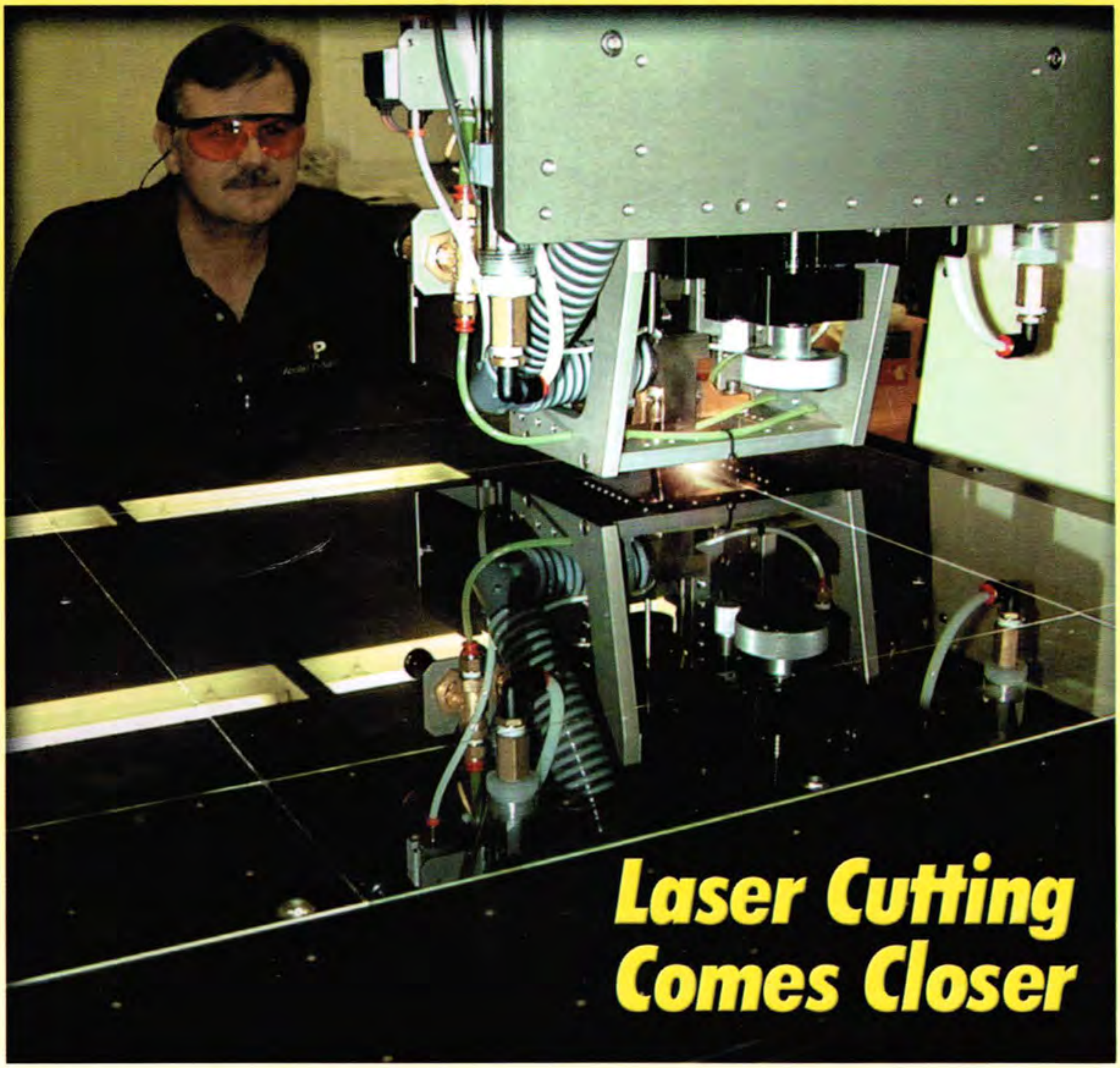
DISPLAY-MANUFACTURING ISSUE

Information DISPLAY

November 2002
Vol. 18, No. 11

SID

Official Monthly Publication of the Society for Information Display



Laser Cutting Comes Closer

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COVER: Although laser marking of substrates is common, high-volume separation of displays is still done primarily by the time-honored scribe-and-break technique. But high-volume laser separation is coming closer, says Brian Hoekstra and Sri Venkat in their article that starts on page 16.

Applied Photonics

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Next Month in *Information Display*

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- A New Angle on Reflective Displays
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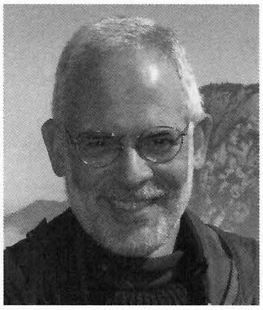
INFORMATION DISPLAY (ISSN 0362-0972) is published eleven times a year for the Society for Information Display by Palisades Convention Management, 411 Lafayette Street, 2nd Floor, New York, NY 10003; Leonard H. Klein, President and CEO. EDITORIAL AND BUSINESS OFFICES: Jay Morreale, Managing Editor, Palisades Convention Management, 411 Lafayette Street, 2nd Floor, New York, NY 10003; telephone 212/460-9700. Send manuscripts to the attention of the Editor, ID. Director of Sales: Joanne Morgenthal, Palisades Convention Management, 411 Lafayette Street, 2nd Floor, New York, NY 10003; 212/460-9700. SID HEADQUARTERS, for correspondence on subscriptions and membership: Society for Information Display, 610 S. 2nd Street, San Jose, CA 95112; telephone 408/977-1013, fax -1531. SUBSCRIPTIONS: Information Display is distributed without charge to those qualified and to SID members as a benefit of membership (annual dues $75.00). Subscriptions to others: U.S. & Canada: $55.00 one year, $7.50 single copy; elsewhere: $85.00 one year, $7.50 single copy. PRINTED by Sheridan Printing Company, Alpha, NJ 08865. Third-class postage paid at Easton, PA.

editorial



The Rising Tide of Bistable-Display Development

Bistable displays have become closely linked with "electronic paper" in the minds of many, but bistability has a strong attraction of its own, whether or not it is in the service of a display medium thought to be suitable for paper-like displays. A bistable display is one that remains in either its ON or OFF state without requiring the expenditure of energy to keep it there. The appeal is obvious: Text or an image is written to the display, and the image remains with no degradation and without consuming any power until the user decides to update or replace the image. In the many applications where a static image is downloaded and then remains on the screen for seconds, minutes, hours, or even days, this approach can result in displays that make remarkably light demands on the batteries that power them.

For a time, the cholesteric liquid-crystal display (Ch-LCD) developed by Kent Displays, Inc. (Kent, Ohio) was thought by many to be synonymous with bistable technology. The development and licensing of this technology has been impeded by the many years of patent and industrial-espionage battles between Kent Displays and Advanced Display Systems (ADS) of Wylie, Texas. Now that Kent Displays seems to have carried the field in the pending court cases, licensing activity is accelerating rapidly, Kent President Gene Miceli told *Information Display*. Even with the legal distractions, Ch-LCD technology is distinguished from other bistable technologies by actually having standard monochrome products on the market. The technology is compatible with flexible substrates, and attractive color prototypes and reasonably high-resolution prototypes have been shown. But standard products are currently on glass substrates and are of fairly low resolution for simple signs and similar applications.

Much of the bistable buzz has now been captured by E-Ink Corp. (Cambridge, Massachusetts), which is the most visible developer of "paper-like displays," and the company's demonstration of its latest generation of black-and-white and color display prototypes at SID 2002 in Boston last May left most observers impressed. E-Ink uses electrophoresis – the moment of charged particles through a fluid under the influence of an electric field – to attract light or dark particles close to the viewing surface to create an image.

There was a lot of research done on electrophoretic displays in the late '70s and early '80s, but problems centering around agglomeration (clumping together) of the particles slowed development, and the rapid progress of LCDs made that technology more attractive. E-Ink puts the electrophoretic particles into microcapsules, which solves not only the agglomeration problem, but also vastly simplifies fabrication because the microcapsules can be screen-printed onto a substrate.

E-Ink currently has development agreements with Toppan for color filters and Philips for active-matrix backplanes. The three partners demonstrated the first color active-matrix "electronic ink" display with reasonably high resolution (80 ppi) at the SID 2002 show, but some observers were more impressed with the simpler black-on-white display, which had remarkable (dare we say "print-like"?) contrast.

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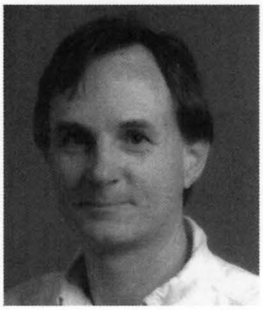
Information
DISPLAY

Circle no. 2

my turn



It's Lights Out for U.S. Displays

by David Mentley

With the announced closure of Planar Systems, Inc.'s TFEL display-manufacturing operation in Hillsboro, Oregon, the issue is now settled: flat-panel-display manufacturing occurs almost exclusively in Japan, China, and Southeast Asia. Earlier in 2002, Planar announced the closure of its Wisconsin-based Standish LCD operation.

Planar's TFEL factory represented the last attempt in a very long list of attempts to establish small- to mid-sized display manufacturing in North America. IBM built a large plasma-display factory in New York and AT&T planned to build one in Pennsylvania in the 1980s. GTE built a large thin-film EL factory in New Hampshire. OIS built one of the many TFT-LCD fabs in the United States – along with Alphasil, LC Systems, ImageQuest, PanelVision, Amoco, Xerox, and IBM.

There were dozens of passive-matrix LCD factories in the U.S. over the past 25 years, including those at Three-Five Systems, Hewlett-Packard, Optel, Intel, General Electric, RCA, Beckman Instruments, Texas Instruments, Motorola, Fairchild, Commodore, ILIXCO, LXD, Princeton Materials Science, Rockwell, Standish, Kylex, Crystal Clear Technology, and many more. FEDs absorbed the most funds, with huge fabs either built or started by Motorola, Micron, PixTech, and Candescent. All are now part of history.

Flat-panel-display manufacturing now is a thoroughly Asian business. Companies in South Korea, Taiwan, and Japan now make all high-value flat-panel displays, though CRTs are still produced in North America and Europe, and small displays are made in abundant quantities in China.

During the 1990s, the U.S. display industry was dragged into industrial-policy debates. HDTV and defense procurement were used by industry players and certain government agencies to make the case that domestic production of flat-panel displays was central to the nation's strength in the 21st century.

This thinking resulted in the National Flat Panel Display Initiative, which proposed a dual-use approach in which high-volume commercial displays and advanced displays for the military would be built on the same lines. This supposedly would save the U.S. display industry, preserve military superiority, and cost less, too! Needless to say, this approach never got past the report stage.

Why Did This Happen and Is It Good or Bad?

Flat-panel-display manufacturing is a very high-risk venture with occasional opportunities for profitability punctuated by regular massive injections of capital. Investors and shareholders of U.S. firms do not embrace this type of business. Why bear such risk when even a mediocre fabless semiconductor company will generate 40% margins? U.S. electronics firms tend to compete best in – and usually dominate – fast-moving sectors like CPUs and graphics processors, while Asian firms excel at mass-producing complex products like display modules. Interestingly, the margins are typically much higher in the former, but the revenue is much larger in the latter.

Nearly every new display company's business plan in the United States now proposes a licensing model – think Rambus, Inc., or Dolby Laboratories, Inc. –

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Making Sure Bigger Is Better

The much larger scale of Gen 5 and 6 motherglass demands not only improved panel testing, but a new approach.

by Russell J. Dover

ONE OF THE KEYS to the technology revolution of the past few decades has been the economy of scale: If more of an item is made at a time, the costs go down. But this principle does not work in the same way for all technology-based industries.

Consider semiconductor manufacturing. There has been steady movement toward using larger and larger silicon wafers, with size increases occurring every 8–10 years. The big gains in scale, however, have come from making the individual elements smaller and smaller, so that more of them can be made on each wafer.

In contrast, the liquid-crystal-display (LCD) industry has different scaling problems. To a large degree, there is limited advantage in making the elements smaller because the added resolution does not have much impact from normal viewing distances. Instead, consumer demand is for increasingly larger displays for notebooks, desktop monitors, and televisions. Economies of scale arise from being able to make more panels from a single sheet of glass. If finished panel sizes are to be larger, then the glass must also be larger (Table 1).

As panel costs decrease, demand for larger panels increases. Larger panels typically require pixel formats with more pixels, which increases panel complexity. An exception to the direct relation between panel size and pixel count is the television market. Pixel pitch is far less critical for televisions because the viewing distance from the screen is much greater than that for a computer monitor. In flat-panel-display (FPD) televisions, panel size, viewing angle, and pixel response seem to be the more important parameters. The LCD industry has enormous growth potential as panels begin to be adopted in the television market (Fig. 1), although, at present, production of FPDs for the market represents only 5% of total panel production.

Even without TV, the market for FPDs has a compound annual growth rate of more than 30%. In March 2002, DisplaySearch reported that revenues for flat-panel monitors exceeded that of the entire cathode-ray-tube (CRT) monitor market for the first time.

As a result of these market forces, the LCD-manufacturing industry is increasing plate size about every 18 months and changing pixel sizes and processing technology every 2 years. The new Generations 5 and 6 production lines are designed to handle glass plates that are more than 1 m square. This

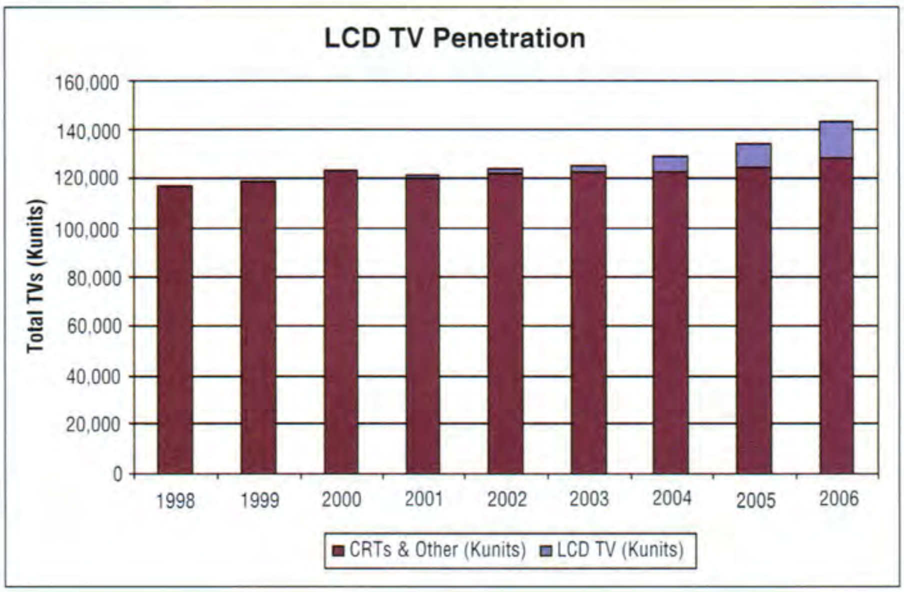

Fig. 1: *LCD TV penetration into the television market is projected to gradually increase in the coming years.*

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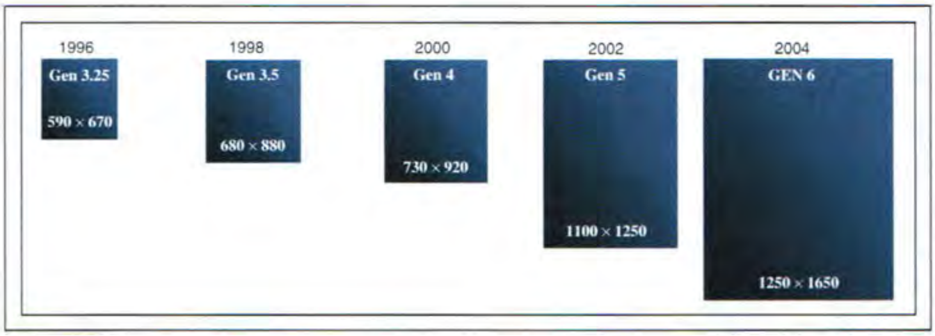


Fig. 2: *Rapidly increasing glass-plate size in LCD manufacturing poses increased challenges for processing and testing.*

rate of change is much faster than in the semiconductor industry, and it creates significant challenges to improve production techniques, not only in terms of handling, but also in throughput and yield management.

One key to improved yields is effective and efficient testing. This article presents a unique test approach – allowing both a pixel optical response and electrical response measurement for Generations 5 and 6 plates – that reduces the risk and cost of testing compared with earlier methods.

The Standards Problem

As might be expected for a relatively young industry, standards have not yet been firmly established for LCD manufacturing. Glass-plate sizes vary among different manufacturers supporting the same markets. This is also true of panel size. The issue for panels is compounded by a lack of standards for computer monitors and laptop displays, which are the dominant end markets for LCD products.

Plates, however, are designated by approximate generations. The current generation of plates that have entered mass production are known as "Generation 5" (or Gen 5 or G5), which doubles the plate area over the prior generation to more than 1.3 square meters using plates measuring approximately 1100 × 1250 mm. An anticipated interim Gen 5.5, which increases the plate area by about 30%, is just entering production. Generation 6, the next series, which is forecast for mid to late 2003, has not yet been defined, but is expected to almost again double the surface area (Fig. 2). There is currently a "war of announcements" between the various FPD manufacturers, each trying to define the next generational size in the hope of being the one to set the standard. The objective is to define a standard that optimally accommodates panels produced by each manufacturer. Until standards are set, however, successful testing solutions must be readily adaptable to different sizes of glass plates.

Larger and thinner panels provide significant challenges for both manufacturing and testing. Handling, uniformity, and – most importantly – yield are the key technology challenges. As panel sizes increase, their retail value also increases, but so does the likelihood of contamination, which results in more defective pixels and lower yields.

A key competitive metric that has to be considered for any LCD manufacturer is turnaround cycle time (TACT). Panel-processing time needs to improve as plate sizes increase instead of scaling up with plate area. In order to realize the full potential of larger plate sizes, testing must also be improved.

The Yield-Control Process of Panel Testing

Until recently, the most common LCD test methods tested each pixel electrically by using a probe card that emulated the finished LCD module. This was called "full-pin contact probing" (FPCP). It is difficult and expensive to align and maintain these probe cards, which are made up of thousands of tiny pins; and the problem scales proportionally with the increasing pixel count as plates and panel sizes become larger and pixel sizes get

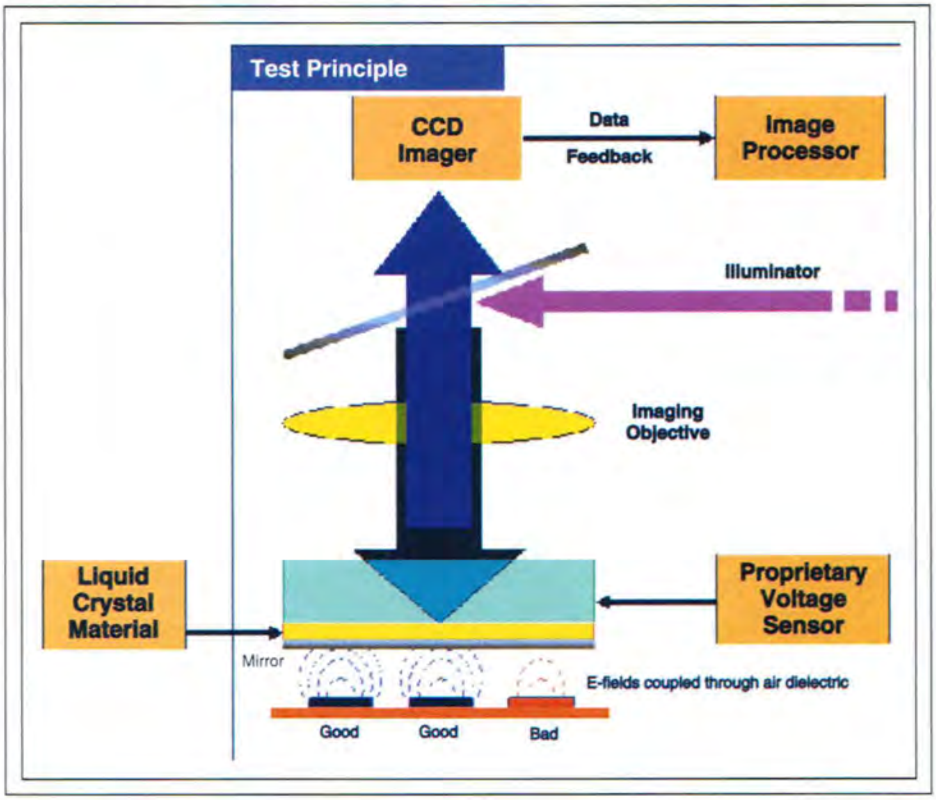
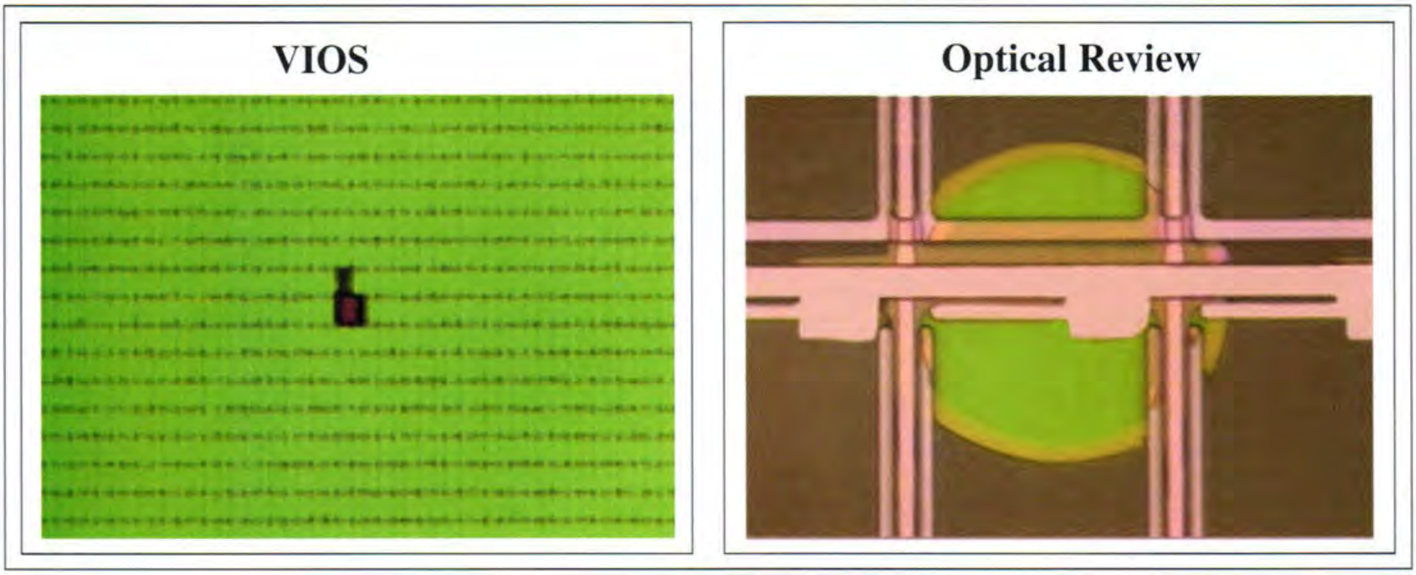


Fig. 3: *The voltage-imaging optical system (VIOS) mimics the optical response of LCD cells at each pixel.*



Photon Dynamics

***Fig. 4:** The AC-3000 ArrayChecker shows operators both electrical and optical test images.*

smaller. There is also risk involved in powering up each pixel with a high voltage, and damage can occur to the probe contact pads, which can result in defects when the module is assembled. As a result of these drawbacks, LCD manufacturers are abandoning the FPCP approach.

The second generation of contact probing is the "next generation array tester" (NGAT). This approach reduces the number of pin contacts by designing the required contacts around a multiplexer. Although this probing technique reduces the number of pin contacts and overcomes the limitations of testing high-resolution LCDs with FPCP, it has three distinct disadvantages:

- The need to redesign panels for the additional circuitry and new contact layout,
- The use of valuable glass area that cannot then be used for panels, and
- The dependency on signal quality from the multiplexer (noise translates directly to poor test results).

Based on market share, nearly all Gen 4 and 5 plate manufacturers have abandoned FPCP and NGAT for a technology patented and provided by Photon Dynamics called "Voltage Imaging." This approach utilizes a non-destructive shorting-bar technique. The shorting bar allows a single probe frame to be used for many panel designs (1 × 2, 2 × 2, and so on, even up to 5 × 6 panels per plate). Shorting-bar technology also allows testing when mixed panel sizes coexist on the same plate. Manufacturers can mix panel sizes to maximize glass utilization or match consumer demands, and thus significantly increase their flexibility and efficiency while reducing costs. In contrast, the number of probe frames for FPCP would be 1:1 for each design and layout.

The risk of damage is also reduced because the shorting bar uses lower contact pressure with high-reliability pins and contact pads that are independent of the pads used during module assembly. If a test pad is damaged as a result of probing, it will not affect the final assembly. The shorting-bar technique provides a huge cost-of-ownership advantage through frame reuse, higher reliability, and a significant reduction in the number of pins required – more than 1000 times fewer pins than in FPCP.

Another disadvantage of FPCP-based testing is that it only tests the electrical response of the pixel. A manual visual inspection is required to determine the pixel's optical response. A more innovative approach is to use a voltage sensor that integrates an illuminated liquid-crystal sensor above the panels. As the pixels are charged, they generate an electric field which triggers a response in the sensor that is equivalent to the optical response required for the completed LCD module. Thus, both electrical and optical responses are tested (Fig. 3).

In 2001, Photon Dynamics introduced the first array tester for Gen 5 plates, the ArrayChecker 3000 (or AC-3000). The stage design and the control of the voltage-imaging optical system (VIOS) reduce TACT and can handle a range of panel resolutions, allowing confidence in testing XGA (1024 × 768 pixels) through WUXGA (1920 × 1200 pixels) on panels 17 in. on the diagonal or larger.

The AC-3000's optical systems allow immediate defect review and verification by

Table 1: Finished Panel Sizes for Various Pixel Formats

Format	Resolution	Minimum Panel Size (in.)
XGA	1024 × 768	9.1
SXGA	1280 × 1024	11.4
SXGA+	1400 × 1050	12.4
UXGA	1600 × 1200	14.1
WUXGA	1920 × 1200	17
QXGA	2048 × 1536	21.1
QSXGA	2560 × 2048	N/A
QUXGA	3200 × 2400	N/A
WQXGA	3820 × 2400	N/A
16:10 HDTV	1920 × 1200	N/A

displaying defects chosen from either a voltage image or a defect map (Fig. 4). Operators can even select automatic defect-image capture using a second pass after the voltage-image test is complete.

Having the capability to automatically capture defect images eliminates the need for separate review stations. It also provides immediate defect information for process engineers and allows the introduction of a Defect Review Queue (DRQ), in which the defect data and defect images from the testers are automatically collected and sent to a dedicated server. This data can be accessed remotely – even outside the manufacturing clean room – and repairs can be dispositioned, allowing faster repair and more efficient use of repair tools. It also reduces the number of operators required.
A single technician can define the repairs assigned to multiple repair panels on multiple repair units, which is an improvement over the basic model of one operator per machine. The combination of optical- and electrical-response data is the key to being able to provide automatic defect classification, which is a precursor to automatic defect repair (ADR), which remains one of the "holy grails" of the test-and-repair industry.

But for now, we believe that the combination of voltage-imaging optical sensors and shorting-bar methodology provides a testing approach that can maximize the economies of scale inherent in Gen 5 and 6 production lines, and accomplish it with low cost of ownership. ■

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Laser Cutting Comes Closer

The "light way" may be the right way to cut and mark FPD glass, and recent advances are improving the chances of a major roll-out for laser cutting.

by Brian L. Hoekstra and Sri Venkat

THE flat-panel-display (FPD) industry has enjoyed remarkable growth during the past year despite weakness in the global economy. This growth has spurred increases in production capacity, but slim profit margins have forced manufacturers to constantly seek new ways to improve yields and lower costs. Recent developments in the laser cutting and marking of glass using carbon dioxide (CO_2) and solid-state lasers have made this technology more attractive by helping to keep costs down while increasing manufacturing productivity through the automation of manufacturing processes.

Growing Markets

Many modern electronic devices use FPDs of various sizes to display information to users. Liquid-crystal displays (LCDs) are the most common displays in applications requiring small devices, such as mobile phones, notebook computers, personal digital assistants, laptops, and small-screen televisions. Applications requiring very large displays, such as wide-screen TVs, use plasma-display panels (PDPs). The new organic light-emitting-diode (OLED) technology has the potential to be a major competitor in all display sizes.

One of the primary reasons for growth in the FPD industry during the past year has been the unprecedented consumer demand for space-saving flat-panel LCDs as monitors for desktop computers. This demand was triggered by a drop in price per unit area for LCD panels, which was caused by manufacturing overcapacity. By providing high-end products in traditional CRT markets such as computer monitors and TVs, and satisfying new automotive and portable-electronics applications, the FPD market is expected to continue to grow at a healthy pace (Fig. 1). This growth is expected to benefit all FPD technologies, but active-matrix LCD (AMLCD) technology will experience the fastest growth (Fig. 2).

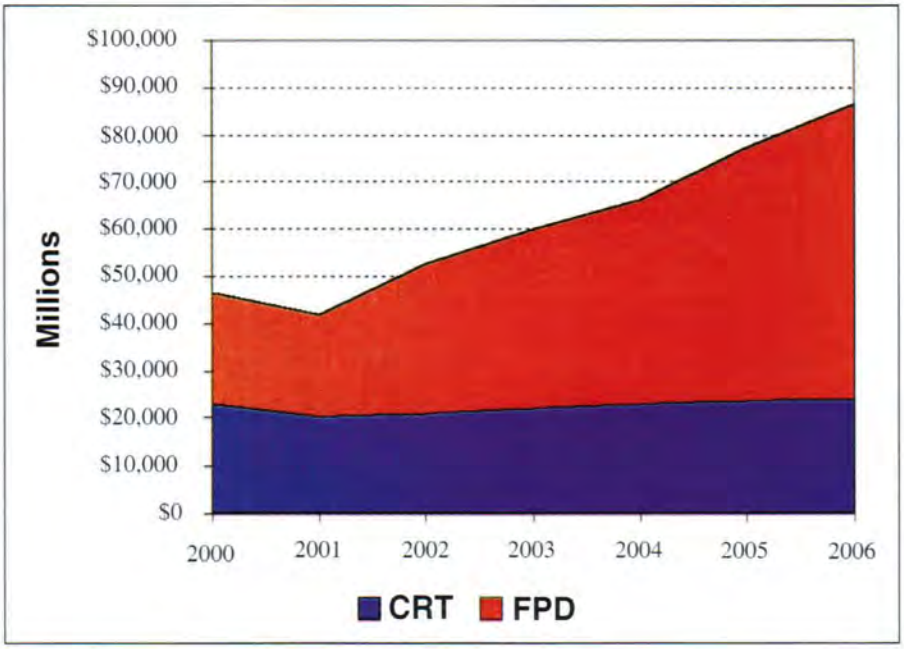

Fig. 1: *The largest growth segment in the worldwide electronics display market will continue to be FPDs.*

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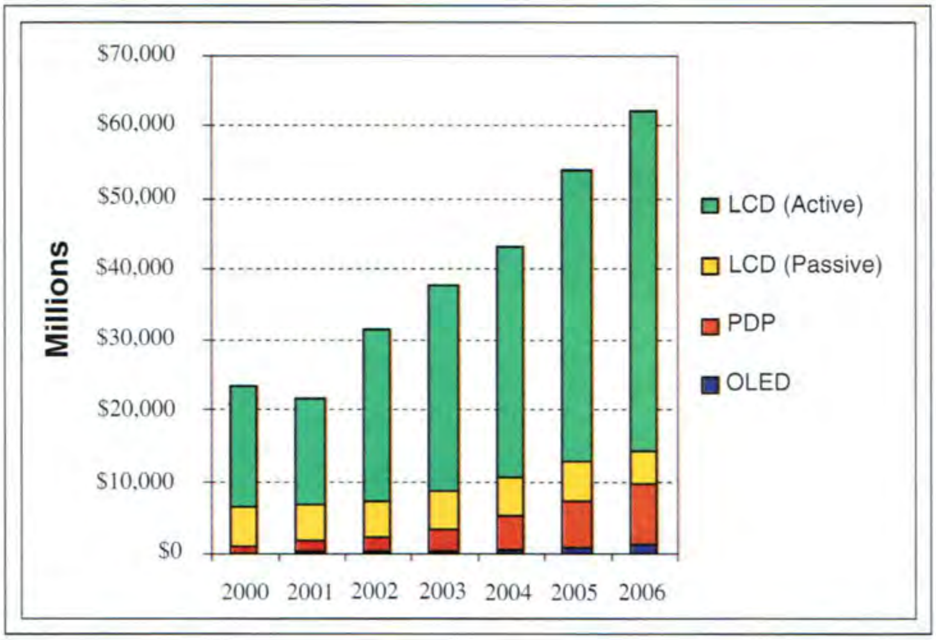


Fig. 2: Worldwide FPD shipments are projected to increase during the next few years for all display types: active and passive LCDs, PDPs, and OLEDs.

Laser Applications

Two key steps in the production of FPDs are that large glass sheets must be cut into individual panels and that they must be permanently marked with serial numbers for identification – a process also known as "titling." Glass cutting and titling present opportunities for the first major applications for lasers in FPD-glass manufacturing, which potentially can increase yields and improve product quality.

In the past, laser cutting of glass was carried out in a two-step process. In this technique, the laser was used to create a shallow scribe line, and the final separation of the glass was achieved by breaking the material mechanically. This approach parallels the process used by traditional mechanical scribing techniques, although the laser scribe would be cleaner.

However, laser-cutting-system manufacturers recently have invested considerable time and effort in perfecting a technique called "full-body separation," in which the laser process cuts completely through the glass sheet, thereby separating it without the need for a mechanical breaking process.

The fastest growing application area for lasers in FPD manufacturing is laser titling of glass. The speed with which lasers can mark serial numbers onto the motherglass (from which individual panels are separated) is far higher than can be achieved by any other means.

Advances in Laser Cutting

The LCDs used in mobile phones, notebook-computer screens, and other similar devices are typically constructed by placing liquid-crystal material between two 0.7-mm-thick glass substrates to create a 1.4-mm-thick panel. The PDPs used in flat-screen monitors and large-screen TVs are typically made of 2.8-mm soda-lime glass. Both types and thicknesses of glass can now be laser-cut using the full-body-separation technique.

In the past, full-body separation could only be used to separate thin sheets of glass, but newly perfected glass-cutting systems can easily separate glass that is up to 3 mm thick. These breakthroughs were first demonstrated 3 years ago and have been perfected over the past 2 years.

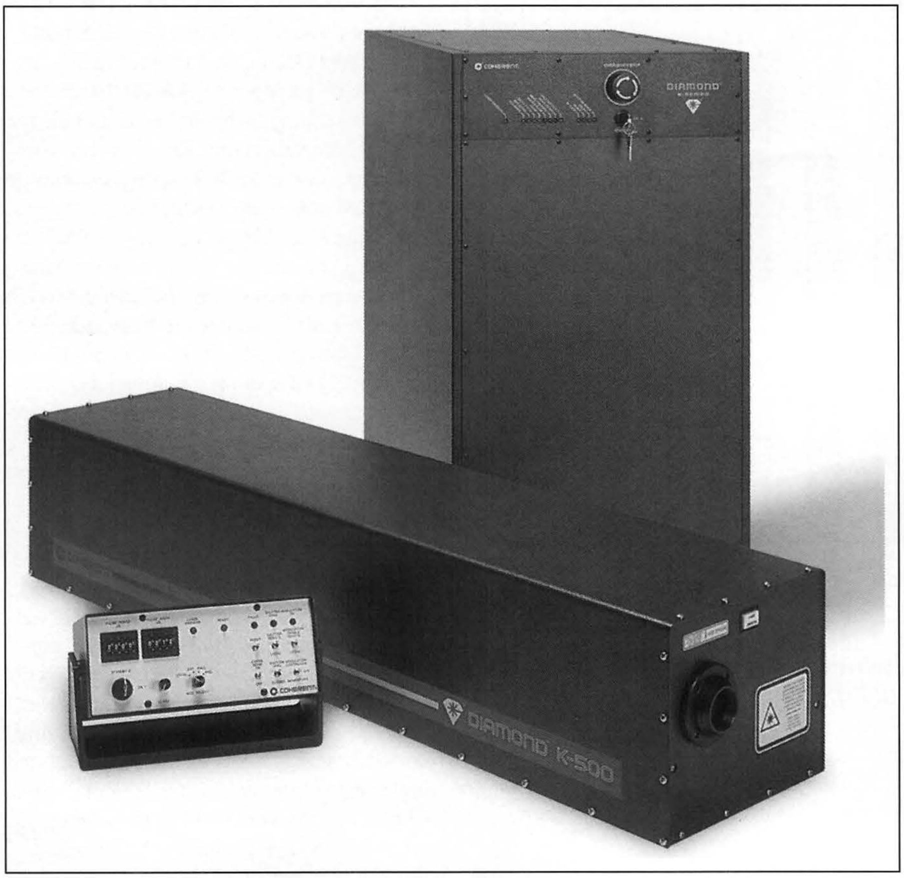
Laser cutting is a non-contact method that uses the energy of infrared light emitted by a carbon dioxide (CO_2) laser at a wavelength of 10.6 μm to create a zone of thermal tension within the glass along the intended break line. Modern laser-cutting systems use a class of compact and maintenance-free CO_2 lasers that are referred to as "sealed" CO_2 lasers. Among these are those manufactured by Coherent, Inc., of Santa Clara, California (Fig. 3). These lasers incorporate slab-discharge and diffusion-cooling technologies that make them ideal for integration into dedicated compact industrial systems such as software-controlled automated glass-cutting stations.

Because sealed lasers completely enclose the lasing gas mixture between two rectangular plate electrodes within the laser cavity, the gas mixture does not need to be replenished or replaced for up to 25,000 hours of continuous operation. The result is a maintenance-free CO_2 laser with few consumables that is inexpensive to operate. Even when operated around the clock, it would take almost 3 years before the gas mixture would need maintenance, at an estimated cost of $10,000.

The most important advantage of a sealed CO_2 laser for FPD manufacturing is the ease and accuracy with which its pulsed light output can be controlled *via* software. By controlling pulse width, pulse frequency, and duty cycle, the quantity of energy and the rate at which it is delivered for material processing can be accurately adjusted. Consequently, a single sealed laser can be used to cut a variety of types and thicknesses of glass by simply switching between preset laser parameters stored in software control.

In full-body separation, the first step is to nick the edge of the glass at the start of the intended break line in order to initiate the crack. In the past, a mechanical device was used for this purpose. However, system manufacturers – including Applied Photonics – have developed proprietary methods of initiating the crack with a separate smaller pulsed laser that creates internal cracks within the glass. This new all-laser method of glass cutting eliminates the glass dust that develops when glass is nicked mechanically.

After the crack is initiated, a pulsed laser beam from a medium-power (250–500 W) sealed CO_2 laser is focused onto a small spot on the surface of the glass. Because glass strongly absorbs 10.6-μm light to a depth of a few microns, the temperature at the glass surface quickly reaches a few hundred degrees. Despite high surface temperatures, there is no thermal damage to LCD material because glass has low heat conductivity and the heat transfer to the LCD active layer produces a minimal temperature rise on the order of tens of degrees.



Coherent, Inc.

***Fig. 3:** Compact but high-powered sealed CO_2 lasers are at the heart of every laser-based glass-cutting system.*

By moving the laser focal spot relative to the surface of the glass sheet at a speed appropriate for each type and thickness of glass, the temperature of the glass is kept well below its melting point but high enough to create local thermal tension. The laser focal spot is closely followed by a quenching/cooling jet consisting of a water and air mixture. Rapid heating and cooling caused by the laser and cooling jet create a crack along the line of maximum thermal tension, which is defined by the path of the laser beam. The depth of the crack depends on the power of the laser and the speed at which the focal spot is translated. Therefore, by properly adjusting these parameters, full-body separation can completely cut through a glass sheet.

One concern about laser-cutting systems has been their speed. During the past few years, linear-cutting speeds for laser systems have gradually increased from approximately 100 to 200 mm/sec for 0.7-mm-thick glass to a current typical full-cut speed of approximately 300 mm/sec. Mechanical systems often have a higher maximum cutting speed (up to 1000 mm/sec), but in production conditions the actual performance of mechanical systems is 300–400 mm/sec in order to create a sufficiently deep scribe, which is comparable to the speed of current laser systems.

The Laser's Edge

The benefits of full-body separation are best described within the context of a manufacturing process such as that used to manufacture 15.1-in. notebook-computer displays. In any manufacturing process, total turnaround time (TAT) is a critically important factor in determining productivity. TAT is the total time required to load, process, and unload material, and must be minimized in order to control costs. The objective of laser-system manufacturers has been to make sure that laser cutting is not the rate-determining step for TAT.

During the manufacture of notebook-computer displays, several laminated LCD panels are cut out of a large sheet of 1.4-mm-thick laminated glass. Generation-4-sized sheets are 720 × 600 mm in size. However, to improve productivity, the FPD industry has already begun using larger glass sheets that have dimensions ranging from 880 to 1800 mm.

Full-body separation requires just three steps to separate laminated LCD panels from a large sheet. First, a CO_2 laser and a quenching jet are used to separate the first side. Next, the sheet is flipped over. And finally, the laser and quenching jet separate the second side.

In contrast, the mechanical scribe-and-break method of cutting glass requires six steps to accomplish the same task. First, a diamond blade or a hard metal wheel is used to scribe the glass on one side. The sheet is then flipped over and scribed on the second side. Next, the glass panel is mechanically stressed on this side until it snaps along the scribe line. The sheet is then flipped back to the first side and mechanically stressed to break the first side. Consequently, the sheet is flipped twice for the mechanical scribe-and-break process, but only once during laser processing.

In addition to reducing the number of steps, laser cutting reduces TAT due to the smaller footprint of laser-cutting stations. For example, the dimensions of Applied Photonics's LaserMagic 700 Laser Cutting Station (Fig. 4) are only 2 × 1.6 × 1.6 m, which is about half the size of an equivalent mechanical system. Therefore, in theory, TAT can be cut in half by replacing multiple mechanical cutting machines with twice as many laser machines in the same space. In practice, however, the saved space gives a factory manager the flexibility to further boost capacity and overall factory productivity by installing additional units of whatever machine is the time-limiting step in the manufacturing process.

Laser cutting also has the potential to increase overall yield and productivity by eliminating most of the post-process polishing and cleaning necessary to smooth rough edges and remove glass dust created during mechanical scribing and breaking. Laser-cut edges are naturally smooth and free of microcracks and chips (Fig. 5). Moreover, the laser process creates no debris or residual glass-dust particles that need to be cleaned. Therefore, several major FPD manufacturers are actively investigating the possibility of using laser cutting without post-processing.

The non-contact nature of laser cutting is another advantage for FPD manufacturers because it reduces ongoing costs and improves product consistency. Since there are no mechanical parts such as diamond blades or wheels to wear out, there are no replacement-part costs, and laser-cut panels exhibit a consistently high edge quality from part to part. A carbide wheel in a mechanical scriber would have to be replaced twice a day for about $15 apiece. As a result, the maintenance costs – excluding the costs of downtime and the labor required to replace the parts – would be nearly $33,000 over 3 years of continuous operation.

Currently, the cost of a Generation-4-sized laser-cutting station, with one or two heads, depending on speed requirements, is approximately $600,000. Although a comparable mechanical scribe-and-break unit costs approximately half as much, the higher capital cost of a laser system is partially offset by its lower cost of ownership. Ultimately, the decision to purchase a laser-cutting system will depend on TAT and overall productivity considerations.

Applied Photonics, Inc.

Fig. 4: Modern laser-cutting stations, such as Applied Photonics's LaserMagic 700, feature computer control and sealed no-maintenance CO_2 lasers, and are only half the size of comparable mechanical scribe-and-break machines.

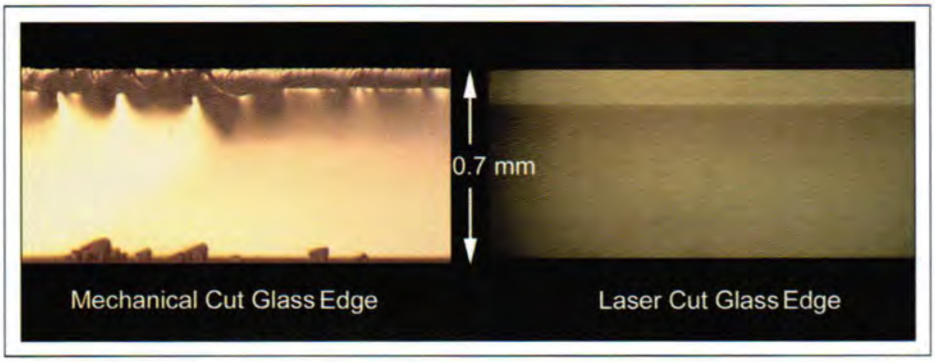
The Road to Implementation

To date, manufacturers have been slow to adopt laser cutting for their FPD production lines because of two interrelated factors. First, replacing familiar mechanical tools with photons requires a significant change in thinking on the part of the industry. Second, demand for LCDs is keeping factories busy, which means that at present the top priority of manufacturers is increasing capacity while maintaining profitability. Consequently, factory managers will only consider a new technology if it has been proven in a manufacturing environment. Therefore, laser-cutting-system manufacturers face a situation in which their products must be proven before they can be installed in a manufacturing line, but must first be installed in a manufacturing line before they can be proven. Despite these difficulties, laser-cutting systems are currently deployed in limited-production pilot lines and are undergoing testing by several FPD manufacturers. In the future, if testing proves that no post-process polishing and cleaning are needed after laser cutting, then switching to laser technology will be even more attractive.

Latest Advances in Glass Titling

In contrast to laser cutting, laser marking (or titling) technology is being accepted much more rapidly. This process uses the pulsed output of solid-state lasers to mark serial numbers on FPDs. For example, during mobile-phone manufacturing each cell-phone display is marked with a unique serial number before cutting so that it can be identified and tracked through the factory. A typical motherglass can be cut into several hundred panels, each of which requires an individual serial number comprising ASCII characters and/or a two-dimensional code with up to 400 individually addressable marks.

During laser marking, the focused beam from an ultraviolet (UV) solid-state laser is directed at the surface of a thin film that is on the patterned side (color filter and/or TFT side) of the glass. Exposure to laser light changes the chemical structure of the film, so that when it is immersed in developing solution, the exposed area is "etched" away, much like a darkroom photo process. This technology can create more than 400 marks in less than 60 sec. Traditional mask methods using incoherent-light sources require at least several minutes to accomplish the same task because the head must be moved 400 times.



Applied Photonics, Inc.

Fig. 5: *Mechanically cut edges (left) are rough and contain microcracks which must be polished smooth after cutting. Laser-cut edges (right) are naturally smooth and free of microcracks and chips.*

To achieve high-speed marking, laser-marking-system manufacturers use proprietary computer-controlled methods of steering the laser beam to the desired location on the work surface. By combining these proprietary high-speed steering techniques with CAD/CAM software, marking is performed in a "direct-write" fashion. The flexibility inherent in this "soft-tooling" approach is ideal for serialized character-marking applications.

The capital cost of laser-marking systems is in the range of $600,000–900,000, depending on specifications. Several laser-marking systems are currently being deployed in Asia, and the technology is being rapidly adopted by the entire industry. There are two primary reasons for the rapid acceptance of laser-marking technology. Unlike the situation with laser cutting, the technology being replaced by laser marking already uses the energy of light – incoherent light from flash lamps – to create marks. Consequently, making the transition from one light-based tool to a more efficient and more powerful one – coherent light from lasers – does not require a great leap of faith or change in thinking. The second reason laser marking is being rapidly adopted is the overwhelming time and cost savings that this technology delivers to FPD manufacturers, as compared to conventional marking methods.

Lighting the Way

Advances in laser cutting and titling continue to make these technologies competitive and attractive to FPD manufacturers. They lower TAT and operating and maintenance costs while increasing versatility and efficiency. As FPD manufacturers respond to the increased demand for their products, it is anticipated that lasers will play a greater role in the production of those products, helping to keep costs down while keeping processing speeds and panel quality up. ■

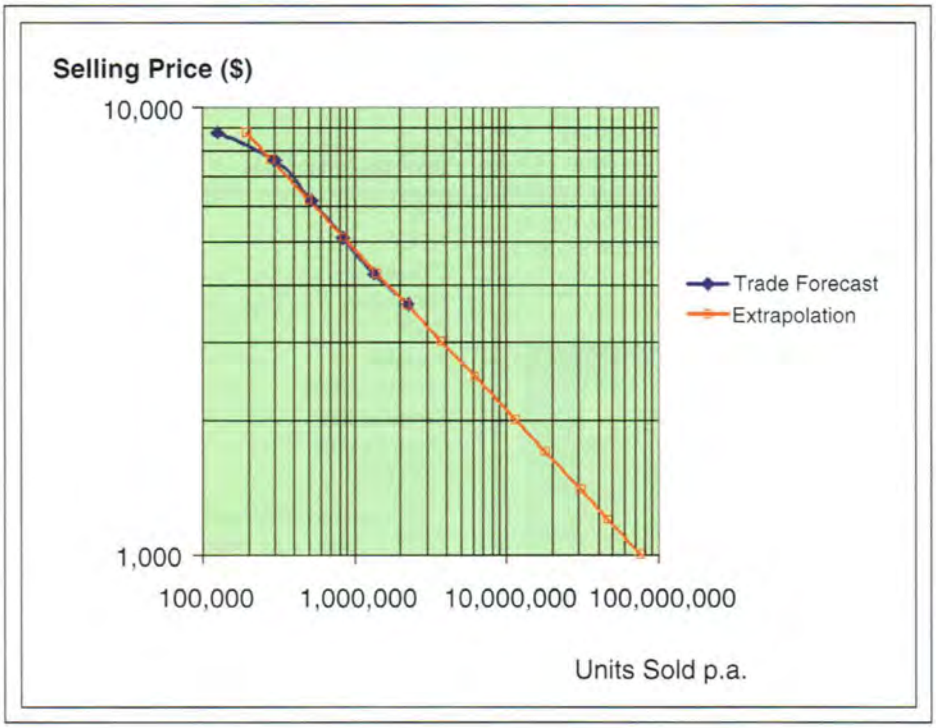


Fig. 2: The price elasticity of the 42-in. display follows a power-of-two function. When plotted on a log-log graph, the resulting curve is a straight line. These DisplaySearch projections are for sales of PDPs vs. *prices of wall-TVs from Printable Field Emitters, Ltd.* (Data courtesy of DisplaySearch.)

some simple mathematical function, then the curve can be extrapolated along the continuation of that function.

The price elasticity of the 42-in. display follows a power-of-two function. When plotted on a log-log graph, the resulting curve is a straight line (Fig. 2). Extrapolating a straight line is wonderfully resistant to sales-force tampering. The same extrapolation can be replotted on a conventional linear graph (Fig. 3).

This price-elasticity chart shows that even as prices for the 42-in. PDPs drop dramatically, the sales volume does not follow suit. Even when the selling price is cut by two-thirds – from $9000 to $3000 – the sales volume barely inches up. Yet once the price approaches the magic number of $2500, it hits the knee of the curve, and below that sales skyrocket.

A similar chart can be made for the sales volume of each different PDP screen size. Adding up the sales volume for each screen size for 2005 results in a total sales volume of 2.9 million units. But what this really means is that *when* the TV manufacturers can get their prices down to an average of $3292, *then* they will sell 2.9 million units. DisplaySearch predicts that this sales volume will be achieved in 2005, but, of course, it is the price, not the date, that determines sales volume.

Our extrapolation shows that in order to sell 3.1 million units, the average selling price must be slightly less than the 2005 prices – about $3000 even. The likelihood is that by the time PDP manufacturers have the selling price down to that figure, they will actually have a capacity well over 5 million units a year, which they can price no higher (on average) than $2500. Reducing their prices to this level implies a manufacturing cost of about $830 – well outside the forecast range, given current estimates of manufacturing costs. Thus, a segment of the display industry will once again face overcapacity and zero – or lower – profits. Can anything be done?

The answer lies in the graphs. Wall-TV manufacturers *must* find flat-panel technologies that will let them manufacture at a much lower cost than that implied by the lowest prices currently forecast for PDPs. If they do, they will reap two enormous rewards: First, they will be able to sell all the displays they can manufacture at a profit. (When was the

Fig. 3: The same extrapolation can be replotted on a conventional linear graph. (Data courtesy of DisplaySearch.)

Table 2: Price Forecasts for PDPs by Size for 2003

Size (in.)	Price ($)	Units (k)	$ Volume (k)	Avg. Price
32	2820	119	336	
33	2961	9	27	
37	3102	132	409	
40	3730	37	138	
42	4256	585	2490	
43	5108	29	148	
50	7225	79	571	
60	9892	7	69	
61	9892	3	30	
63	13008	1	13	
		1001	4231	$4226

last time that happened?) And secondly, if they can find an inexpensive wall-TV technology, they can enormously increase the size of the total wall-TV market – a market currently forecast to reach $30 billion in 2006 even at current forecast prices.

Where's the New Technology?

Of course, everyone is trying to find such a technology, or so one would imagine. But, amazingly, that is not so. The staffs of major TV manufacturers are dominated by engineers. And engineers are experts at engineering: They tend to see all problems – including economic problems – as having engineering solutions. If they are approached with a resoundingly cheaper manufacturing scheme, it can be guaranteed that their first and only response will be, "Show me a perfected sample." And approach them with a fascinating new technology, especially if its name contains the prefix "nano," and a clean sample, and they will spend an enormous amount of time admiring the technology, trying to understand the scientific basis, and dreaming up ways it could be adopted. Only a cursory look – if any – will be given to downstream costs *vs.* resulting sales volume.

This omission often ends in the same way: A great new technology is produced and sold with much fanfare, while the manufacturers bleed red ink. If more sales are required to achieve lower costs, then "forward pricing" is used to achieve the higher volume. Forward pricing – reducing the selling price to that at which the product could sell profitably if it had the higher volume the lower price would generate – is a wonderful tool if a company is in the market alone. But if it is competing against similar manufacturers, all with similar overcapacity problems and all seeking to increase volume by forward pricing, the result is grim indeed.

Is there any reasonable solution? I can think of only one: Staying completely out of the market is a non-starter. One cannot be a leading TV manufacturer by not selling TVs. However, in a climate where the price-elasticity issues are clear and the technology issues quite fluid, the optimum solution may be to hold one's losses to a minimum and just manufacture (or have private-labeled) enough flat TVs to stay in the game. Let the other guys bleed to death for their companies. Whatever money is left can then be spent to find a display technology that offers the low costs it takes to convince consumers to buy in large numbers. That may take a few years of patient waiting – or one could contact my company, Printable Field Emitters (PFE), Ltd. But there is no other path that makes sense from a stockholder's point of view. Being the biggest and best carries no honor when it results in losing money.

Table 3: Price Forecasts for PDPs by Size for 2005

Size (in.)	Price ($)	Units (k)	$ Volume (k)	Avg. Price
32	1587	251	398	
33	1666	33	55	
37	1884	524	987	
40	1996	55	110	
42	3633	1668	6060	
43	3633	63	229	
50	5220	238	1242	
60	7150	37	265	
61	7250	5	36	
63	9400	13	122	
		2887	9504	$3292

References

[1]All figures in this article are from the DisplaySearch study *Flat Display TV Market Overview* (February 2002), and are used with permission. ■

Taipei Hosts IDMC for the First Time

OLED inventor Ching Tang, BenQ/AU Optronics CEO K. Y. Lee, and Taiwan Deputy Minister of Economic Affairs Yen-Shiang Shih to deliver keynotes at IDMC '03.

by Han-Ping D. Shieh

THE Third International Display Manufacturing Conference (IDMC '03) and FPD Expo will be held February 18–21, 2003, at the Taipei International Convention Center. The first two editions of IDMC were held in Korea, a country that shares with Taiwan the recent distinction of becoming a major supplier of flat-panel displays (FPDs).

By rapidly building new TFT-LCD, LCD, PDP, and OLED production facilities and by adopting new manufacturing technologies, both Korea and Taiwan have become major suppliers of FPD devices, modules, and systems since the late '90s, in addition to being major suppliers of CRTs and CRT data monitors, in which they have been leaders for some time.

The year 2002 has so far been a good one for Taiwan's display industries. Total revenues of FPDs are forecasted to reach US$8 billion, a growth of 94% over 2001 (Fig. 1). Of this amount, US$5.8 billion will be generated by TFT-LCDs, whose worldwide market share has increased from 22.7% in 2001 to 34.3% in 2002. Major TFT-LCD manufacturers like AU Optronics, CPT, Chi Mei, Hannstar, Quanta Display, Toppoly, and Primeview are all actively expanding their respective capacity and product lines, using more advanced production facilities and technologies. Moreover, the number of local equipment and materials suppliers is increasing, forming clusters surrounding major panel manufacturers.

In addition to rapidly expanding production facilities, R&D groups of major FPD companies and research institutes are expanding their activities in the exploration of advanced technologies. Taiwanese companies are rapidly emerging as major players in the display-manufacturing industry.

The first two International Display Manufacturing Conferences were very successfully held in Seoul in 2000 and 2002, with the Korean Chapter of the Society for Information Display (SID) as the key sponsor for the events. For IDMC 2003, the SID Taipei Chapter will be the key sponsor and will attempt to maintain the high standards established in Korea.

Parallel with the conference, SEMI Taiwan will hold FPD EXPO 2003, featuring exhibit-

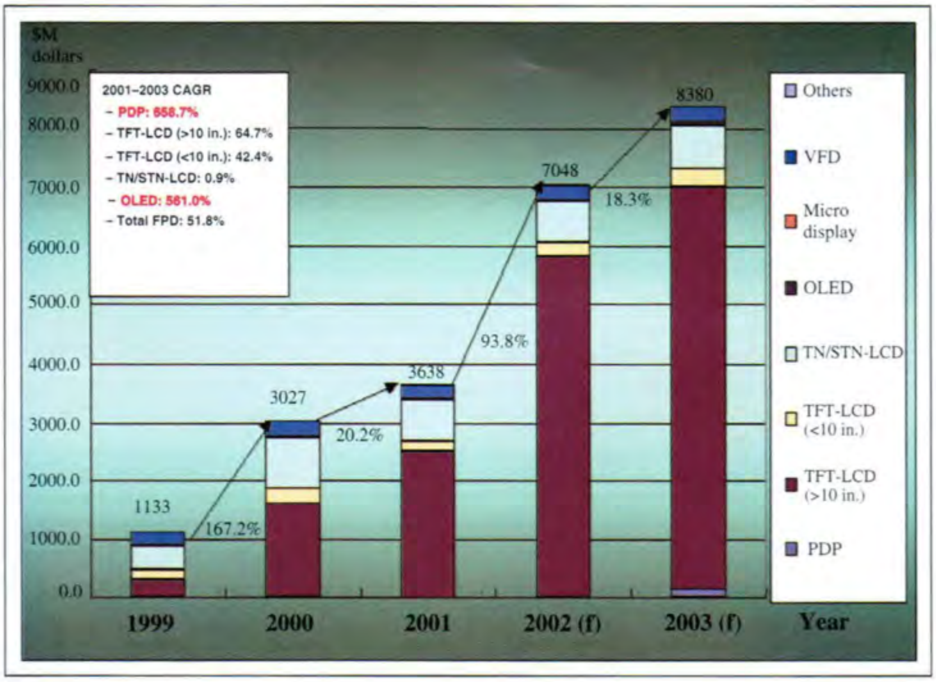


Fig. 1: Taiwan's display industry has experienced remarkable growth in 2002. Updated estimates place 2002 sales at US$8 billion, rather than the US$7 billion indicated on this chart. (Source: ITIS, 2002/2003.)

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0362-0972/02/1811-026$1.00 + .00 © SID 2002

ors of FPD manufacturing equipment, materials, and products. Other co-sponsoring organizations include the Taiwan TFT-LCD Association (TTLA), the Taiwan Liquid Crystal Society (TLCS), the National Science Council (NSC), the National Chiao Tung University (NCTU), ERSO/ITRI, the Taiwan Industrial Development Bureau, the Taiwan Ministry of Economic Affairs, and the Asian Office of Aerospace Research and Development of the U.S. Air Force Office of Scientific Research (AFOSR).

Dr. Fang-Chen Luo of AU Optronics Corp. and Dr. Jyuo-Min Shyu of ERSO/ITRI are the conference chairs; Dr. Kei-Hsiung Yang of Hannstar Display Corp. (Taiwan) is program chair; and Prof. Han-Ping D. Shieh of the National Chiao Tung University (Taiwan) is executive committee chair.

By having a three-day technical symposium and a one-day workshop in parallel with a major exhibition sponsored by SEMI, the event will provide the display community with the best possible opportunity to discuss and observe the current status and prospects of manufacturing technologies. IDMC 2003 will start on February 18 with four half-day workshops on OLED, PDP, LTPS, and projection technologies. In another workshop, Prof. Steve Forrest of Princeton University will provide extensive reviews on the current and future prospects of OLEDs and other display devices.

IDMC 2003 will feature three keynote speakers for the opening session of the three-day symposium. Dr. Yen-Shiang Shih, Deputy Minister of Economic Affairs, one of the key government officials in charge of high-tech affairs, will discuss the development of and prospects for information technologies in Taiwan. Mr. K. Y. Lee, Chairman of the Board and CEO of both BenQ and AU Optronics Corp. will talk about display devices and their impact on information and consumer applications. Dr. Ching Tang of Kodak, the inventor of the OLED, will report on the development history and current status of OLED technologies.

The technical symposium, with its main focus on manufacturing technologies, is comprised of parallel sessions covering nine main topics: AMLCDs, LC technologies, emissive displays (PDPs, FEDs, ELs, and carbon nanotubes), OLEDs/PLEDs, CRTs, projection displays, manufacturing equipment, new-generation manufacturing technologies, and environment, health, and safety issues.

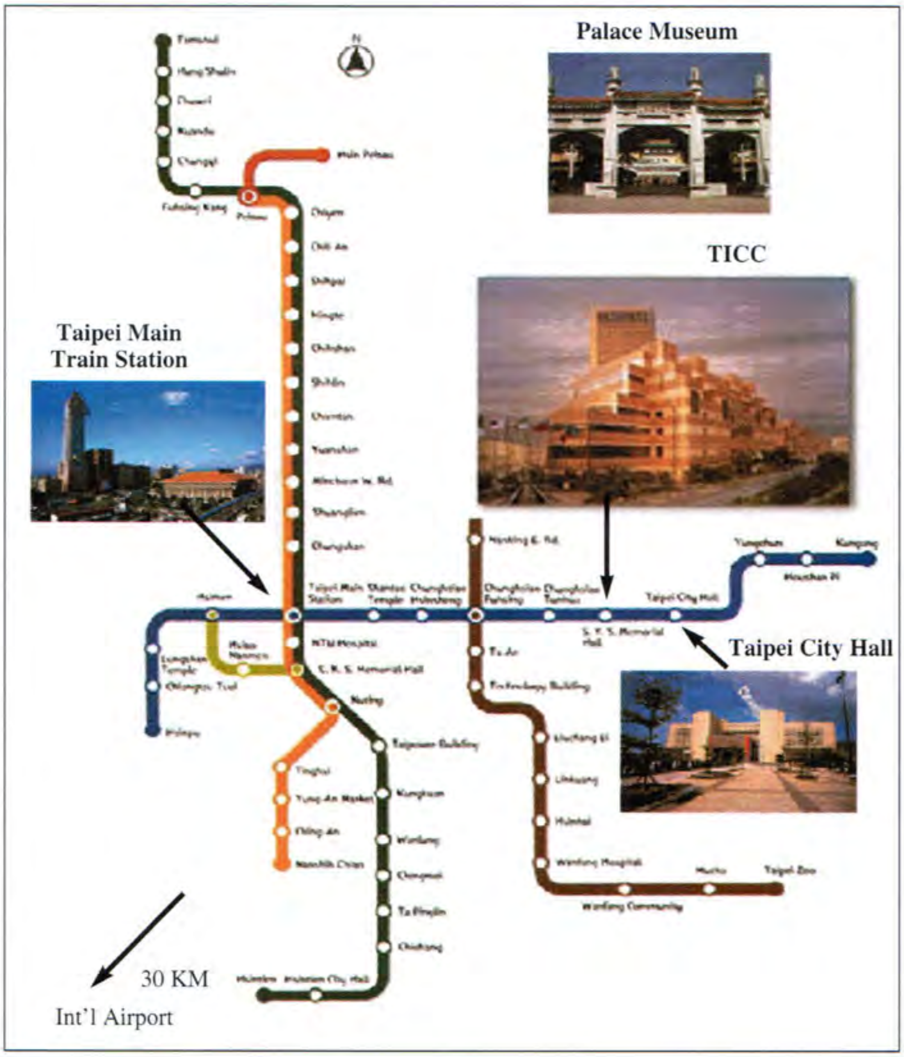


Fig. 2: *IDMC 2003 will be conveniently located at the Taipei International Convention Center, which is near hotels, shopping, and cultural attractions, and is well served by the Metro-Taipei subway system. The Palace Museum contains an astoundingly rich collection of ancient Chinese art, crafts, and artifacts.*

The AMLCD sessions will address subjects such as low-temperature polysilicon (LTPS) TFT-LCDs, driving circuits and peripheral integrated circuits, reflective TFT-LCDs, plastic/flexible AMLCDs, novel processes and devices, and video applications. The confirmed invited speakers for these topics include

- Hiroshi Haga (NEC) on system-on-glass technologies for mobile applications,
- Jin Jang (Kyung Hee University, Korea) on high-performance TFTs with MIC poly-Si, and
- Hiroyuki Ohshima (Seiko-Epson Corp.) on LTPS and related technologies.

Other device sessions will specifically focus on the characteristics of and the key issues in device manufacturing. For each topic, well-known experts from the U.S., Europe, Japan, Korea, Hong Kong, Taiwan, and other areas will serve as invited speakers.

To produce the necessary production volume and to control manufacturing costs, panel-manufacturing front runners can not postpone the adoption of large substrates and more advanced equipment and manufacturing

Taipei City Government Tourist Bureau

Fig. 3: *The Taipei Lantern Festival, one of the major traditional festivals in Taiwan and China, is held in mid-February.*

technologies. Companies that are not among the front runners will have to follow soon. Other topics to be addressed include equipment issues, such as fifth-generation factories for a-Si AMLCDs and advanced equipment and technology development for larger-sized panels; high-quality poly-Si; new technologies and strategies for producing AMLCDs using 0.5-mm-or-thinner glasses of tatami size; new ideas and methodologies for fast, reliable on-line or *in situ* inspection and monitoring; and particle reduction.

In the area of new-generation (Gen 5, Gen 6, or higher) manufacturing technologies, the organizers decided to cover flexible substrates, innovative factory automation, process control, fab design concepts and modeling, quality, yield improvement, productivity improvement, manufacturing-process modeling, cost analysis and modeling, mask reduction, manufacturing technologies for LTPS and a-Si TFT-LCDs, and innovative manufacturing technologies.

IDMC 2003 will have sessions dedicated to key issues in display-device manufacturing and applications, including environmental, health, and safety (EHS) issues. The topics for the sessions will include green production, waste management, water treatment, exhaust control, fire and smoke control, recovery and re-utilization, energy savings, safety, worker protection, and EHS management.

Now that Taiwan is becoming a key supplier of display devices, modules, and panels, IDMC attendees are likely to find pertinent information on Taiwan's display industries to be valuable. Serving this need, there will be an evening session on "Resources in Taiwan's Display Industries." A market overview of display industries will highlight the session, followed by several technical analysts who will discuss the status of key display industrial sectors, such as TFT-LCDs, OLEDs, and STN-LCDs. To complement the panel presentation, a half-day technology tour of TFT-LCD factories, ITRI in Hsinchu, and other facilities will be arranged for overseas attendees.

Visiting Taipei

The Taipei International Convention Center (TICC), located within a short distance of Taipei City Hall, is close to exhibition halls, department stores, shops, major hotels, and many attractions. TICC can be reached by subway lines (Taipei City Hall Station), which provide a very convenient way to travel in the Taipei metropolitan area (Fig. 2). TICC is about 30 km from Taipei International Airport, and there are frequent shuttle buses between the airport and the TICC area.

The Taipei Lantern Festival, one of the major traditional festivals in Taiwan and China, is held in mid-February (Fig. 3). Last in a series of springtime celebrations, this second New Year's is widely celebrated. In addition to displaying and inviting the appreciation of lanterns, the festival provides celebrants with rich entertainment – such as an historical lantern display and riddle competitions – and includes expressions of ancient wisdom. In splendid variety, the lanterns feature different folk arts and leave visitors with vivid impressions. IDMC 2003 will be a good opportunity to see the folk arts, music, and crafts of Taiwan.

The Taiwanese Government is strongly promoting the display-related industries as one of the two industrial groups – along with semiconductors – to reach revenues of US$30 billion before the year 2008. Vast investments and aggressive R&D to develop new technologies are under way. IDMC 2003 will be a good opportunity for the international display community to witness the beginning of a new era for Taiwan's display industries.

Updated information on IDMC 2003 and FPD Expo 2003, along with registration and hotel information, can be viewed on the conference Web site, http://osdlab.eic.nctu.edu.tw/IDMC/index.htm. ■

18 **03**

FEBRUARY

3rd International Display Manufacturing Conference & Exhibition (IDMC '03)

TAIPEI, TAIWAN
FEBRUARY 18–21, 2003

• An international gathering of display scientists, engineers, manufacturers, marketers, integrators, users, analysts, consultants, and investors, where all aspects of display manufacturing will be discussed.
• Sponsored by the Korea Chapter of the Society for Information Display.

Los Angeles Chapter News

by Peter Baron

The Los Angeles SID Chapter has two new officers: Ed Bernard (Northrop) is the new chair and Bob Carson (consultant) is the new secretary. Both previously held chapter offices. As a former chair (1992-94), Ed Bernard brings valuable experience to lend the chapter for the coming year.

The Liquid Crystal Display Product & Technology one-day seminar scheduled for January 17, 2003, is intended to provide an opportunity for SID members to keep up to date with technologies that are critical for developing effective LCD products. Four seminars, 1 hour and 45 minutes in duration, will feature talks on LCD markets, technologies, and supplier issues; LCD backlight fundamentals and developments; LC display electronics, including multimedia consideration; and practical aspects of delivering good color performance in LCDs. The fees ($150/$250 for members/non-members) are being kept low to encourage attendance and new member sign up. Seminar speakers are internationally recognized experts in their respective topics. (See ad on page 35 for details.)

SID Announces New SID Senior Member Grade

by Shigeo Mikoshiba
SID Senior Member Grade Committee Chair

It is my pleasure to announce that a new membership grade, SID Senior Member, has been proposed by the Board of Directors and approved by vote of the membership. The Senior Member Grade was established to provide added recognition to those members who have made significant technical contributions to the advancement of displays and who have demonstrated active participation in the display community and in SID. Each newly elevated Senior Member will receive an attractive parchment certificate. The elevation will be announced in *Information Display* and on the SID Home Page (www.sid.org).

The SID Senior Member Grade candidates must fulfill the following requirements.

SID Senior Member Grade Application Form

(to be submitted by applicant or nominator)

Applicant's Name	
First	
Middle Initial	
Family	
SID Membership Number	
SID Chapater	
Affiliation	
Job Title	
Mailing Address	
Phone	
Fax	
E-mail	
Name of Nominator (if relevant)	
Name of Reference	
List "significant performances" over a period of at least 5 years in the field of information display. (See requirement #3 of "An Invitation to SID Senior Member Grade.")	
List experience as a "practicing professional" for at least 7 years in the field of information display (requirement #4)	
List publications and presentations (five, altogether). (requirement #5-a)	
List services to SID (requirement #5-b or #5-c)	

#1. A candidate must have been a member of SID in good standing for at least 3 years of continuous membership immediately prior to the submission of an application.

#2. A candidate must have been an SID member for at least 5 years.

#3. A candidate must have demonstrated "significant performance" over a period of at least 5 years in the field of information display. "Significant performance" means substantial job responsibilities such as a program or project leader, engineer or scientist with some proven measure of success, or faculty member developing and teaching courses that include research and publication.

#4. A candidate must have been a "practicing professional" for at least 7 years in the field of information display.

#5. A candidate must satisfy at least one of the following conditions:

(a) Published or presented (authored or co-authored) at least 5 papers in the *Journal of the SID*, in *Information Display*, at SID-sponsored conferences, or at SID-sponsored regional

SID Senior Member Grade Reference Form

(to be submitted by reference)

Applicant's Name:	
Applicant's Membership number (if known)	
How long have you know the candidate?	
What is your professional relationship to the candidate?	
Has the candidate demonstrated "significant performance" over a period of at least 5 years in the field of information display?	
Has the candidate been a "practicing professional" for at least 7 years in the field of information display?	
My Name	
My SID Membership Number (if known)	
My affiliation (company/institution)	
My Mailing Address	
My Phone	
My Fax:	
My E-mail	
Date	

For additional information, please see "An Invitation to SID Senior Member Grade"

conferences or workshops. Local Chapter conferences are excluded.

(b) Served on the Executive or Organizing Committee of at least two SID-sponsored conferences, regional conferences, or workshops.

(c) Served as an SID Chapter or International Officer for at least 5 years.

An application form may be submitted by the candidate or by a nominator who shall be an SID member in good standing. A reference must be provided from an SID member in good standing. The nominator may serve as the reference. Fellows and Life Members of SID are not eligible for the Senior Member Grade.

Please submit the SID Senior Member Grade Application Form *via* the SID Home Page, by e-mail (seniormember@sid.org), or by fax (+1-408-977-1531, Attn: Dee Dumont). An SID Senior Member Grade Reference Form should accompany the application.

Russian Display Pioneer Sergei Darevsky Dies at 82

by Vladimir Samsonov and Igor Litvak

Sergei Darevsky, an outstanding creator of devices and systems for information display and an effective manager of technical programs, died in Moscow on September 8, 2001.

Darevsky was born in Moscow on May 23, 1920. In 1943 he graduated from the Moscow Aviation Institute with a specialty in "airplane equipment," and participated in World War II. He received his Ph.D. in 1953, was elected as an Active Member of the International Information Academy in 1993, and was elected an Honorary Member of the Russian Tsiolkovsky Academy of Astronautics in 1994.

Darevsky's main activity was running the Flight Test Institute (LII) in the town of Zhukovsky, Moscow region, where he held the position of Chief Constructor of the Special Design Bureau for display systems. He developed equipment for the pilot's cabin, including indicator panels for airplanes and simulators.

Darevsky created control desks for the astronauts for all Soviet spacecraft and space stations starting with the Vostok of Yuri Gagarin, and continuing to Voskhod, Soyuz, Salyut; the spacecraft for the Soviet lunar program; and the Russian shuttle system Buran. He also created training systems for astronauts.

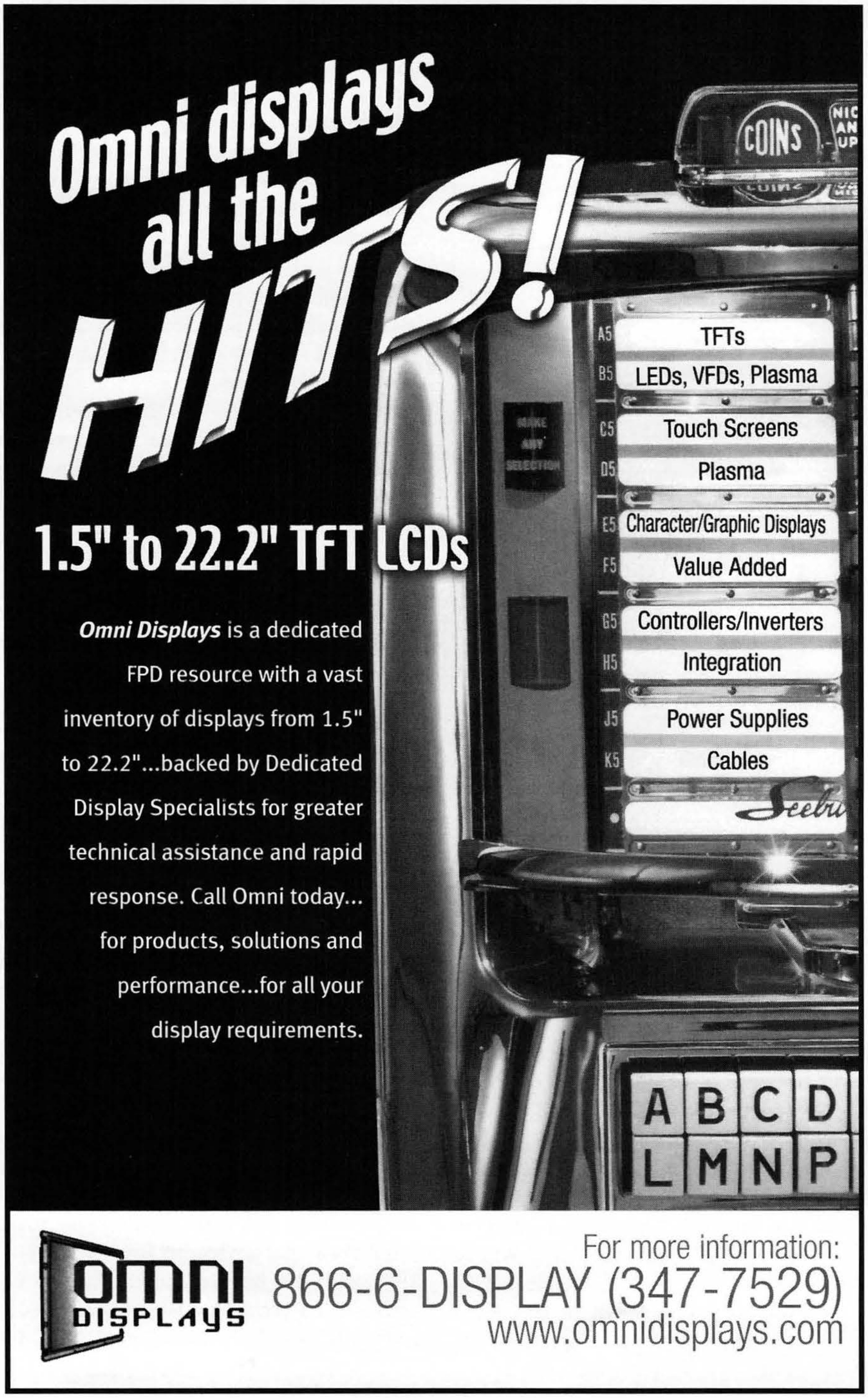
It was under Darevsky's supervison that installations were created in LII, Zhukovsky, and Cosmodrome Baikonur to develop and refurbish display systems. He organized a country-wide cooperative system among developers of display systems, including specialists in ergonomics. Darevsky wrote many scientific articles and created many inventions – 60 in all. He was the first in the USSR to propose and develop display facilities that allowed operators to monitor the activity of complex systems.

In 1975, Darevsky created the Coordinating Council on Display Devices (CCDD) and was its permanent Scientific Secretary until his death. Among many other positions and honors, he was Director of the Information-Editorial Enterprise Informatizatsiya, Deputy Chief Editor of the theoretical, scientific, and industrial magazine *Problemy Informatizatsii* (Informatics Problems), and Vice-Chair of the Department of Radioelectronics & Informatics at the International Information Academy. From 1998 until 2000 he was Chair of the SID Russia Chapter, and held the title of Honorary Chair until his death. Darevsky worked hard to establish productive relationships between state authorities and the scientific community.

Darevsky won many awards over his lifetime, including a medal "For Moscow Defense" in 1944, a medal "For Extraordinary Work During Great Patriotic War" in 1945, the Order of Lenin in 1961 for preparation and implementation of Yuri Gagarin's first space flight, the Order of October Revolution in 1971, and other medals from the Russian Federation, the Russian Academy of Sciences, and the Russian Exhibition Center.

In 1966, Darevsky was awarded the Lenin Prize for the preparation and provisioning of the first exit into open space by Alexei Leonov (astronaut-pilot Pavel Belyaev). Darevsky's erudition, organizational talent, and his great productivity and intuition in the field of displays gave him great credibility in Russia and in the international community. His vibrant personality and his contributions to the development of Russian and international science and technology are unforgettable.

He is survived by a daughter and a son, both of whom are scientists. ■



Circle no. 15

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rather than a manufacturing model. The U.S. display company of today is one that invents or develops new materials, processes, techniques, or architectures that will make displays made in Asia better or cheaper.

In the long run, the steady supply of excellent and low-priced flat-panel displays do provide a great opportunity to develop and add value to system-level products in North America and Europe. However, it is lights out for the non-Asian display-manufacturing industry – at least until the next startup comes along.

David E. Mentley is Senior Vice President at iSuppli/Stanford Resources; e-mail: d.mentley@stanfordresources.com. ■

SID Conference Calendar

Next Show!

The Tenth Color Imaging Conference

The premier international technical conference on Color Imaging is held every year in Scottsdale, Arizona. In November 2002 we will celebrate the 10th anniversary of this conference, and we are committed to make it a truly special one. If you are a scientist or engineer working in the areas of color science or color engineering and their applications to color imaging products, this is your Conference. The hallmark of this conference is a broad mix of professional interests. The range of professional areas represented includes: color science, color engineering, image processing, color reproduction, pre-press, color displays, digital photography, visualization in color, psychophysics concerning human color vision, optical physics, color in systems engineering, and color in software and hardware development.

12 NOVEMBER 02

10th Color Imaging Conference: Color Science Engineering: Systems & Applications

SCOTTSDALE, ARIZONA
NOVEMBER 12–15, 2002

- An international multidisciplinary forum for dialogue on:
  - Creation and capture of Color Images
  - Color Image reproduction and interchange
  - Co-sponsored with IS&T

4 DECEMBER 02

The 9th International Display Workshops (IDW)

HIROSHIMA, JAPAN
DECEMBER 4–6, 2002

- Invited and contributed papers will be presented in the following workshops:
- LC Science and Technologies • AMLCDs • FPD Materials & Components • CRTs • Plasma Displays • EL Displays • FEDs • Large-Area and Projection Displays • 3-D Display Technologies

18 FEBRUARY 03

3rd International Display Manufacturing Conference & Exhibition (IDMC '03)

TAIPEI, TAIWAN
FEBRUARY 18–21, 2003

- An international gathering of display scientists, engineers, manufacturers, marketers, integrators, users, analysts, consultants, and investors, where all aspects of display manufacturing will be discussed.
- Sponsored by the Korea Chapter of the Society for Information Display.

18 MAY 03

SID '03

BALTIMORE, MARYLAND
MAY 18–23, 2003

- SID's MAJOR ANNUAL EVENT
- An International Symposium, Seminar, and Exhibition – Featuring:
  - Technical Sessions – Poster Sessions
  - Author Interviews
  - Short Courses – Applications Tutorials
  - Technical Seminars – Applications Sessions
  - Product Exhibits – Vendor Theater

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Circle no. 18

Liquid Crystal Display Products Technology Seminar

(Sponsored by the LA Chapter of SID)

Friday, January 17, 2003
(8:30 am - 4:00 pm)

Costa Mesa Country Club, Costa Mesa, California

LCD Technology Developments, Markets & Panel Supply Issues
iSuppli/Stanford Resources

LCD Backlight Technology & Application
Munisamy Anandan, Extreme Devices

LCD Electronics
Nikhil Balram, SonicBlue

Practical Color Issues for TFT-LCDs
Gabriel Marcu, Apple Computer

Fees: SID Members -- $150; Non-Members -- $200 ($75 towards membership)
(Includes continental breakfast, lunch, and seminar notes)

Registration Deadline: **December 20, 2002**
(for late and on-site registration add **$50**)

To register and to obtain additional information, visit: www.sidchapter.org/la/

Circle no. 19

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One such attention-getter at SID was the "Stingray" (see photo). Built on a steel-foil substrate, the Stingray was billed, at 0.3-mm thick, as the world's thinnest active-matrix display. Commercialization of the Stingray and the color active-matrix display is slated for 2004–2005.

The only other developer of bistable displays that adopts the "electronic paper" metaphor more literally than E-Ink does is Gyricon (see photo). Gyricon also uses small particles, but instead of using electrophoresis it rotates the spherical particles under the influence of an electric field. Since each half of each sphere is a different color, it is possible to make monochrome, multicolor, or full-color displays. Gyricon calls its particles "bi-chromal microbeads."

E-Ink Corp.

E-Ink's Stingray electrophoretic display is just 0.3 mm thick.

Until it was spun off late in 2000, Gyricon was part of Xerox, and Xerox may have applied the paper metaphor too literally, promoting it as "electronic reusable paper" and designing a sheet-fed printer that would erase the old image and print a new one. The first press release on the new company's letterhead, though, was already taking a different tack and promising to "use the power of electronic reusable paper to provide networked, reusable retail signs that can be updated with the click of a mouse." And that is the marketing thrust the company continues to pursue today.

Nemoptic (Magny Les Hameaux, France) has developed a clever bistable approach using plain old nematic liquid-crystal (LC) material. In the company's BiNem® displays, the LC material is weakly anchored to one of the substrates. This weak anchoring can be broken and re-established with a different orientation, which produces the bistable display. Prototypes show impressively high contrast in the reflective mode. Manufacturing agreements have been consummated with Tecdis in Italy and PicVue in Taiwan, says Nemoptic President Alain Boissier.

Entirely new display approaches come along rarely, but Iridigm Corp. (San Francisco, California) has one in its iMOD Matrix™ device – a direct-view reflective MEMS display that relies on optical interference both to create color and to define the ON and OFF states. This display was described in the SID 2002 Overview article in our September 2002 issue. As we said there, the technology does not absorb light in polarizers or color filters, so it should have high reflectivity. A feature article describing the iMOD matrix technology in more detail will appear in *Information Display* soon.

Zenithal Bistable Devices (ZBD™), being developed by ZBD Displays, Ltd. (Malvern, Worcestershire, U.K.), uses a grating alignment layer to generate two stable states in a nematic LC, a high-tilt HAN state and low-tilt TN state. At ASID 2002 in Singapore, the company described a way of generating gray scale in such displays.

We have a variety of bistable technologies under development, but is bistability really necessary? J. H. Morrissy of Three-Five Systems, Inc. (Tempe, Arizona) and Yoshiharu Nakajima of the Association of Super Advanced Electronic Technologies (Tokyo, Japan) have made the point that reflective

Gyricon

Gyricon's paper-like bistable displays use "bichromal microbeads."

LCDs with various structures can have very low power consumption, have demonstrated higher pixel densities and far faster refresh times than the bistable technologies, and have an established infrastructure that will make them very hard to beat on price.

Nonetheless, the characteristics of at least some of the bistable technologies give them great applications potential, and the potential is due to viewing characteristics that traditional LCDs have not yet matched. To get a quick idea of how great that potential is, we need only look around to see people squinting at their cellular phones and PDAs, and to notice that almost nobody attempts to use a notebook PC out of doors on a sunny day.

About This Issue

A new column begins in this issue of *Information Display*. It's called "My Turn," and each one will give a different industry representative a chance to voice his or her opinion to *ID*'s readers. "My Turn" will alternate with Aris Silzars' popular, long-running column, "The Display Continuum." The first "My Turn" features David Mentley's comments on the end of FPD manufacturing in the U.S. I recommend it highly.

– KIW

We welcome your comments and suggestions. You can reach me by e-mail at kwerner@nutmegconsultants.com, by fax at 203/855-9769, or by phone at 203/853-7069. The contents of upcoming issues of *ID* are available on the *ID* page at the SID Web site (http://www.sid. org).

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consumers frequently pay for in both computer and consumer products that they never use or do not value, and of how historically new capabilities can be misused.

I recall that when the first color printers became available to the mass market, garish, overwrought business graphics and marketing materials ensued. I recall the arrival of the first 3-D business-graphics software packages and the confusing slides and printouts that resulted as the sophisticated new capabilities made the data presented less precise. And then, with time and the increasingly capable applications that appeared, things got even worse – which is where they remain to this day.

How many magazines now create complicated charts, graphs, and maps with a palette of pastels whose lack of differentiating chromaticity and contrast completely obfuscates the data? Color, meant to speed the comprehension of data, here serves instead to confuse the data. It makes one wish for the good old days of black and white and easily distinguishable cross-hatching.

Surely, no such ill effects will arise from Philips's incorporation of an OLED into an electric razor, but it makes one wonder what might have been, what real value and utility might have been injected into some other type of product which previously lacked a high-quality display or any display at all.

On another front, the monitor industry deserves a pat on the back regarding ease of use, especially in comparison to certain segments of consumer electronics. When I recently had the occasion to setup a new LCD monitor and a new telephone answering system, the LCD was plug-and-play beyond my wildest expectations. The monitor's dedicated legacy analog interface plugged right into an adapter supplied by the computer maker, marked with easily understood icons. The adapter plugged right into the computer and up the image came.

Of the telephone answering system, the less said the better. The slowly learned, immediately forgotten set-up process took most of an hour, with a confusing array of choices and cumbersome data entry through dedicated keys. Oh, for a quick set-up *via* touch input on a nice little display! ■

David Lieberman is a veteran display journalist living in Massachusetts.

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backlight

In Search of Pizzazz

by David Lieberman

I received a request from a reader a few months back, asking that I pay some attention to unusual uses of displays. Since then, I have been keeping my eyes particularly wide open for such things, but I regret to report that only one really unusual display use has presented itself to me in the intervening time: an electric razor from Philips with an OLED incorporated into the handle.

Anecdotally, I have heard that Central European opera houses have been taking advantage of FPDs to good effect. On a recent vacation trip abroad, an analyst friend of mine named Paul Z. encountered two such displays in his travels: one in Budapest and one in Prague. The opera house in the Czech Republic, he told me, places a large display above the stage to provide a rolling translation of Italian operas into Czech for the local audience. "I got lost in all the C's and Z's," Paul told me. He was much more taken with the small display monitor in the standing room of the Hungarian opera house, which let him choose (by touch input) to see a German or English translation of the opera as it was sung.

Automotive displays are, of course, not at all unusual, but it is worth mentioning a little evidence of how far FPDs have come in this application to date. There is a wealth of untapped opportunity for FPDs in automobiles beyond conventional alphanumeric radio displays, and coming days will see a number of FPD technologies vying for an extended role in the car.

I recently did a quick automotive display check on a trip to hometown Chicago, where traditionally, at some family function or other, I walk out to an alley or parking lot with my cousin Arthur to take a look at his newest car. This tradition began, if I remember correctly, way back in the early or middle 1970s, when FPDs made a dramatic, though brief, appearance in cars from a number of companies.

Arthur's newest chariot at the time had a bright yellow speedometer display incorporated into the dashboard, essentially a moving bar graph that completely displaced the traditional electromechanical dial. This electronic speedometer maintained the comfortable analog feel of the dial, but it offered nothing of value beyond that dial – which, more than twenty years later, is still the norm in automobiles – except, of course, pizzazz. The application was short lived.

The FPD in Arthur's newest pride and joy on wheels likewise has plenty of pizzazz but it also has one other, far more important, characteristic: extraordinary utility. It is a full-color FPD integrated into the middle of the dashboard as part of a mapping system with global positioning. "I don't know how I ever got along without it," Arthur told me. So, too, will more and more car buyers.

Which brings us back to Philips's razor, expected to be on the market soon, and which I got a quick look at at the recent SID Symposium. According to company spokesmen at the show, the sole function of this leading-edge display – a nice, bright yellow alphanumeric device – is to show the battery time remaining after the razor is removed from its cradle. "That's it?" I asked. Lots of sizzle, no steak.

Philips does deserve some credit for innovating and finding a way to use an FPD technology that it now can use, a potentially high-value display type now becoming available to OEMs. But the razor reminds me of all the capabilities

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calendar

The 9th Annual Symposium on Vehicle Displays. Contact: Mark Goldfarb, Palisades Convention Management, 212/460-8090 x212, fax -5460, e-mail: mgoldfarb@pcm411.com.
October 23, 2002 Detroit, Michigan

LCD/PDP International 2002. Contact: Nikkei Business Publications, Inc., +81-(3)-5210-7044, e-mail: lcd@nikkeibp.co.jp.
Oct. 30 – Nov. 1, 2002 Yokohama, Japan

Tenth Color Imaging Conference: Color Science, Engineering, Systems & Applications. Sponsored by IS&T and SID. Contact: SID HQ, Dee Dumont, 408/977-1013, fax -1531, e-mail: office@sid.org, www.sid.org.
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The 9th International Display Workshops (IDW '02). Contact: SID HQ, Dee Dumont, 408/977-1013, fax -1531, e-mail: office@sid.org.
December 4–6, 2002 Hiroshima, Japan

19th Annual Flat Information Display Conference 2002. Contact: Laura Castellano, 408/360-8400.
December 9–11, 2002 Monterey, CA

The Third International Display Manufacturing Conference & Exhibition 2003. Contact: SID HQ, Dee Dumont, 408/977-1013, fax -1531, e-mail: office@sid.org.
February 19–21, 2003 Taipei, Taiwan

FPD Expo Taiwan 2003. Contact: Sue Chung, 408/943-7961, e-mail: schung@semi.org.
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