

Scanning the Issue: Special Issue on LCD TVs

LOOKING BACK ON the history of LCD developments [1], Richard Williams of RCA David Sarnoff Research Center discovered what—was-later-called “Williams Domains” in 1962, and indicated that liquid crystals could be used for electronic displays. In 1964, George Heilmeyer, L.A. Zanoni, and L. A. Barton discovered Dynamic Scattering Mode (DSM), and then devised the first liquid-crystal display with the use of a room-temperature liquid-crystal mixture formulated by Joel Goldmacher and Joseph Castellano. Heilmeyer said that a wall-sized flat-panel color TV would be just around the corner.

In the early 1970s, there were efforts to translate the DSM to commercial products, particularly wrist watches by companies, such as Timex, Optel, and Microma. However, the first reliable and commercial product ever made was a pocket calculator offered by Sharp Corporation in May 1973. This was immediately followed by a liquid-crystal watch by Suwa-Seiko (now Seiko-Epson) in September 1973; the key for the success of the watch was to use a Twisted Nematic (TN) mode discovered by Wolfgang Helfrich, Martin Schadt, and James Ferguson. Since then, the TN mode has been the basis of operation of liquid-crystal displays. The rapid growth of the pocket calculator and digital watch industries was possible because of reliable and colorless cyanobiphenyl liquid-crystals invented by George Gray, and Peter Raynes *et al.* of the United Kingdom.

In the early 1980s, the industry of LCD had been serving a niche portable-TV market with displays smaller than 3" diagonal. In 1988, I. Washizuka, H. Take, and K. Yano *et al.* of Sharp developed a TV-type color display as large as 14 inches, which revolutionized the industry. Managers in the electronics industry now recognized that the LCD would soon replace the standard-at-the-time CRT. Electronic giants, which had been performing only research into LCDs, but had not been involved in the business of manufacturing them, suddenly joined the burgeoning LCD industry. They supplied displays primarily to the PC industry, which was ever growing, and needed thin displays. In 1992, Sharp commercialized a Liquid-Crystal Museum TV; the realization of the Heilmeyer's dream of a wall-hanging-TV, after a long quarter of a century from his invention.

The concept of Active-Matrix Thin-Film-Transistor (AM-TFT) display, which current LCD TVs incorporate, originates in the presentation by Bernard Lechner on May 28, 1968, in the Press Conference, “RCA announces breakthrough in liquid crystal field; demonstrates thin screen displays of print, pictures, moving images.” at the Rockefeller Center in New York City. The concept was implemented in 1973 using CdSe as base material for TFT into a 6" × 6" display panel by Peter Brody *et al.* of Westinghouse. For reliable and commercial displays, the industry had to wait the invention at University of Dundee of Scotland, U.K., in 1979 of hydrogen-added amor-

phous-silicon TFT. C. T. Liu of AUO reviews the developments of AM TFT displays in this issue.

In the 1990s, Japanese companies launched a true LCD television industry; Yutaka Ishii of Sharp presents an excellent review on the developments of LCD TVs in this issue. The industry solved the remaining technical problem of narrow viewing angle with an In-Plane Switching (IPS) technology [2], the recent development of which would be addressed by HyungKi Hong, HyunHo Shin, and InJae Chung of LG Philips. The second method of solving the problem was a Multiple Vertical Alignment (MVA) technology [3], which would be covered in the Ishii's article. Another problem was a slow response of moving pictures. This has been solved step-by-step by lowering liquid-crystals viscosity and thinning the cell gap. Various technologies have been developed on the improvements of picture quality, recent development of which is addressed by Jun Souk and Jongseo Lee of Samsung Electronics. One component of the display that significantly affects the picture quality is a backlight. Yi-Fu Chen, Che-Chin Chen, and Ke-Horng Chen of National Chiao Tung University discuss the improvement of picture quality with using a novel LED backlight system.

Joined by Korean and Taiwanese industries in the latter half of the 1990s, the LCD TV industry was addressing to increase the manufacturing efficiency thereby to reduce its cost. To that end, the industry has ever been expanding the size of mother glass used in the production. In 2004, Sharp started manufacturing panels with using the 6th generation glass, the size of which is 1.8 M × 1.5 M. This was followed by Samsung in 2005 with the 7th generation glass (2.2 M × 1.87 M) and by Sharp in 2006 with the 8th generation glass (2.46 M × 2.16 M). Sharp has announced to use the 10th generation glass, the size of which is as large as 3.05 M × 2.85 M, in 2009. The key item for the manufacturing is a giant-size vapor deposition system, which is addressed by Ya-Tang Yang, Tae Kyung Won, Soo Young Choi, Takako Tekehara, Yasunori Nishimura, and John M. White of AKT in this issue.

Recently, the panel technology is pretty much standardized, the competition on the quality of TV is now focused on how we process the signals coming out of the display panel. Fumikazu Ga, Kengo Umeda, Keiichi Nakajima, Takeshi Watanabe, and Masaharu Takahashi of NEC will address the technologies for the electronic circuits peripheral to the display panel.

The liquid-crystal display has come a long way from the first prototype in 1964 to the central device in the electronic industries in 2007. It is very timely that we can offer this Special Issue at the events that LCD TV industry took over the CRT TV industry in dollar value in 2006 and is projected to reach 70 billion dollar mark in this year [iSuppli data]. Though having a competition from the Plasma Display Panel and facing with an upcoming Organic Electro-Luminescent Display, the LCD is

expected to stay in the main stream of electronic displays for a foreseeable future.

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Hirohisa Kawamoto (S'69–M'70–SM'83–F'92–LF'04) received the B.S. degree in electronics from Kyoto University, Japan, in 1961, and the M.S. and Ph.D. degrees in electrical engineering and computer sciences from the University of California, Berkeley, in 1966 and 1970, respectively. He is the chair of the first steering committee organized to launch the new IEEE/OSA JOURNAL OF DISPLAY TECHNOLOGY (JDT) in 2005.

From 1961 to 1968, he was with the Matsushita Electronic Corporation, Osaka, Japan. In 1970 he taught as an acting assistant professor at the Department of Electrical Engineering and Computer Sciences of the University of California, Berkeley. From 1970 to 1980 he worked for RCA David Sarnoff Research Center, Princeton, NJ. In 1980 he founded the Sony Consumer Electronics Laboratories in Paramus, NJ, where he served as general manager until 1985. During the same time he founded the Princeton Community Japanese Language School, Princeton, NJ, and served as the chair of its Board of Trustees until 1985. From 1985 to 2001 he was with the Sharp Corporation, Japan, where he participated in the founding of Sharp Laboratories of Europe at Oxford, U.K., and Sharp Laboratories of America at Camus, WA. His last assignment at Sharp was as vice president and division general manager of the Technical Information Center. Since July 2001, he has been a senior business advisor with Silicon Image Inc., Sunnyvale, CA, stationed in Nara Gakuen-Mae, Japan. From 1994 to 2000 he acted as a delegate from Japan to the Committee of Action of International Electro-Technical Commission, Geneva, Switzerland. He is currently a professor at Nara Institute of Science and Technology, Takayama, Nara, Japan.

Dr. Kawamoto was elevated to IEEE Fellow in 1992 for contributions to materials, device, and systems technologies for the use in video systems. He has also received the IEEE Centennial Medal and Third Millennium Medal.



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Dr. Shieh has been made Fellow of the Society for Information Display (SID) in 2005, for many novel applications of optics and micro-optics for projection and liquid-crystal displays and for his contributions to display education.



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