FLAT PANEL DISPLAYS - PHOTONICS NEWSLETTER

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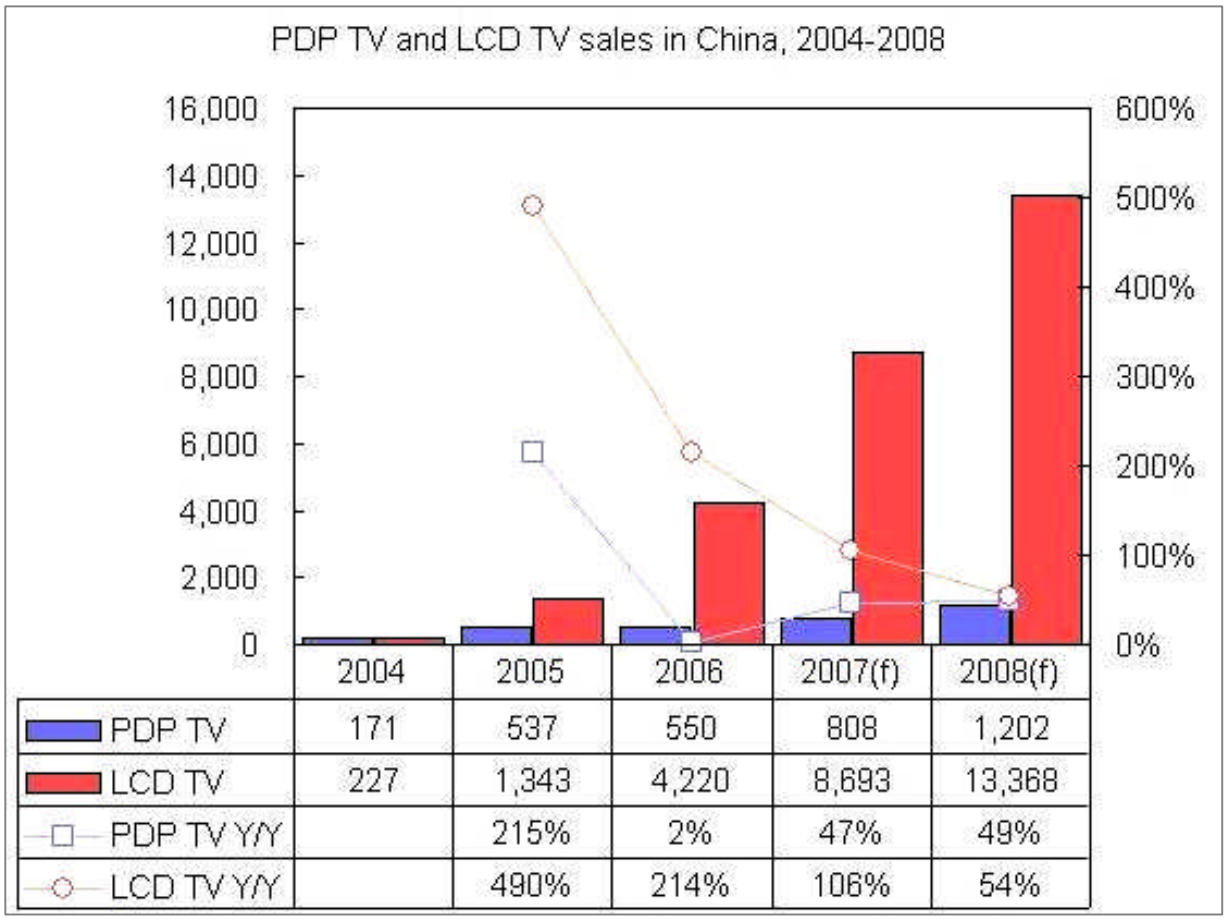
MARKET & BUSINESS INFORMATION

Display Wars - ***We've been watching the battle of display technologies for that past year or two, and winners are emerging - or maybe, losers. More expensive, and less scalable plasma, has been slipping in most, but not all, size markets.*** The sales ratio of LCD TV to PDP (Plasma Display Panel) TV will reach 10:1 in China in 2008 according to DigiTimes Research who has done a good job of forecasting. PDP TVs are fast losing market share to LCD TVs in China, where LCD TVs are expected to sell almost ten times more than PDP TVs next year. With the average size of LCD TVs available in China smaller than that of PDP TVs, but prices more affordable, it is natural for consumers in China to go for LCD TVs, as price is a major issue for TV selection, the research unit said in a recent report assessing the impact of the Beijing 2008 Olympic Games on the TV market in China. The report remarks that it will be easier for consumers in China to make a decision to buy a mainstream 32-inch LCD TV than to buy a 42-inch PDP TV. In 2004, the unit sales ratio between LCD TV and PDP TV in China was 4:3, but in the first half of 2007, the gap was widened to 11:1, the report points out. Of sales in the first half of the year, the 32-inch segment accounted for 38% of the LCD TV sales, followed by 42-inch at 15%, 37-inch at 13% and 40-inch at 11%. Source: DigiTimes.



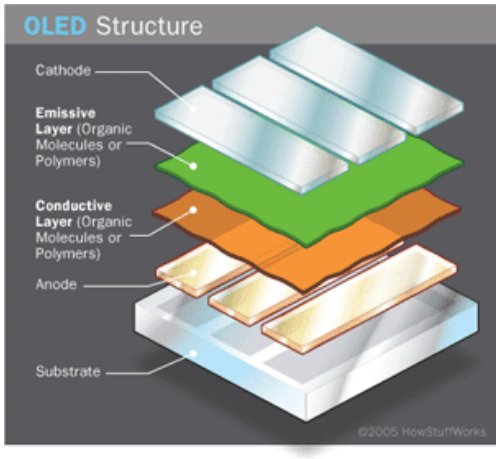
	2004	2005	2006	2007(f)	2008(f)
PDP TV	171	537	550	808	1,202
LCD TV	227	1,343	4,220	8,693	13,368
PDP TV Y/Y		215%	2%	47%	49%
LCD TV Y/Y		490%	214%	106%	54%

Digital Undivided - Global shipments of digital TVs are expected to hit 101-million units in 2007, up by 38% from 2006. The 2011 worldwide estimate is 167-million units that will represent 76% of total TV shipments. Geographically, 96% of the TVs shipped in North America this year will be digital, moving to 100% in 2008. Japan and Western Europe will have 92.3% and 89.8% digital for TV shipments. China DTV will be 44% and Eastern Europe, 40%, while Asia Pacific, Latin America, and the Middle East will be under 20%. Samsung had a 16.9% share of all digital TVs shipped worldwide in Q2-07, while Philips and LG Electronics each had 8.7% of the market. Source: DisplaySearch.

Global digital TV market share by brand, 3Q07

No.	Brand	Market share
1	Samsung	16.9%
2	Philips	8.7%
3	LGE	8.7%
4	Sony	7.9%
5	Sharp	7.4%
6	Panasonic	6.9%
7	Toshiba	5.2%
8	TCL	3.7%
9	Funai	3.6%
10	Vizio	3.2%
Others		27.8%
Total		100%

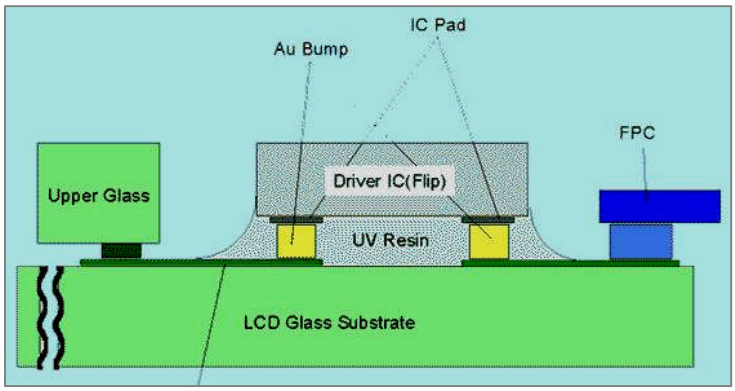
LCD and OLED Coexist - Sony is betting on both LED and OLED displays. Sony will extend both LCDs and OLEDs flat panel displays markets. They hope to evolve LCD TVs by increasing their screen size and luminance. OLEDs are in a different position and are positioned according to on their applications. Trends of TV technologies include evolution of shape, such as thinning and weight saving, larger and larger screen HDTV, improvement in image quality, environmental friendliness, novel devices, and compatibility with other applications and products. The technologies are advancing interdependently and creating opportunities for new products and new businesses areas. LCD TV development involves making continuous efforts to make them compatible with various image qualities depending on contents and to connect them easily to systems that are more complicated. OLEDs work is leading to developing new devices and this technology is the most powerful for the next-generation displays; commercialization is moving ahead immediately. Sony wants to offer new life spaces by taking advantage of OLED's 3-mm thinness and exceptional high image quality. While there prototype product is an 11-inch OLED, it provides deep images so that users do not feel its only 11 inches. You can get closer without the imaging looking fuzzy. The plan is to develop large OLEDs, but there are some hurdles; it's difficult to develop larger OLED sizes without breakthroughs. In summary - LED is about evolution, OLED is revolution. Source: TechOn.



OLED's Future - OLED only generated 0.5% of FPD sales with revenue growth of 13% Y/Y to $0.1-billion in 2006. For 2007, DisplaySearch expects OLED revenues will exceed $0.7B and more than double to $1.7B in 2008. The visual impact of organic LED displays has always been exciting and the industry is launching real products, albeit small-screens, like the 11" TV set. The OLED industry has a lot of infrastructure to develop, however. OLED will not challenge LCD TV in the short term. The OLED business will grow product by product over the coming years. OLED has considerable potential but the timeline is difficult to predict. Source: DisplaySearch.

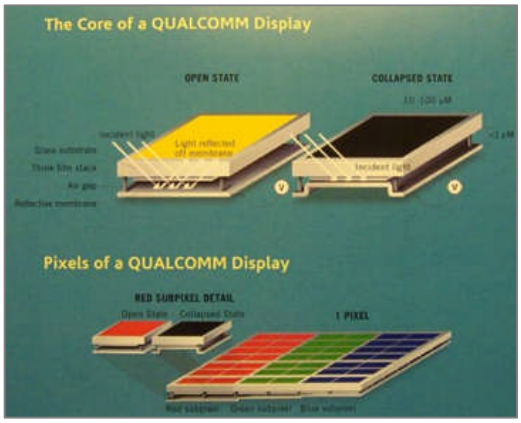
Thin is In - ***Last year it was "how big can you rig" for TV, but today, its ultra-slim products for large to small-size LCD applications. But does this really make good marketing sense?*** LG.Philips LCD recently announced that it plans to launch a 42-inch full HD LCD TV panel that has a

thickness of 19.8-mm set for Q1-08. The panel is 40% thinner and 10% lighter than conventional 42-inch LCD TV panels, according to the company. Samsung introduced a 40-inch full HD LCD TV panel that is 10-mm thick, reduced from a conventional 30-mm. The panel, using an LED backlight, reproduces 92% of the NTSC standard for color saturation and features power consumption of 90W or less. AUO demonstrated a 32-inch LCD module (LCM) with a thickness of 20-mm, compare to the average industry thickness of 32.5mm. The company plans to volume produce 32-, 37- and 42-inch super-slim TV panels during the first quarter of 2008.



Sharp announced a prototype 52-inch LCD TV with a thickness of 20-mm, a contrast ratio of 100,000:1, and power consumption of 140-kwh/y. Panel makers are also focused on thinness for notebook applications. A 13.3" notebook panel from CMO has a thickness of only 2.5-mm and a new record weight of only 163g. The panel **driver ICs are double-sided COG (Chip-on-Glass**) + WOA (Wire on Array) technology and a 0.4-mm ultra-thin light guide plate (LGP) backlight module. ***[The industry has been moving away from TAB and toward flip chip for a decade, but the transition is accelerating; UV underfill is popular***.] LG.Philips LCD's 13.3-inch widescreen LCD panel is also 40% thinner and 20% lighter, thanks to the use of white LED backlights instead of conventional cold cathode fluorescent lamps (CCFL), according to the company. One of the reasons that LCD TV makers are now using slimness as a feature trend in the market is that they expect to improve LCD technology and compete against OLED technology. OLED is self-luminous, which means there is no need for backlighting. [***I'm not sure that thinness for mega TVs, without something else, is a strong selling point. Thinness for OLED is probably not as important as other attributes, especially appearance and low power.]***

NEW PRODUCTS



MOEMS Displays - QUALCOMM MEMS Technologies Inc. and Hisense Communication Co Ltd have announced their collaboration in bringing QUALCOMM MEMS displays to market mobile phones. The MEMS technology developed by QUALCOMM is the first direct view MEMS display for mobile devices, and said to offer sharp display clarity in a wide range of environmental conditions including bright sunlight. It's based on a reflective technology called interferometric modulation (IMOD). The MOEMS displays harness ambient light and require no backlighting, thereby consuming significantly less power than typical displays. Many others MOEMS systems use mirrors that can tilt (TI's DLP) or be steered; 3-axis. The QUALCOMM displays are designed to enhance the hand-held products by providing more run-time per charge and expanding the capabilities of today's mobile devices. Their MEMS displays will be available in Hisense mobile phones in 2008. Source: Tech On

OLED TVs are Here with More on the Way - Toshiba plans to begin selling OLED televisions with as soon as panels are ready. The first Toshiba OLED television sets should hit the market in 2009. OLED boasts higher contrast and faster response times than LCD (liquid crystal display) screens and screens can also be thinner since no backlight is required. The organic materials for OLEDs illuminate themselves when an electrical current is applied. But, so far, OLEDs are difficult to manufacture and degrade over time. The focus at Toshiba, and among others, has been to improve production yields and increase the lifespan of the screens. Sony is probably the OLED TV leader, however, and was the first company to introduce an OLED television, the XEL-1. This OLED TV goes on sale in December 2007, has an 11-inch screen, and has an estimated of lifespan of around 30,000 hours; eight hours of TV per day for 10 years. While Sony was first to market with an OLED set, a lot of work remains to be done before the screens are ready for widespread adoption. The XEL-1 will only be available in limited quantities; 2,000 sets per month. Source: PC World.

Rohm introduced a prototype of full-color OLED micro-screen that's smaller than a fingernail, yet offers resolution of 320 pixels by 240 pixels. The display measures approximately 4-mm x 3-mm, is embedded in a prototype chip and is designed for use in a video-camera viewfinder. The full-color image on the OLED display is barely visible to the naked eye and requires a magnifying glass to be seen clearly. Under a magnifying glass, the prototype screen shows good detail and outstanding colors. [Sounds like the right product for 3D viewing glasses - or head display that will take off when the technology is right, now that we have portable viewers with too-tiny displays]. Source: OLED TV Technology.

Seiko Epson OLEDs - The company plans to make ultra-thin flat OLED displays when it increases the lifespan of the panels. The company has a production line at its Nagano plant and will take orders for OLED panels by the end of 2007. The line is capable of making only a few thousand OLED panels a year, however. They have expanded the life of OLED panels to more than 50,000 hours, up from 30,000 hours, and that is satisfactory. The first product is an 8" business-use OLED monitor that is 2.8-mm thick. The production line is also capable of manufacturing larger models of up to 21 inches. The screen size is 20.3-cm diagonal (8 inches), with pixels (W×H): 800×480, brightness of 200 cd/m2, and contrast ratio of 100,000 : 1 or greater. Source: OLED TV Technology.

CMEL (Chi Mei EL) announced that it would invest 30.6-million to expand to a second OLED production line with high-volume production slated for 2008. Besides the planned expansion, CMEL will introduce a 4.3" OLED panel during the first quarter of 2008. Another OLED panel sized at 7.6" will be launched in the second quarter. They further noted that when the second OLED production line starts operation, CMEL would also introduce 11" and 12" panel production. While large-screen OLED is a challenge, CMEL expects to offer 32" AMOLED panels during 2010. Source: DigiTimes.

PROJECTION

DLP Cinema Surpasses 5,000 Screen Milestone - MOEMS is showing in every major circuit including AMC, Carmike, Cinemark and Regal Cinema and now in 42 countries. Texas Instruments announced that its DLP Cinema® technology has surpassed the 5,000-screen milestone on a path to doubling that next year. There are 5,260 DLP Cinema enabled theatres. The pristine picture quality and ideal combination of contrast, color and brightness created by DLP Cinema allowed DLP Cinema technology to quickly become the **industry standard**. DLP Cinema® technology is deployed throughout 99% of the digital cinema market and is in every continent in the world except Antarctica. DLP Cinema expects to surpass **10,000 screens by the end of 2008**. In today's highly competitive commercial theatrical market, DLP Cinema®, the authority in digital cinema projection and imaging, is making it more economical for theatres to show both 2D and 3D feature presentations using the only proven single projector solution, as compared to other emerging and commercially unproven formats. DLP Cinema projectors are at the heart of **3-D** feature presentations and 3-D movies have grown rapidly through 2007 to become a key catalyst in the expansion of DLP Cinema systems in the U.S. 300 additional DLP Cinema projectors are expected to be fitted with 3-D capability in anticipation of the November release of Beowulf from Paramount Pictures, bringing the total 3-D equipped movie screens in the U.S. to 1,000. DLP Cinema® continues to be the driving force behind digital cinema as companies like Real D and Dolby continue to push 3-D developments on DLP projection technology, DLP Cinema installations are surging to deliver the world's most engaging movie theatre experience. DLP Cinema is a bulletproof projection technology with proven reliability and picture quality as well as the film-like presentation. Source: TI.

Pico-MOEMS - TI demonstrated the second-generation MOEMS-based pico-projector prototype at the SID (Society for Information Display) Mobile Display Conference. DLP Products Group announced that three technical manufacturers, Foxconn, Sypro Optics and Young Optics, plan to design and build mobile products that utilize DLP Product's pico-projection technology. DLP pico-projectors, either as standalone projectors or as integrated components in mobile devices, will provide consumers and business professionals with the flexibility to share video and graphic content in a larger way. The streamlined prototype is thinner and smaller, which allows easier integration in many mobile devices such as cellular phones, digital cameras and portable media players. DLP's latest prototype is in the form factor of a contemporary slim cell phone, measuring in at around 10 millimeters in thickness, with no fan or other moving parts. DLP has enhanced picture quality of its smallest projector, the pico, by

incorporating the first ever speckle-free solution, which delivers a clear and crisp image using the same DLP display technology that consumers have come to know from DLP HDTVs and projectors. Products powered by DLP pico-projector technology, will enable viewers to watch pristine images and video clips on most surfaces with an image the size of a standard piece of paper (8.5 x 11 inches). Key benefits of DLP projectors include: smoother images with no "screen door" effect; crisp and clear presentation of fast motion video; vibrant colors created by its BrilliantColor technology; and proven reliability across all facets -- picture reliability over time (no fading, yellowing or color decay over time as compared to other display technologies), overall performance and dust-resistance.

TECHNOLOGY BREAKTHROUGHS

Long-life OLED - Lifetime has been one of the issues with OLED, so improvements here are critical. Seiko Epson has developed an 8-inch light-emitting diode (OLED) panel and put into operation a manufacturing line for small-scale production of OLED for practical applications, according to the company. The company says it has already installed and commenced operations of a development and manufacturing line at its Fujimi Plant in Nagano prefecture, Japan. Epson was successful in lengthening the life of the device to more than **50,000 hours**, a level appropriate for practical application. The light emitting capabilities of OLED displays make possible such features as high contrast, wide viewing angles, and fast response times. In addition, the display can be made very thin and lightweight, making this new device a candidate for next-generation flat panel displays. However, in order to make the device viable for practical applications, it was critical to find a solution to a number of technical problems, including how to give the device a longer life, according to Epson. Epson exhibited this new OLED display system at FPD International 2007, an international exhibition of display technologies to be held at Pacifico Yokohama. Source: DigiTimes.

OLED is More Exciting - Samsung SDI is supplying OLED panel products now and has an aggressive technical roadmap. OLED panels have opened the new era of organic optoelectronics; not just displays but also new applications such as OLED lighting systems, organic electro-luminescent power generators and organic sensors will emerge in the near future. In the mobile display industry, the shift from monochrome to color displays formed the first wave, the realization of high-resolution TFT panels made the second wave and active matrix OLED panels will be the third wave. The OLED panel market will grow to US$3.7 billion in 2010. Samsung initiated OLED panel volume production in Q3-07 and the current output is 1.5-million units per month on a 2-inch panel basis; output will reach 3 million units per month in 2008. Roadmap: small panels launched in 2007, 3.5- to 7-inch panels including 4.1-inch panels will be applied to ultra mobile PCs, for example, in 2008. Goal is 14-, 15- and 21-inch panels in 2009 and large 40- to 42-inch full HD (high definition). Finally, true OLED TVs in 2010. There will be a flexible OLED display by 2012 at the latest. OLED lighting systems will be commercializes soon because the output efficiency is doubling every year. Samsung currently achieves 50lm/W luminance, a life of 20,000 hours till the initial luminance halves and a color rendering property of more than 80 colors. Source: TechOn.

Soda Glass for Displays - Samsung has developed a technology to manufacture LCD panels from inexpensive soda-lime glass, the same as used to make regular bottles. The company exhibited a 19-inch panel based on the technology at FPD International 2007. They are ready to mass-produce soda-lime glass substrate with the size corresponding to that of the fifth-generation product (1100 × 1250mm). Soda-lime glass is inexpensive and is easily formed. But it could not be used in the high-temperature process employed for the formation of regular LCD panel TFT because it deforms in the process. Therefore, an expensive, special glass substrate with lower impurity level was required to manufacture LCD panels. In order to use soda-lime glass, Samsung drastically lowered the TFT process temperature. The company did not reveal the details of the process. The exhibited prototype is a 19-inch SXGA (1280 × 1024 resolution) panel. It has a contrast ratio of 1,000:1, a luminance of 300 cd/m2 and a color gamut of 72% of NTSC. Source: TechOn.

Simplified OLEDs Manufacturing - Researchers at Technische Universität Braunschweig have designed a **simplified OLED** with only two organic layers. OLEDs are predicted to eventually replace the LCDs with their outstanding low energy consumption and several performance attributes. OLEDs are currently used in small portable devices such as cell phones, but adapting them to large screens will still require a few modifications and improvements. Besides increasing the OLEDs' lifetime, one of the biggest challenges is designing a simpler fabrication process. Recently, these researchers have designed a highly simplified OLED consisting of **only two organic layers**, compared to the considerable number used in typical OLEDs. Besides its simplicity, the OLED's efficiency (40-lm/W at 100-cd/m2) also surpasses those of other OLED devices of comparably simple design. The key to the simplicity is the ability to directly inject electron holes into the device's conductive layer.

An OLED consists of an emissive layer and a conductive layer, which are flanked by a negative cathode and positive anode at either end, respectively. Under an applied voltage, a current of electrons flows from the cathode to the anode through both layers. During this flow, the cathode injects electrons to the adjacent emissive layer, while the anode injects electron holes to the adjacent conductive layer (which can also be thought of as taking electrons away). By using tungsten oxide as the anode, the researchers found that the process of injecting holes into the conductive layer of the OLED could be made more efficient. This improved the current density, which meant that less voltage was required to operate the devices, resulting in about twice the power efficiency of an OLED without tungsten oxide. The researchers hope to enable easier and fail-safe manufacturing processes, but there are some other challenges that OLEDs must overcome before being widely used in large displays. These include finding a method to pattern the red, green and blue pixels for larger displays without compromising the quality. LCDs have matured and moved on with an enormous speed, but OLEDs still have to catch up in order to become a real alternative in the consumer TV or laptop market. However, OLEDs emitting white light are also very attractive for ambient lighting with low energy consumption. This application will likewise benefit from the concept of simplified OLEDs. Besides their low energy consumption, OLEDs offer other advantages including ultra-thin screens, fast action, excellent picture quality, flexible screens, and transparency (totally new products). Source: PhysOrg.