots. This is quite representative of the real world, since pro-cap and resistive are expected to account for more than 95% of the world's total touch-screen revenue in 2011.

Projected Capacitive

Perceptive Pixel announced a 27-in. projected-capacitive touch monitor at Display Week 2011 (shown in Fig. 1). Jeff Han, the founder, president, and CEO of Perceptive Pixel, is well known for his conference presentations over the last several years (including at Display Week 2010) during which he has complained that the touch industry's habit of settling for the minimum acceptable performance is a harbinger of serious future problems. Jeff decided to show the industry how to do it right – *i.e.*, put performance first. His 27-in. monitor is exceptional, starting with a 2560 × 1440 (109 dpi) premium IPS-LCD. The touch screen uses a 32-in. piece of glass; this "intentional overscan" beyond the edge of the 27-in. LCD creates a significant advantage in usability. For example, touching a close-window button in the upper-right corner of the screen becomes much easier because one can touch anywhere above or to the right of it in the "overscan margin" of the touch screen.

The key to the monitor's performance is the custom pro-cap controller developed by Perceptive Pixel. The controller implements the absolute minimum hardware necessary to collect the data that comes out of the sensor and puts everything else in software, along with a large amount of signal processing. This makes it much easier to tune the controller's design for absolute maximum performance (*e.g.*, the 1-msec touch-response time that Perceptive Pixel claims, which leaves everyone else – including 3M Touch, the former performance leader – in the dust).

Roll-Your-Own Controller

Perceptive Pixel, developing its own pro-cap controller, is actually symptomatic of a trend that is occurring in the touch industry. At

Table 1: Twelve touch technologies were shown by the 37 companies exhibiting touch modules or controllers at Display Week 2011. The total adds to more than 37 because many companies showed multiple technologies.

Touch Technology	Exhibitors
Projected Capacitive	23
Analog (Single-Touch) Resistive	13
Multi-Touch Resistive	6
Surface Acoustic Wave (SAW)	3
Infrared (IR)	2
Electromagnetic Digitizer (EMR)	2
In-Cell	2
Surface Capacitive	1
Dispersive Signal Technology (DST)	1
Acoustic Pulse Recognition (APR)	1
Camera-Based Optical	1
Force-Sensing	1
TOTAL	**56**

Geoff Walker *is a Principal Analyst for Touch Research at IMS Research, a leading independent provider of market research and consulting to the global electronics industry. He has also been* Information Display*'s Guest Editor for Touch in 2007, 2010, and 2011. He can be contacted at geoff.walker@imsresearch.com or 408/945-1221.*

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Fig. 1: *Jeff Han, the founder, president and CEO of Perceptive Pixel, shows off his brand-new 27-in. pro-cap multi-touch monitor. Photo courtesy Geoff Walker.*

least 40% of the software inside pro-cap controllers sold by major suppliers such as Atmel and Cypress is typically totally proprietary; *i.e.*, the source code is not available to an OEM customer under any circumstances. Integrating a pro-cap touch screen is still somewhat of an art rather than a science, and the lack of access to source code can create a significant barrier when "tweaking" the match between the sensor and the controller. If an OEM customer is buying multiple millions of controllers (*e.g.*, for a smartphone), the controller supplier simply provides whatever amount of on-site field-applications-engineering (FAE) resource is required to solve any problems.

But what if the OEM customer is a medical-device manufacturer that's making only tens of thousands of devices? The major controller suppliers simply cannot afford to support such a small customer. In response to this situation, a number of pro-cap module suppliers are developing their own controllers. Apex Material Technology (AMT) is an example of such a supplier; taking this approach allows the company to supply a complete, integrated touch solution that it can fully support. Even TPK, the largest supplier of pro-cap in the world, has developed its own controller.

Yet another example of this trend is 3M Touch – which announced at Display Week 2011 that the pro-cap touch screens used in its high-performance touch monitors are now available as components. This leading-edge product consists of two patterned-ITO films manufactured on 3M's own roll-to-roll equipment and laminated to the back side of a sheet of glass, along with a 3M-developed controller. While 3M's initial focus for these new components remains on vertical markets, the company is confident that continued cost-reduction in its manufacturing processes will allow it to meet the price points demanded by consumer electronics manufacturers in Asia.

This trend can be viewed as a good-news/bad-news situation. The good news is that it is enabling pro-cap technology to spread quickly to all sizes of customers; the bad news is that it is probably prolonging the time it will take for pro-cap to reach the level of standardization enjoyed by mature touch technologies.

Other Interesting Pro-Cap Exhibits

NEC LCD Technologies (through its U.S. representative, Renesas Electronics America) demonstrated a prototype of a 10.4-in. SVGA industrial LCD with fully integrated touch. The touch screen in this product is on-cell pro-cap, meaning that the sensor is located on the top surface of the color-filter glass, underneath the polarizer. The most unusual aspect of the product is that the controller (apparently designed by NEC, in another example of the previously described trend) is totally contained within the LCD's standard-sized frame. This makes the integrated touch display a drop-in replacement for existing displays.

There were two other examples of on-cell touch on the show floor, one from Sharp and one from LGD. The latter was in a 3.2-in. IPS-LCD. IPS makes doing on-cell touch more difficult, since the primary noise source is closer to the touch sensor. LGD claims a 20:1 signal-to-noise ratio for its design, which is about double that typically reported for in-cell and about half that typically reported for add-on (out-cell) technology. LGD believes that it can scale its on-cell technology to 22 in. without difficulty – although nobody has actually done it yet, particularly with IPS.

Touch International showed a 10.4-in. pro-cap touch screen made on a sheet of 0.7-mm cover glass. The sensor consisted of two ITO-PET films laminated to the back of the glass; the glass also had logos on it and holes drilled in it. Touch International said that in volumes of 25K, this configuration would sell for $35–$40 – which is actually quite economical, considering the underlying current market price of $3 per diagonal inch for plain pro-cap with no decoration.

Zytronic showed a 10.4-in. ITO-based pro-cap touch screen that represented a significant change for the company, since it has long been a proponent of wire-based pro-cap. A booth representative said that the change was

driven by a desire to be able to participate in higher-volume vertical applications.

Wacom finally launched its 22-in. pro-cap touch screen (with its own custom controller) at Display Week 2011. This is a significant milestone because the company has been showing it in prototype form since November of 2008. Performance of the product is decent for a 22-in. screen; Fig. 2 illustrates the response in a worst-case test (top: 10 fingers drawing circles as quickly as possible) and an average-case test (bottom: two fingers, one drawing circles at a moderate pace while the other one writes the letters A-B-C).

N-trig provided a refreshing change at Display Week 2011. Instead of displaying its dual-mode (pen and finger) pro-cap touch-screen hardware, it focused on showing off some of its OEM customers' products. The most interesting product was the HTC Flyer, a 7-in.,very thin (0.5-in.) Android tablet currently selling at Best Buy for $499 (see Fig. 3). While the appearance of the product is very appealing, HTC's implementation of N-trig's touch screen is less so in that it is entirely modal; *i.e.*, the user must manually select either pen or finger mode as desired. This is a very clumsy user interface compared with the elegant automatic mode-switching implemented by some of N-trig's other OEMs.

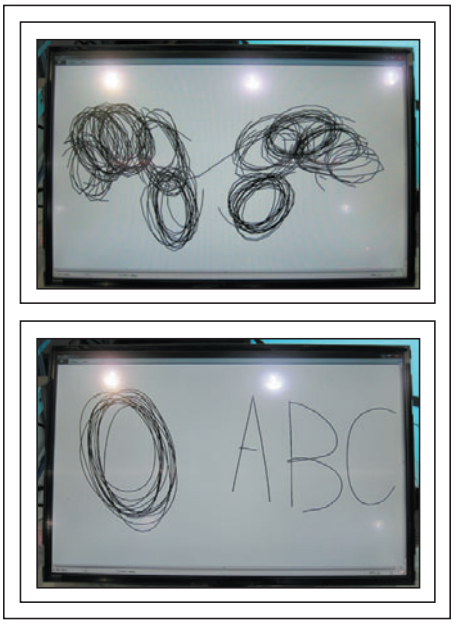

Fig. 2: *Top: Wacom's 22-in. pro-cap touch screen shows a worst-case test with 10 fingers drawing circles as fast as possible. Bottom: An average-case test uses two fingers, one drawing circles at a moderate pace while the other writes the letters A-B-C. Photo courtesy Geoff Walker.*

Fig. 3: *The HTC Flyer Android tablet with a 7-in. display and N-trig's dual-mode (pen and finger) pro-cap touch screen. With the product thickness at only 0.5 in., there is no internal storage for the stylus. Photo courtesy Geoff Walker.*

In-Cell Touch

Not much is happening yet commercially with in-cell touch technology. The only two examples shown at Display Week 2011 were prototypes from Samsung and Toshiba. Samsung showed its 40-in. Interactive Display, developed jointly with Microsoft as the basis for Microsoft's second-generation Surface product (announced in January 2011). This is a 1920 × 1080 (55 dpi) LCD with optical in-cell touch, branded by Samsung and Microsoft as "PixelSense." Samsung's main breakthrough in this product is that it uses one sensor per pixel (that's 2M sensors!), something that nobody else has been able to accomplish without significant loss of aperture.

Interestingly, Samsung's demonstration included a secondary display that showed the output of the sensor array (presumably infrared light converted to visible light). Figure 4 shows the effect of touching the 40-in. display with a flat palm (top) versus just the fingertips (bottom).

The only other example of in-cell touch at Display Week was a 7-in. 1024 × 600 LCD by Toshiba that employed a variation of in-cell capacitive. Instead of measuring the change in capacitance between two internal electrodes

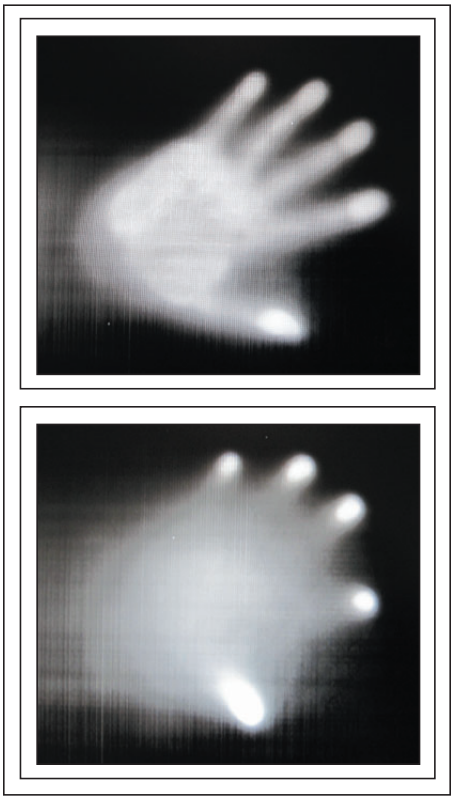

Fig. 4: *These photographs show the sensor-array output (displayed on a secondary LCD) from Samsung's 40-in. in-cell optical ("PixelSense") LCD. Top: The author's palm flat against the display. Bottom: Fingertips only. Photo courtesy Geoff Walker.*

due to the change in dielectric constant of the liquid-crystal material that results from the pressure of the user's finger, Toshiba's scheme measures the change in capacitance of a single electrode due to the addition of the user's body capacity. The scheme uses one sensor per 16 pixels, which is typical of most in-cell implementations (other than Samsung's). Unfortunately, the author was unable to make the demo function properly; it would not even consistently recognize two touches, even though the demo signage said that the display was capable of recognizing 10 touches.

Other Touch Technologies

Hanvon's new dual-mode (pen and finger) electromagnetic resonance (EMR) digitizer was the only totally new touch technology announced at Display Week 2011. Hanvon is a well-known supplier of EMR digitizers; the company competes with Wacom in applications such as pen systems for eReaders. Hanvon's breakthrough is the addition of an array of pressure-sensing piezo capacitors to the existing EMR sensor (see Fig. 5). These are very similar to the capacitors used as the pressure sensor in the tip of the digitizer pen, so in a sense it is like replicating a portion of the pen circuit on the sensor board beneath the display. The operation of the pen is unchanged; the addition of the capacitors allows finger pressure to be sensed through the electronic-paper display (EPD). This is a particularly good solution for touch on e-Readers because nothing is added on top of the EPD, which relies entirely on reflected light for its operation. None of the touch technologies currently used in eReaders (resistive, pro-cap, infrared, and EMR digitizer) offer this combination of high-resolution stylus and light-pressure finger touch. In the author's opinion, this new touch technology is likely to gain significant traction in the eReader space.

F-Origin's force-sensing touch technology was a welcome addition to Display Week 2011. During 2010, F-Origin had contracted down to only one person; with the infusion of an investment and a partnership with TPK, it is now back on a growth path. The company is also on its second major generation of technology. In the previous implementation, the display was supported by strings of monofilament; in the latest, it is supported by two metal suspension spring arms (see Fig. 6), which seems to be a much more robust approach.

Elo TouchSystems, now a trademark of TE Touch Solutions (a business unit of TE Connectivity, formerly called Tyco Electronics), focused attention on its latest innovation, a two-touch zero-bezel SAW touch screen and monitor. Performance was very good, showing significant improvement over the previous non-zero-bezel generation. In support of its basic "touch-technology agnostic" positioning, Elo also showed a set of hand-sized samples of six of its touch technologies. While this isn't rocket science, it is good (and fun) marketing. The samples made very clear the

Fig. 5: *In Hanvon's dual-mode (pen and finger) EMR digitizer, the sensor board (labeled "ERT unit") is shown inserted between the electronic-paper display (EPD) and the motherboard in an e-Reader. The circles shown on the sensor board represent one column of an array of force-sensing piezo capacitors. Image source: Hanvon.*

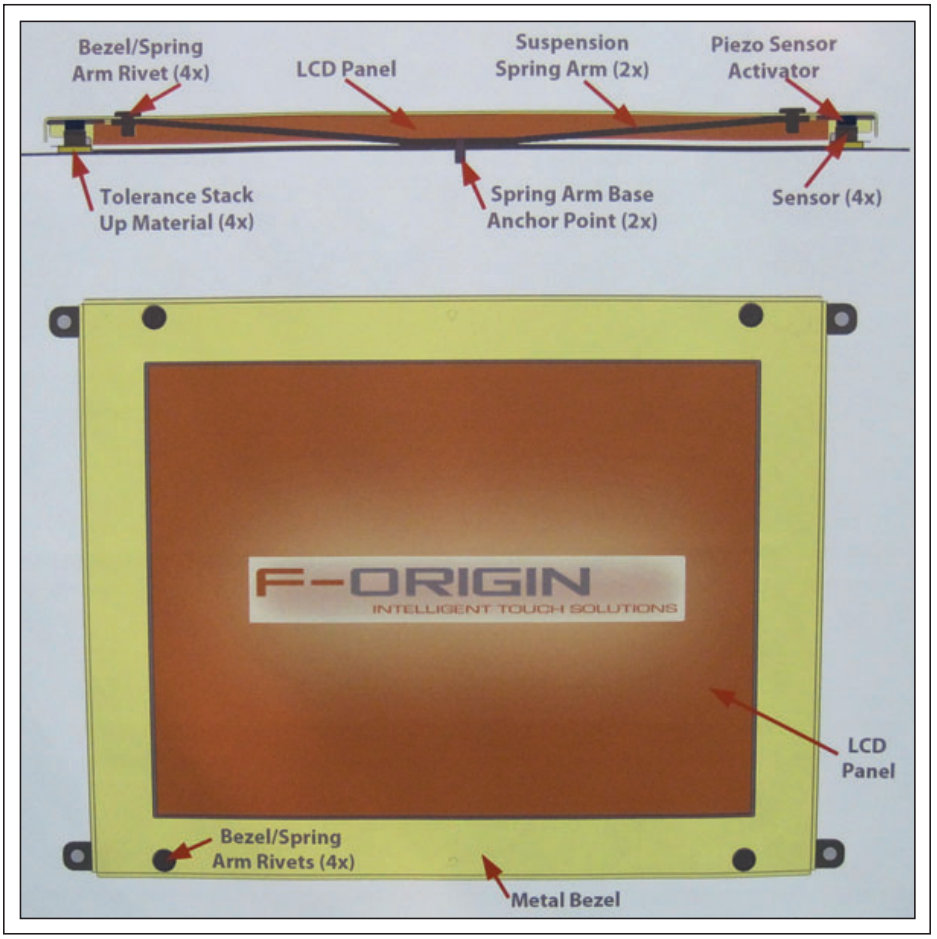

Fig. 6: *F-Origin's force-sensing touch technology uses metal spring arms to support the LCD and constrain its movement to only the Z-direction. Image source: F-Origin.*

physical differences in the touch technologies, something that's often valuable for newcomers to experience.

Other Interesting Bits

As previously shown in Table 1, there were six companies demonstrating multi-touch resistive. However, none of them would admit to winning any significant amount of business with the technology, at least not in the consumer-electronics space. The problem seems to be that it is very difficult to compete with the pro-cap express train, even at two-thirds the cost.

Baanto was the only supplier of camera-based optical touch exhibiting at Display Week 2011. While the performance it demonstrated was definitely a significant improvement over its 2010 performance, in the author's opinion it was not significantly better than that of competitors such as NextWindow and Quanta.

Fujitsu showed a new version of its four-wire resistive touch controller that included integrated two-point "gesture touch" – *i.e.*, multi-touch that works well for gestures such as pinch/zoom but does not actually meet the Microsoft Windows 7 touch-logo requirements. Unfortunately, the demo/prototype gods were not kind to Fujitsu; when the author tried it, the two points could not be recognized if they were closer than about two inches.

Summary

Once again, there was an amazing amount of touch technology at Display Week 2011, probably more than at any other conference worldwide in the last year. This is especially clear when one considers the additional touch resources at Display Week beyond the exhibits, including the Symposium touch papers, the Sunday Short Course on touch, the two Monday Seminars on touch, the Wednesday SID-IMS conference ("The Future of Touch and Interactivity"), and, finally, the Thursday touch posters. There was so much touch at Display Week 2011 that it was actually overwhelming. ■

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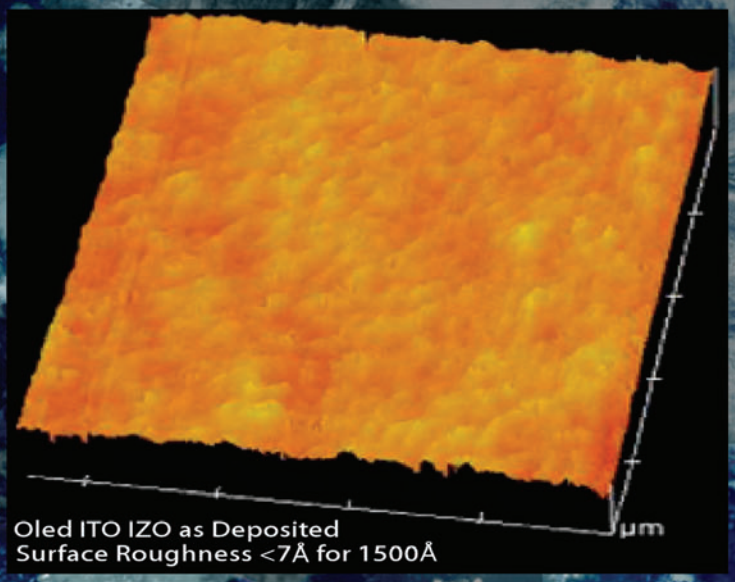

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Photonic-Crystal Display Materials

Photonic Ink (P-Ink) technology comprises an active photonic crystal that reflects a band of color that can be tuned by controlling the applied current or voltage. All the individual spectral colors in the visible range can be reflected by a single P-Ink material. This technology provides an opportunity to create a wider range of primary colors than the conventional RGB system, given the same numbers of pixels for color mixing.

by Hai Wang, Fergal Kerins, Ulrich Kamp, Leonardo Bonifacio, André C. Arsenault, and Geoffrey A. Ozin

PHOTONIC CRYSTALS (PCs)[1] are materials with a periodic modulation in their refractive index. They are exemplified by opal gemstones and countless other natural materials and can be used to reflect bright and pure visible colors through coherent Bragg diffraction. While studies on natural and synthetic opals have been ongoing for over half a century, the development of a theoretical framework for PCs in the late 1980s heralded a resurgence of interest and potential applications for these materials. Once the physics was outlined, it took some time for the associated materials chemistry to catch up, specifically around self-assembly routes to PC structures using monodisperse spheres. Over time, by harnessing the incredible diversity of synthetic chemistry, an encyclopedic array of structures could be produced. As an additional matter of great interest, it was found that incorporating active materials into such structures could allow the reflected colors to be tuned over a wide range of spectra, from UV to visible to near-IR.

Opalux, Inc., is developing a platform of technologies based on photonic color. These technologies consist of active polymer-based PC materials that can respond to an array of stimuli such as pressure, stretching, heat, humidity, and electrical current/voltage. Each of these technologies is created through the incorporation of specially formulated polymer materials. One of the technologies is Photonic Ink (P-Ink), a tunable electroactive material. By applying different voltages to this material, the PC structure can be modulated to reflect any desired spectral color in the visible spectrum. Not only is the color tunable, but switching is carried out at low voltages (1.5 V or lower) and amperages (μA), and the resulting color states are bistable.

The e-paper market is growing at a staggering rate, with a diversity of product offerings slated for release in the coming months. However, there are few color e-paper products available on the market; current examples such as E-Ink's Triton technology represent a strong first step, but the available color gamut is quite limited, which suggests that a large and unmet consumer demand still exists. Given its unique opto-electronic properties, P-Ink could form the basis of a next-generation e-paper material. Opalux has been testing and developing P-Ink technology for display applications, and many of its metrics compare favorably with alternative technologies. This technology maintains the strong advantages of full-spectrum tunability, low power, and bistability, while providing high reflectivity, saturated colors, and fast switching speeds.

P-Ink Materials

P-Ink materials are nanocomposites, fabricated through a combination of colloidal, inorganic, and polymer chemistry.[2,3] The structural scaffold of P-Ink materials is made up of an ordered array of silica microspheres. The voids between these microspheres are filled with a crosslinked network of a ferrocene-based metallopolymer, which is known to display reversible redox properties.[4] Ferrocene is an organometallic species consisting of an iron atom sandwiched between two aromatic organic ligands. It displays remarkable chemical stability.

P-Ink Display Devices

P-Ink display devices are fabricated by incorporating P-Ink composite films coated on a conductive substrate into a sealed electrochemical cell. A spacer material is used to separate a counter-electrode from the P-Ink film, with the resulting gap filled with an electrolyte. More-complex devices incorporating pixels are fabricated using standard lithographic techniques.

***Hai Wang, Fergal Kerins, Ulrich Kamp, Leonardo Bonifacio**, and **André C. Arsenault** are with Opalux, Inc., based in Toronto, Canada. **Geoffrey A. Ozin** is a professor in the Chemistry Department at the University of Toronto. **André C. Arsenault** is CTO of Opalux and can be reached at andre.arsenault@opalux.com.*

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The color switching of P-Ink film in response to external electrical stimuli is caused by the expansion and contraction of the crosslinked electroactive polymer network. Shown in Fig. 1 is the schematic structure of a P-Ink device and how the P-Ink materials respond to external electrical stimuli.

When a positive voltage is applied to a P-Ink device, the iron atoms in the polymer can lose electrons to become positively charged. This results in an influx of negatively charged counter-anions from the electrolyte to maintain electrical neutrality in the P-Ink film. Consequently, this electrical charging is accompanied by an increase in volume, which pushes apart the silica spheres. Since the inter-sphere spacing (δ) is what dictates the reflected color of the materials, these devices can span the entire visible spectrum ($\delta_B \rightarrow \delta_G \rightarrow \delta_R$) simply by changing the applied voltage. This process also works in reverse by applying a negative voltage, where the thickness of the film decreases and the reflected light shifts to "bluer" wavelengths. The amount of voltage applied determines the degree of charging. When a given fixed voltage is applied, the polymer is charged, but only to a certain level. Initially, a very small current will flow, but once the charge level is reached, current flow stops. Therefore, both voltage and charge are essential parameters for switching P-Ink devices.

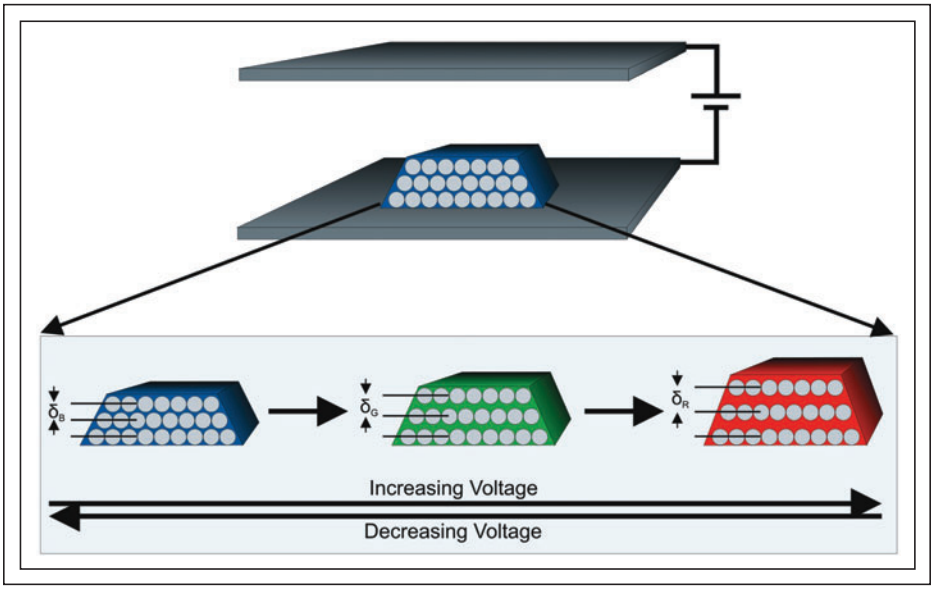

Fig. 1: *The structure of a P-Ink electrochemical cell is shown, including the effect of film thickness on reflected colors.*

One key characteristic of Opalux's P-Ink materials is their bright and highly saturated color. A series of pictures showing different color states of a P-Ink device during color switching is presented in Fig. 2, together with their corresponding reflectance spectra.

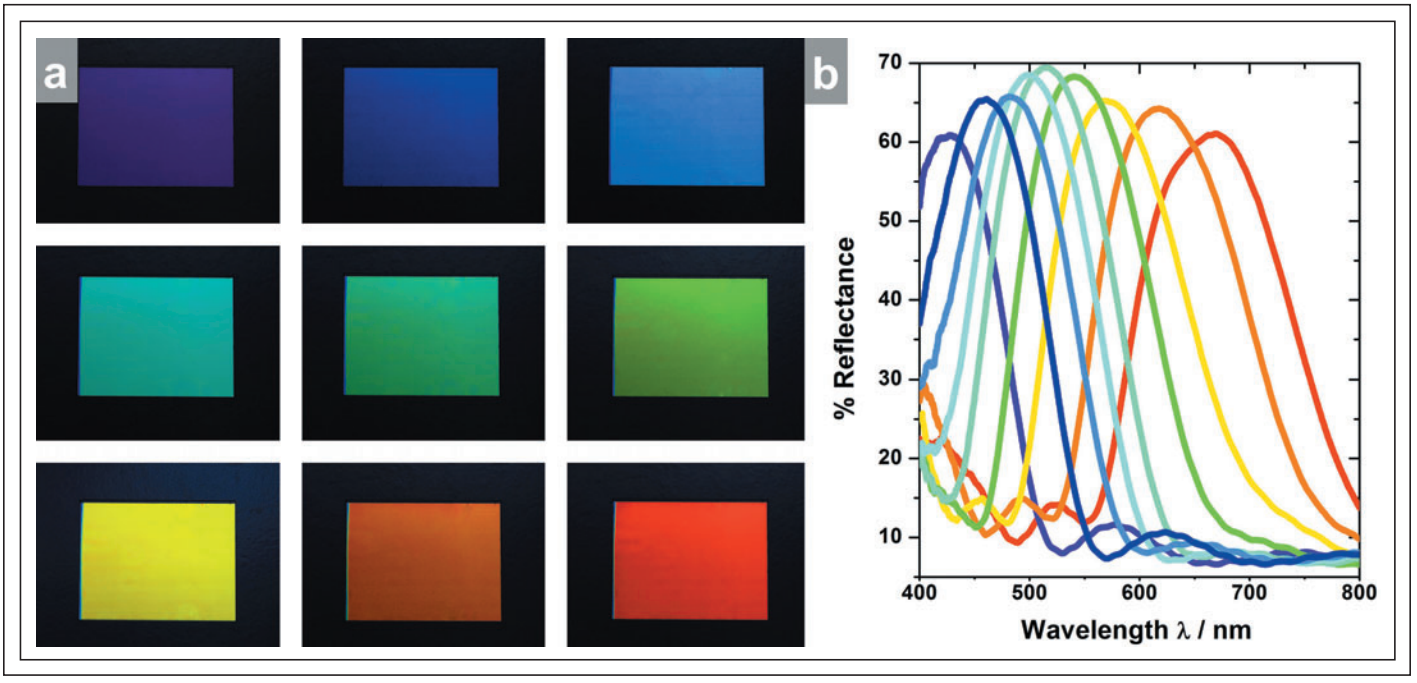

Fig. 2: *Pictures of the display window of a P-Ink device show (a) an array of progressively red-shifted color states from violet to red and (b) their corresponding reflectivity curves.*

One can see the color progressively shifting toward red, starting from violet when a positive bias is applied. Representative intermediate color states shown in the figure include deep blue, blue, cyan, turquoise, green, yellow, and orange. The average peak reflectivity of these spectra is ca. 60%, with peak widths at half-maximum between 75 and 150 nm, which compares favorably to other reflective color technologies.[5] The spectral features of the P-Ink material present a good compromise for reflective color, providing peaks narrow enough to generate good color saturation while being wide enough to generate significant reflectivity. The result is a material reflecting bright and vibrant color states.

To estimate how the colors produced by a P-Ink device compare with standard display technologies, standard CIE coordinates were extracted, based on the reflectance curves shown in Fig. 2(b). The chromaticity diagram used in Fig. 3 is obtained from the CIE 1931 standard with a D65 illuminant.

One can see that the color gamut of P-Ink reflective display devices covers a significant portion of the CIE color space. When compared to other reflective technologies such as electrophoretics, the palette of a P-Ink device is significantly broader.

Fast switching speed is another important attribute of the P-Ink materials. Through continued development, current switching speeds for P-Ink devices are comparable to those of other eBook display technologies – high enough that switching between any spectral colors in the visible spectrum takes less than 0.2 sec. The driving scheme for P-Ink displays can either operate via analog voltage control or by fixed-voltage pulse-width modulation, providing simple options for the development of an electrical driving scheme.

Electrical bistability and low power consumption also render P-Ink materials a viable option for next-generation full-color reflective displays. Preliminary studies indicated that P-Ink devices can retain their color for hours without any external electrical input. When the electrical connection to a pixel is opened, that pixel continues to retain the previously established charge level. If a new connection is established at a higher or lower potential, the charge level of the pixel subsequently changes as directed. On the other hand, a short circuit will dissipate all charge and the pixel reverts to its native starting color state. In addition, by optimizing the formulation of the composite materials, the authors were able to achieve color switching of P-Ink displays at as low as 0.1 V, while most alternative "e-paper" display technologies require an input of 5–30 V.[5] Both of these properties are crucial for potential applications in areas such as portable electronics and full-color e-paper devices.

A simple demonstration of a pixilated alphanumeric P-Ink display device is shown in Fig. 4. It is sequentially switched to spell out "OPALUX," shown under ambient office lighting.

The pixels are fabricated by photolithography and addressed via separate leads. The precisely defined green color of the switched areas is achieved by applying a controlled voltage to given pixels. As can be seen, the reflective colors are bright and uniform.

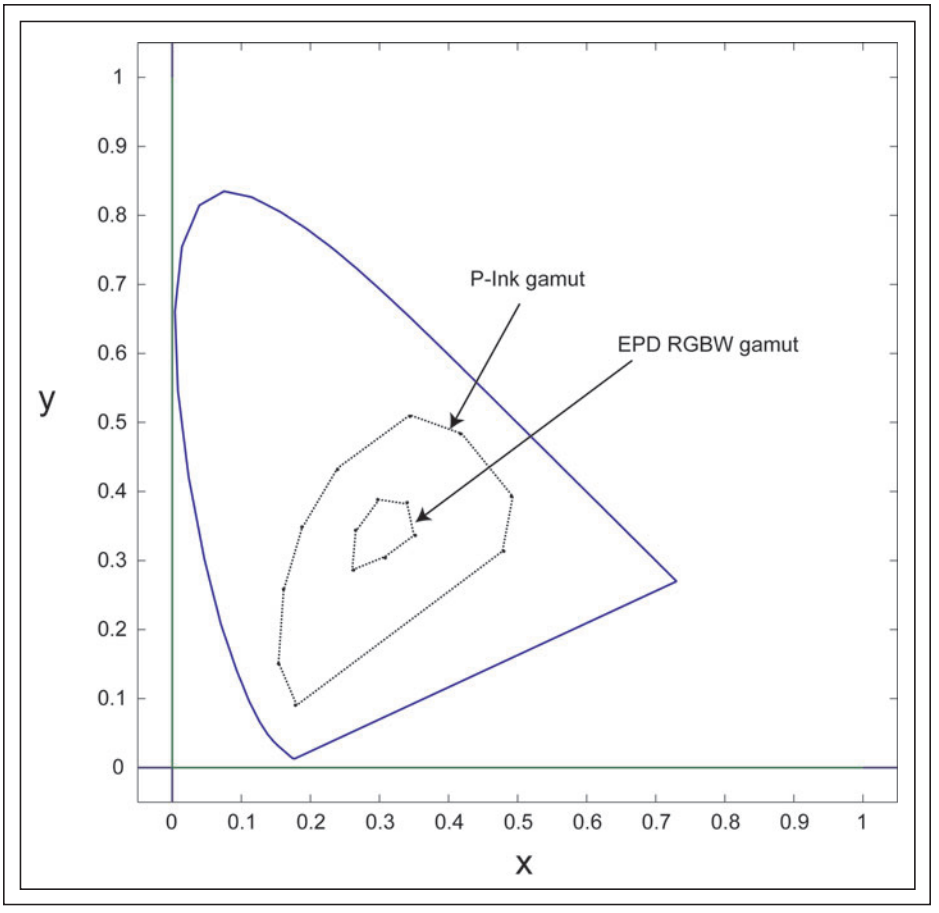

Fig. 3: *The CIE diagram shows color gamut produced by a P-Ink reflective display. The gamut of a published electrophoretic-display (EPD) color space is defined by the dashed polygon for Ref. 6.* ***Note:*** *The EPD RGBW gamut was generated based on prototype devices with color filters, while the P-Ink gamut was produced by using a device without the use of a color filter.*

Scalability of P-Ink Materials

In addition, P-Ink materials can be produced using established high-throughput roll-to-roll coating processes. This allows for not only an effective cost reduction, but also for the fabrication of large, thin, and flexible P-Ink devices. A roll of P-Ink materials on a flexible ITO-PET substrate is shown in Fig. 5(a).

When assembled in a device using all-flexible conductors and substrates, fully flexible P-Ink devices can result. Figure 5(b) shows three extracted video frames displaying blue, green, and red color states of a flexible P-Ink device. The video was taken when the device was being simultaneously switched and flexed. The performance characteristics of P-Ink flexible devices are comparable with those made on rigid substrates.

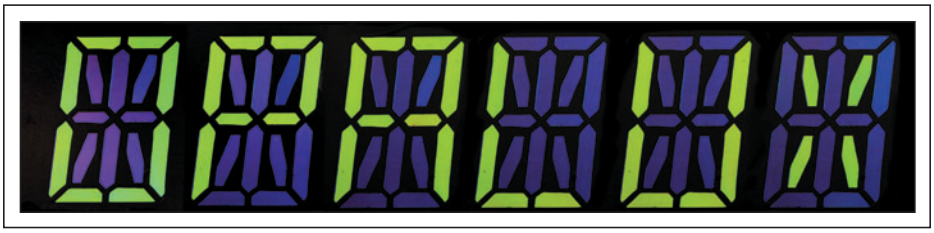

Fig. 4: A pixilated alphanumeric P-Ink display device spells "OPALUX" under ambient office lighting.

The Road Map

Recent advances in P-Ink's performance include brightness, switching speed, and lowered power consumption. Pixilated displays with individually controlled colors have been demonstrated, and roll-coated materials on flexible substrates are available in pilot quantities. These achievements together bring P-Ink to the threshold of commercialization.

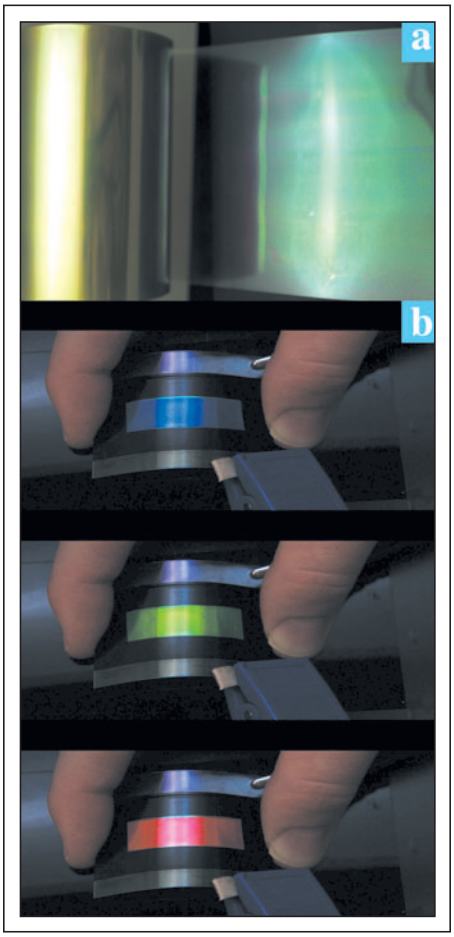

Fig. 5: (a) Above is a roll of P-Ink coating materials on a flexible substrate produced by a roll-to-roll coating process into a finished display device prior to assembly and (b) extracted frames from a video taken when a flexible P-Ink device was being simultaneously switched and flexed.

Full characterization of P-Ink is now under way. This includes extensive cycling stability, bistability, and UV and environmental stability tests to reflect specific requirements of various markets. In addition, attaining well-defined black, white, and gray-scale states will require the integration of additional technologies such as high-resolution active-matrix backplanes for effective color mixing. However, given the inherent simplicity of the P-Ink display itself, such approaches are readily achievable.

Roll-outs will focus first on simpler and less-demanding devices, in color, construction, and working environment, to be followed by increasingly sophisticated and higher-volume applications. For example, given the intrinsically bright and eye-catching colors produced by P-Ink coatings, a large number of potential applications related to simple color-changing surfaces, from mobile electronics to office interiors, are currently under development. In addition, due to mechanical flexibility and competitive price points, a variety of simple displays integrated into products such as plastic cards of all types and size, as well as product packaging, are being envisioned. Following the launch and adoption of such simple display products, more-complex devices incorporating active-matrix driving schemes will follow. Opalux is now seeking parties interested in developing specific, innovative display concepts.

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2011 Best-in-Show Awards

Nanosys, RealD, and Samsung win inaugural Best-in-Show awards at Display Week 2011

by Jenny Donelan

THE WINNERS of the Society for Information Display's inaugural Best-in-Show awards were announced on May 18 during the 49th annual SID International Symposium, Seminar, and Exhibition in Los Angeles. The winners were selected by an independent panel of display experts based on the significance of their development and/or product and for their ability to generate excitement within not only the display industry, but also the general public and the media. The awards were open to all exhibitors on the show floor during Display Week 2011.

Three companies – ***Nanosys***, ***RealD***, and ***Samsung*** – received SID's first-ever Best-in-Show awards at Display Week 2011. The winning products were a 47-in. quantum-dot-enabled display from Nanosys, an LCD-based 3-D display from RealD, and a 240-Hz 70-in. ultra-definition 3-D/2-D panel from Samsung Electronics. Awards were given in three categories: small, medium, and large exhibit, respectively.

The Best-in-Show awards were created by SID in order to recognize examples of cutting-edge technology, including prototypes that stimulate a great deal of interest on the show floor. The new honors complement the Display of the Year awards, which SID has for many years conferred on shipping products that advance the state of the art of electronic displays. DYA winners are chosen prior to the show and must be in commercial distribution by the end of the year leading up to Display Week.

Jenny Donelan *is Managing Editor of* Information Display *magazine. She can be reached at jdonelan@pcm411.com.*

The Best-in-Show distinction allows SID to honor those developments that are often first showcased at Display Week, according to Robert Melcher, chairman of the SID Best-in-Show committee. Says Melcher, "We felt it was important to recognize the incredible range of noteworthy innovations exhibited on the actual show floor and to highlight the standouts."

The Winners

Nanosys received the Best-in-Show award in the small-exhibit category for its display demonstration comparing a 47-in. quantum-dot-enabled display against a standard TV (sRGB) (Fig. 1). The company's quantum-dot technology (size-controlled nanocrystals) is designed to create a visual experience that is truer to reality by enabling LCDs to display about 50% more color than they can today. This translates to richer reds and deeper greens. Nanosys' proprietary, high-efficiency quantum-dot phosphors convert blue light from a GaN (gallium nitride) light-emitting diode (LED) into different wavelengths based on size. Larger dots emit longer wavelengths (red), while smaller dots emit shorter wavelengths (green). Blending together a mix of red and green dots allows Nanosys to engineer a new spectrum of light.

The current product based on this technology is called Quantum-Dot Enhancement Film (QDEF), an optical film component for LED-driven LCD backlight units. Based on Nanosys' proprietary high-efficiency quantum-dot phosphors, the QDEF enables a new level of LCD performance by providing a high-quality tri-color white light from a standard blue LED light source.

RealD received the Best-in-Show award in the medium-exhibit category for its LCD-

Fig. 1: *A Nanosys QDEF-enabled 47-in. display (right) shows deeper green compared to a standard display (left).*

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based 3-D displays based on the company's RealD TV Display Technology (formerly known as RDZ 3D Display Technology) that deliver full-resolution HD 3-D images using passive 3-D glasses. These displays were developed from RealD's award-winning 3-D cinema projection technology, itself based on a liquid-crystal shutter system. They work with the same inexpensive glasses that are used at movie theaters and also display 2-D imagery without degradation.

Current 3-D display technologies either use more expensive active-shutter 3-D eyewear or a patterned retarder installed directly in front of the LCD panel. This latter method is believed to cut the effective screen resolution in half in 3-D mode, while the former method requires expensive and rather clumsy eyewear. The new RealD TV technology is integrated on an LCD panel, as shown in Fig. 2, and actively syncs with the left- and right-eye images for full-resolution HD 3-D video. This is the first consumer-electronics display technology to be announced and demonstrated that delivers a full-resolution 3-D image utilizing passive 3-D glasses without negatively impacting 2-D image performance. This technology is being jointly developed by RealD and Samsung Electronics LCD Business. Demonstrations of RealD TV displays at SID included a 46-in. TV, 23-in. monitor, and a 17-in. laptop.

Samsung Electronics Co., Ltd., received the Best-in-Show award in the large-exhibit category for the world's first prototype 70-in. ultra-definition (UD) 240-Hz 2-D/3-D panel (Fig. 3).

Key features for the panel include oxide TFT backplane technology, UD (3840 × 2160) resolution with a 240-Hz refresh rate, and 3-D imagery at UD resolution with the use of active-shutter glasses. This prototype is the world's first panel fabricated in a Gen 7 LCD manufacturing line using oxide-semiconductor technology, which is the most promising candidate for TFT backplanes for the near future, as the display industry works to overcome the limits of current a-Si TFT performance.

Among materials that are used for TFT active layers, oxide semiconductors show at least 10 times higher carrier mobility than amorphous-Si, and their amorphous structure can provide higher large-scale uniformity than polycrystalline LTPS for next-generation large-scale display devices. The high mobility

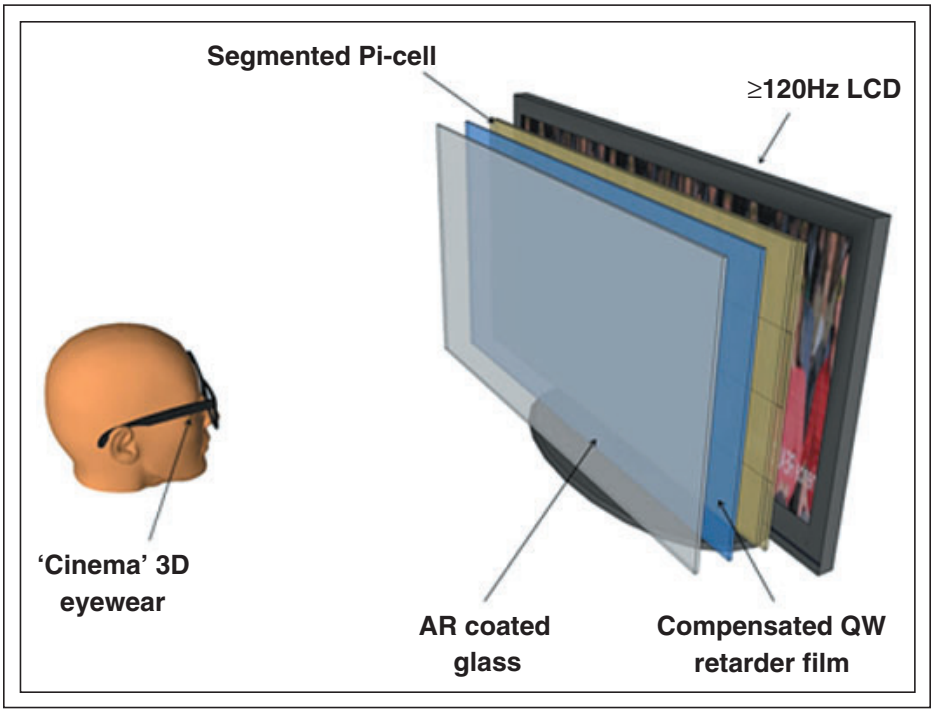

Fig. 2: RealD TV technology is integrated on an LCD panel.

Fig. 3: Samsung's 70-in. UD panel incorporates an oxide-TFT backplane.

in TFTs is an important barometer for enabling the large panel size and high-resolution limits, as demonstrated in the winning prototype.

Best in Show Going Forward

"The first Best-in-Show awards generated a great deal of excitement – we will be continuing the process for the 2012 show and into the future," says Melcher. Companies wishing to be considered for the program can download a nomination form now at http://www.sid.org/awards/bis.html. Best-in-Show awards qualifications include prototypes and manufacturing processes as well as products, but are only awarded to Display Week exhibitors. The criteria used by the committee members to evaluate the exhibit material included timeliness and significance to the display industry among the products, prototypes, processes, and technologies exhibited and the creative use of audio, visual, or other effects to present and highlight the new material. ■

Display Week 2012

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SID DISPLAY WEEK Boston 2012

Boston is a city with a rich history of innovation and progress. It serves as the perfect host for the 2012 SID International Symposium, Seminar & Exhibition. Display Week will be held June 3–8 at the Boston Convention & Exhibition Center. The exhibition will be open from June 5 to 7.

Display Week is the once-a-year, can't-miss event for the electronic-information-display industry. The exhibition is the premier showcase for global information-display companies and researchers to unveil cutting-edge developments in display technology. More display innovations are introduced year after year at Display Week than at any other display event in the world. Display Week is where the world got its first look at technologies that have shaped the display industry into what it is today; that is, liquid-crystal-display (LCD) technology, plasma-display-panel (PDP) technology, organic light-emitting-diode (OLED) technology, and high-definition TV, just to name a few. Display Week is also where emerging industry trends such as 3-D, touch and interactivity, flexible and e-paper displays, solid-state lighting, digital signage, and plastic electronics are brought to the forefront of the display industry. First looks such as these are why over 6500 attendees will flock to Boston for Display Week 2012.

SID 2012 honors and awards nominations

On behalf of the SID Honors and Awards Committee (H&AC), I am appealing for your active participation in the nomination of deserving individuals for the various SID honors and awards. The SID Board of Directors, based on recommendations made by the H&AC, grants all the awards. These awards include five major prizes awarded to individuals, not necessarily members of SID, based upon their outstanding achievements. The **Karl Ferdinand Braun prize** is awarded for ***"Outstanding Technical Achievement in, or contribution to, Display Technology."*** The prize is named in honor of the German physicist and Nobel Laureate Karl Ferdinand Braun who, in 1897, invented the cathode-ray tube (CRT). Scientific and technical achievements that cover either a wide range of display technologies or the fundamental principles of a specific technology are the prime reasons for awarding this prize to a nominee. The **Jan Rajchman prize** is awarded for ***"Outstanding Scientific and Technical Achievement or Research in the Field of Flat-Panel Displays."*** This prize is specifically dedicated to those individuals who have made major contributions to one of the flat-panel-display technologies or, through their research activities, have advanced the state of understanding of one of those technologies. The **Otto Schade prize** is awarded for ***"Outstanding Scientific or Technical Achievement in the Advancement of Functional Performance and/or Image Quality of Information Displays."*** This prize is named in honor of the pioneering RCA engineer Otto Schade, who invented the concept of the Modulation Transfer Function (MTF) and who used it to characterize the entire display system, including the human observer. The advancement for this prize may be achieved in any display technology or display system or may be of a more general or theoretical nature. The scope of eligible advancement is broadly envisioned to encompass the areas of display systems, display electronics, applied vision and display human factors, image processing, and display metrology. The nature of eligible advancements may be in the form of theoretical or mathematical models, algorithms, software, hardware, or innovative methods of display-performance measurement, and image-quality characterization. Each of these above-mentioned prizes carries a $2000

SID honors and awards nominations

Nominations are now being solicited from SID members for candidates who qualify for SID Honors and Awards.

- KARL FERDINAND BRAUN PRIZE. Awarded for an outstanding *technical* achievement in, or contribution to, display technology.
- JAN RAJCHMAN PRIZE. Awarded for an outstanding *scientific* or *technical* achievement in, or contribution to, research on flat-panel displays.
- OTTO SCHADE PRIZE. Awarded for an outstanding *scientific* or *technical* achievement in, or contribution to, the advancement of functional performance and/or image quality of information displays.
- SLOTTOW–OWAKI PRIZE. Awarded for outstanding contributions to the education and training of students and professionals in the field of information display.
- LEWIS & BEATRICE WINNER AWARD. Awarded for exceptional and sustained service to SID.
- FELLOW. The membership grade of Fellow is one of unusual professional distinction and is conferred annually upon a SID member of outstanding qualifications and experience as a scientist or engineer in the field of information display who has made widely recognized and significant contribution to the advancement of the display field.
- SPECIAL RECOGNITION AWARDS. Presented to members of the technical, scientific, and business community (not necessarily SID members) for distinguished and valued contributions to the information-display field. These awards may be made for contributions in one or more of the following categories: (a) outstanding technical accomplishments; (b) outstanding contributions to the literature; (c) outstanding service to the Society; (d) outstanding entrepreneurial accomplishments; and (e) outstanding achievements in education.

Nominations for SID Honors and Awards must include the following information, preferably in the order given below. Nomination Templates and Samples are provided at *www.sid.org/awards/nomination.html*.

1. Name, Present Occupation, Business and Home Address, Phone and Fax Numbers, and SID Grade (Member or Fellow) of Nominee.

2. Award being recommended:
   Jan Rajchman Prize
   Karl Ferdinand Braun Prize
   Otto Schade Prize
   Slottow–Owaki Prize
   Lewis & Beatrice Winner Award
   Fellow*
   Special Recognition Award
*Nominations for election to the Grade of Fellow must be supported in writing by at least five SID members.

3. Proposed Citation. This should not exceed 30 words.

4. Name, Address, Telephone Number, and SID Membership Grade of Nominator.

5. Education and Professional History of Candidate. Include college and/or university degrees, positions and responsibilities of each professional employment.

6. Professional Awards and Other Professional Society Affiliations and Grades of Membership.

7. Specific statement by the nominator concerning the most significant achievement or achievements or outstanding technical leadership that qualifies the candidate for the award. This is the most important consideration for the Honors and Awards committee, and it should be specific (citing references when necessary) and concise.

8. Supportive material. Cite evidence of technical achievements and creativity, such as patents and publications, or other evidence of success and peer recognition. Cite material that specifically supports the citation and statement in (7) above. (Note: the nominee may be asked by the nominator to supply information for his candidacy where this may be useful to establish or complete the list of qualifications).

9. Endorsements. Fellow nominations must be supported by the endorsements indicated in (2) above. Supportive letters of endorser will strengthen the nominations for any award.

E-mail the complete nomination – including all the above material by **October 7, 2011** – to fan.luo@auo.com or sidawards@sid.org or by regular mail to:
Fan Luo, Honors and Awards Chair, Society for Information Display,
1475 S. Bascom Ave., Ste. 114, Campbell, CA 95008, U.S.A.

stipend sponsored by AU Optronics Corp., Sharp Corporation, and Samsung Mobile Display, respectively.

The **Slottow–Owaki prize** is awarded for ***"Outstanding Contributions to the Education and Training of Students and Professionals in the Field of Information Display."*** This prize is named in honor of Professor H. Gene Slottow, University of Illinois, an inventor of the plasma display and Professor Kenichi Owaki from the Hiroshima Institute of Technology and an early leader of the pioneering Fujitsu Plasma Display program. The oustanding education and training contributions recognized by this prize is not limited to those of a professor in a formal university, but may also include training given by researchers, engineers, and managers in industry who have done an outstanding job developing information-display professionals. The Slottow–Owaki prize carries a $2000 stipend made possible by a generous gift from Fujitsu, Ltd., and Professor Tsutae Shinoda.

The fifth major SID award, the **Lewis and Beatrice Winner Award,** is awarded for ***"Exceptional and Sustained Service to the Society."*** This award is granted exclusively to those who have worked hard over many years to further the goals of the Society.

The membership grade of **SID Fellow Award** is one of unusual professional distinction. Each year the SID Board of Directors elects a limited number (up to 0.1% of the membership in that year) of **SID members** in good standing to the grade of **Fellow.** To be eligible, candidates must have been members at the time of nomination for at least 5 years, with the last 3 years consecutive. A candidate for election to Fellow is a member with ***"Outstanding Qualifications and Experience as a Scientist or Engineer in the Field of Information Display who has made Widely Recognized and Significant Contributions to the Advancement of the Display Field"*** over a sustained period of time. SID members practicing in the field recognize the nominee's work as providing significant technical contributors to knowledge in their area(s) of expertise. For this reason, five endorsements from SID members are required to accompany each Fellow nomination. Each Fellow nomination is evaluated by the H&AC, based on a weighted set of five criteria. These criteria and their assigned weights are creativity and patents, 30%; technical accomplishments and publications, 30%; technical leadership, 20%; service to SID, 15%; and other accomplishments, 5%. When submitting a Fellow award nomination, please keep these criteria with their weights in mind.

The **Special Recognition Award** is given annually to a number of individuals (membership in the SID is not required) of the scientific and business community for distinguished and valued contribution in the information-display field. These awards are given for contributions in one or more of the following categories: (a) ***Outstanding Technical Accomplishments,*** (b) ***Outstanding Contributions to the Literature,*** (c) ***Outstanding Service to the Society,*** (d) ***Outstanding Entrepreneurial Accomplishments,*** and (e) ***Outstanding Achievements in Education.*** When evaluating the Special Recognition Award nominations, the H&AC uses a five-level rating scale in each of the above-listed five categories, and these categories have equal weight. Nominators should indicate the category in which a Special Recognition Award nomination is to be considered by the H&AC. More than one category may be indicated. The nomination should, of course, stress accomplishments in the category or categories selected by the nominator.

While an individual nominated for an award or election to Fellow may not submit his/her own nomination, nominators may, if necessary, ask a nominee for information that will be useful in preparing the nomination. The nomination process is relatively simple, but requires that the nominator and perhaps some colleagues devote a little time to preparation of the supporting material that the H&AC needs in order to evaluate each nomination for its merit. It is not necessary to submit a complete publication record with a nomination. Just list the titles of the most significant half a dozen or less papers and patents authored by the nominee, and list the total number of papers and patents he/she has authored.

Determination of the winners for SID honors and awards is a highly selective process. Last year less than 30% of the nominations were selected to receive awards. Some of the major prizes are not awarded every year due to the lack of sufficiently qualified nominees or, in some cases, because no nominations were submitted. On the other hand, once a nomination is submitted, it will stay active for three consecutive years and will be considered three times by the H&AC. The nominator of such a nomination may improve the chances of the nomination by submitting additional material for the second or third year that it is considered, but such changes are not required.

Descriptions of each award and the lists of previous award winners can be found at *www.sid.org/awards/indawards.html*. Nomination forms are available at *www.sid.org/awards/nomination.html* where you will find Nomination Templates in both MS Word (preferred) and Text formats. Please use the links to find the Sample Nominations, which are useful for composing your nomination since these are the actual successful nominations for some previous SID awards. Nominations should preferably be submitted by e-mail. However, you can also submit nominations by ordinary mail if necessary.

Please note that with each Fellow nomination, only five written endorsements by five SID members are required. These brief endorsements – *a minimum of 2–3 sentences* to a maximum of one-half page in length – *must state why clearly and succinctly, in the opinion of the endorser, the nominee deserves to be elected to a Fellow of the Society. Identical endorsements by two or more endorsers will be automatically rejected* (no form letters, please). Please send these endorsements to me either by e-mail (preferred) or by hardcopy to the address stated in the accompanying text box. Only the Fellow nominations are required to have these endorsements. However, I encourage you to submit at least a few endorsements for all nominations since they will frequently add further support to your nomination.

All 2012 award nominations are to be submitted by October 7, 2011. E-mail your nominations directly to fan.luo@auo.com or sidawards@sid.org. If that is not possible, then please send your hardcopy nomination by regular mail.

As I state each year: "In our professional lives, there are few greater rewards than recognition by our peers. For an individual in the field of displays, an award or prize from the SID, which represents his or her peers worldwide, is a most significant, happy, and satisfying experience. In addition, the overall reputation of the society depends on the individuals who are in its 'Hall of Fame.'

When you nominate someone for an award or prize, you are bringing happiness to an individual and his or her family and friends, and you are also benefiting the society as a whole."

Thank you for your nomination in advance.

— Fan Luo
Chair, SID Honors & Awards Committee

sid news

continued from page 34

LA Chapter Earns High Honors

The international event known as Display Week took place in Los Angeles last May, but a great deal of SID activity goes on year-round in the City of Angels. In fact, the LA Chapter of the Society for Information Display recently received a presidential citation from SID for being the most active chapter in the Americas region in 2010. "The LA Chapter is an outstanding example," says Society for Information Display President Munisamy Anandan, citing chapter officers' ongoing interest in SID and their dedicated service to members. Anandan notes the importance of local chapter activities with regard to the health of the overall organization: "The progress of SID is in their hands."

At Display Week 2011, the LA Chapter hosted a "Meet and Greet" table during the author-interview sessions on all three days of the symposium. The Meet and Greet gave current and prospective SID LA chapter members a chance to say hello and to offer recommendations on topics to be covered at future meetings, including the chapter's one-day technical symposium held each February. The top vote getter with regard to topics, according to LA Chapter chairman Phillip Joujon-Roche, was Emerging Display Technologies, followed by Flexible Displays, OLEDs, and 3-D in a three-way tie for second place, followed by LCDs, LEDs, Smart TV, and Backlights. "The SID LA board decided on Emerging Display Technologies as the topic for our one-day symposium in Februrary," says Joujon-Roche.

At the end of June, the chapter hosted a program that included an overview of quantum-dot technology and a review of the recent symposium. Featured speakers were chapter director Larry Tannas, who announced the awards; Ken Werner, Principal of Nutmeg Consultants and Senior Analyst for Insight Media, who presented the quantum-dot technology information via remote feed from Connecticut; Larry Iboshi, who discussed highlights from the symposium, including small devices and the Pentile HiRes Display; and Phil Joujon-Roche, who offered a look at 3-D LC-TV advances from Sharp.

The upcoming one-day symposium will be held on February 3, 2012, at the Costa Mesa Country Club. Ken Werner will be the program chairman.

For more information on the activities of the SID LA Chapter or to become a member, visit www.sidla.org. ■

president's note

continued from page 4

Yet another hot topic of interest is oxide TFTs. Some member companies from around the world have been working on this technology. Papers presented at Display Week 2011 amply demonstrated that oxide TFTs are progressing from "lab to fab." For example, a 14-in.-diagonal AMOLED has been fabricated by using oxide TFTs in the backplane. We have also seen the progress in organic TFTs.

Papers presented at Display Week are also testimony to the fact that touch-interactive displays and displays that consume low power, and hence placing a lighter load on our environment, have made substantial progress. The progress toward e-paper displays becoming full color was also practically demonstrated.

The members of SID should be very proud of the fact that the promotion and growth of these technologies of the future will later appear as commercial products in other trade shows around the world. The Society for Information Display is truly the birthplace of display technology.

Show Specifics

On the business side, this year's exhibition saw continued increases in attendance, exhibit area, and revenue. We also introduced a new award, "Best in Show." Our Display of the Year Award committee, headed by Robert Melcher, worked hard to select the winners. This new award complements our prestigious Display of the Year Awards, giving exhibiting companies an opportunity to promote their products. In the words of one of the award winners, "… the award has been great for our company. Since and during SID, we've seen a tremendous amount of new interest from customers from around the world. Additionally, we've seen a large spike in social media/web traffic and received interest from major international press. So not only was this recognition by our peers meaningful to us personally, it had a real impact on our business."

Publicity for Display Week continued to grow this year, with video coverage of all award-winning companies and other exhibitors. For social media, we had "Twitter Towers" operating on the exhibit floor for the first time, thanks to Palisades Convention Management, SID's main contractor for Display Week 2011. There were about 477 followers of tweets. It is significant to note that companies such as Tianma and Hanvon from China and Asahi Glass Company from Japan participated in the exhibition. Los Angeles's main local TV station, Channel 5 (KTLA), covered the technology highlights in both the morning and evening news. The *Wall Street Journal* carried the news on Display Week in its Technology Section on May 17.

In the words of Marie Labrie, CEO of MCA, the publicity company for SID, "Display Week 2011 once again brought out some of today's top-tier mainstream media, both print and broadcast, along with key electronics and display trades and leading market analysts – with numbers reaching approximately 140 from around the globe including all major countries in Asia, Europe, and even south of the border in Mexico. Coverage surrounding Display Week and its many exhibitors continues to pour in from all major outlets, offering further proof that we are the premier forum for showcasing the latest and greatest display innovations on the horizon. To this end, Display Week was featured in several prime-time broadcast segments among leading local LA and global news stations – but we also received marquee mentions in leading dailies, business, financial, and electronics print and online news sites."

All of us at SID whole-heartedly thank our members and member companies for continuing to support the Society and the future of display technology, even in a tight economic environment. We look forward to next year's show in Boston. ■

Submit Your News Releases

Please send all press releases and new product announcements to:

Jenny Donelan
Information Display Magazine
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- Learn through SID's educational publications, including seminar notes, course notes, and the **SID•Wiley Book Series.** Price discounts are available to SID members.
- Stay informed of industry developments and events through ***Information Display Magazine*** – *FREE* to SID members.

Participation in Conferences

SID members benefit from substantially lower registration fees at key display-industry events.

- Display Week: The world's premier conference and exposition covering all aspects of display technology, applications, and services.
- International Display Research Conference (IDRC)
- International Display Workshops (IDW)
- International Meeting on Information Display (IMID)
- Many regional conferences, seminars, workshops, and webinars.

Networking – Develop your career and become a vital part of the display community

- Over 5,000 members in industry and academia consisting of your prospective colleagues, sponsors, suppliers, customers – and competitors.
- Chapter activities to network, learn, and serve your local display community.
- On-line *FREE* access to the SID member directory – only available to members.
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- Receive recognition through SID professional and achievement awards.
- Access to on-line job market.

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The following papers appear in the August 2011 (Vol. 19/8) issue of *JSID*.
For a preview of the papers go to sid.org/jsid.html.

Contributed Papers

continued from page 2

Newcomer (to these pages) Jason C. Heikenfeld covered the e-Paper and flexible technology space, noting that thus far, despite all the innovation, the field has been mostly dominated by monochrome offerings. This may have been the year that marks the transition to color, with at least four major players either already in production or on the verge of full-color offerings: E Ink (electrophoretic), Bridgestone (liquid powder), Qualcomm (mirasol), and Samsung (electrowetting). I think I was surprised by both the amount of new investment dollars going into e-Paper applications and the sheer number of companies (small and large) taking a renewed look at the market for e-Readers and similar devices. Even Qualcomm, which has been so focused on handheld phones and PDAs, made a big statement with its emphasis on e-Readers as its first push for mirasol displays by the end of 2011. This space has grown much larger than the pundits had predicted. (In fact, you may even be reading this issue of *ID* on an e-Reader).

3-D displays in all their various embodiments were ably scrutinized for your enjoyment by Steve Sechrist, and naturally he provides a great analysis of the various 3-D offerings and the Samsung/RealD breakthrough. 3-D was literally everywhere at Display Week, even in the special evening event, at which we enjoyed hearing distinguished speakers working at the cutting edge of 3-D cinema, as well as watching short works by professional and amateur 3-D filmmakers from around the world. Yes, you can get this technology wrong, but as the speakers of this session showed us, the movie industry is fully committed to 3-D – and to making it a truly high-quality artistic experience for both movie-goers and home viewers.

Of course, Geoff Walker continued as our resident expert on touch technology and the in-depth analysis he provided for us will be the industry roadmap I will use for the rest of the year. As Geoff affirms, this was the year that projected-capacitive technology achieved a dominant revenue position and there were literally PC products in every aisle of the exhibit floor. In fact, touch technology in general was so pervasive this year (almost 40% of the approximately 200 exhibitors being directly or indirectly related to touch) that it almost seemed like Display Week had become a touch exhibition. Similarly, as Geoff notes, Display Week may be the largest single exhibition of touch technology in the world. I'll let him explain most of the highlights, but one thing I cannot resist talking about is in-cell touch, which was shown by both Samsung and Toshiba. Though it is not yet available commercially, I'm partial to this technology, especially the optical version, because it opens up so many new possibilities for natively interactive displays with the highest possible image quality. It also can enable a whole new family of hybrid displays that double as scanners and possibly cameras for face and gesture recognition as well as touch. This somewhat futuristic view was a common theme at Wednesday's Touch Technology market-focus event. I had the honor of reprising a portion of my earlier editor's note comments on this topic and after hearing everyone else's opinions and the work they already have done, I now think I was not imagining enough of what can happen in this space – maybe sooner than we think.

For more news about what our crack reporting team saw at Display Week, and what they thought about it, visit the *ID* show blog at http://informationdisplaysid2011.blogspot.com/

In addition to these great Display Week reviews, we also welcome this month Dr. Hai Wang and his colleagues from Opalux, Inc., based in Toronto, Canada, who wrote about their latest work with "Photonic Crystal Display Materials." I've been looking forward to publishing this article for several months now because I think their new P-Ink technology is truly innovative and very promising for the future of reflective displays. I think you will find it interesting as well, especially those of you who were at the exhibition and had a chance to get an early look at P-Ink technology.

Earlier in this rundown, I mention the inaugural "Best-in-Show" awards. These awards were created by SID in order to recognize examples of cutting-edge technology, including prototypes, that generate excitement on the show floor. This year's recipients set the bar pretty high and having taken part in the selection process myself, I think this is going to turn into a highly coveted title in the years to come. Please enjoy Jenny Donelan's review of this year's winners and the future of the award itself.

In this issue, we also have a President's note from SID President Munisamy Anandan, some great industry news, and a story about the SID LA chapter's recent activities.

At the end of the day, everything we do boils down to a simple question: "How much does the display enhance our lives?" The best technology in the world cannot get effectively monetized unless it solves a compelling problem or enables a new way of living for the end user. As I walked the floor and listened to the technical presentations, I kept asking myself this question, and for the first time in a few years I really believe the industry is starting to understand this – the focus is much sharper than it was before. Maybe the last few years of hardship were (no, I won't dare to say "a good thing") beneficial in that they helped us learn to focus on the things that can really make a difference, whether they are industrial applications, portable devices, lifesaving or mission critical applications, or even pure entertainment. Displays (and touch screens) really do continue to reflect life as we envision it! ■

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Business and Editorial Offices

Palisades Convention Management
411 Lafayette Street, Suite 201
New York, NY 10003
Jenny Donelan, Managing Editor
212/460-9700
fax: 212/460-5460
jdonelan@pcm411.com

Sales Office – Asia

Dr. Jia-Ming Liu
Industrial Technology Research Institute
Building 77 Chungsing Road, Sec. 4
Chutung, Hsinchu 310 Taiwan
+886-3-591-6939
fax: +886-3-582-0217
jiamingliu@itri.org.tw

Sales Office – Europe

George Isaacs
12 Park View Court
The Paddock, Eaton Ford
St. Neots, Cambridgeshire
PE19 7SD U.K.
+44-(0)-1480-218400
george@gandg.demon.co.uk

Sales Office – Taiwan

Jie Tsai, Project Manager
ACE Forum, Inc.
10F-1, No. 180, Sec. 4
Nanjing E. Rd.
Taipei 105, Taiwan
+886-2-2570-6960 x302
fax: +886-2-2570-2305
jie@aceforum.com.tw

Sales Office – U.S.A.

Christine von Steiger, Sales Manager
Palisades Convention Management
411 Lafayette Street, Suite 201
New York, NY 10003
413/783-0473
fax: 413/783-0474
cvonsteiger@pcm411.com

Michele Klein, Sales Coordinator
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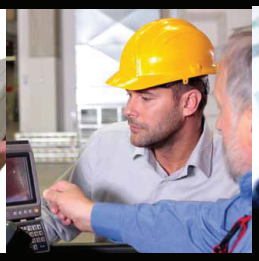

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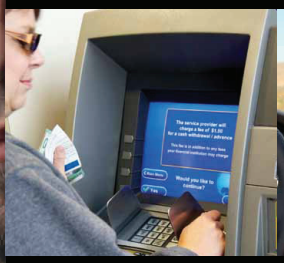

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A new class of optical technologies is here…set free your imaginations to create brand distinctions and spark product revolutions that were once unthinkable.

Collaborate with 3M Optical Systems to create revolutionary consumer electronics that

- are viewable in any light
- are brighter with a wider viewing angle
- meet or exceed power expectations
- cost less to produce with our supply chain solutions

Experience the wonder.

3M