

## 액정 광학과 최신 TFT-LCD 기술

**Optics of Liquid Crystals and Emerging Technologies of  
TFT-LCDs**

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## Abstract

The liquid crystal display (LCD) technology, compatible with highly integrated and low power consuming electronics, will play a key role in the area of flat panel displays such as high performance information displays and future high-definition television sets. The range of applications of LCDs is expanding to include virtually every field - from office automation equipment to consumer and industrial equipment. The basic physics of LCs, the principles of LCDs, and some progress toward solving the existing problems will be described in view of the current status of LCDs.

Recently, liquid crystal displays (LCDs) are widely used for applications in computers, communications, and consumer electronics. Multi-media, mobile communications, personal digital assistants, and viewer camcorders are some of these applications. For the growing success of LCD technology, there have been three major prerequisites: the successful synthesis of new LC materials with suitable properties, the discovery of new physical phenomena and electro-optic effects for LCDs, and the last but not the least, the development of required manufacturing processes and tools.

Thin-film transistor (TFT) LCDs have made great progress in late 80's and early 90's. The combination of Si-based microelectronics and twist-nematic (TN) effect of LC materials makes it possible to produce a flat panel display featuring lightweight, low power consumption, and full color representation. In addition to conventional notebook personal computers (PCs), LCD manufacturers are gearing up to develop a new generation of large-screen TFT-LCD panels with much improved viewing characteristics, lower power consumption, and lower reflectance. Currently, color TFT-LCD products have been mainly focused on monitors for laptop computers and HDTV systems beyond portable applications such as notebook PCs and small TVs. The product applications as large-screen monitors for video applications will lead the future LCD market, followed by portable game machines and car navigation systems.

In the following, several issues on large-screen TFT-LCDs are discussed along with emerging innovative technologies.

- LCD manufactures are improving visibility with technologies that widen the viewing angle. The wide viewing characteristics are essential for large-screen LCDs when viewed from different angles depending on the use. The establishment of product-level technology with less process is a major task for manufacturers. Some approaches to wide viewing are based on an optical compensation method, multi-domain alignment, photo-induced alignment, and new LCD modes such as in-plane switching and homeotropic-twisted planar configurations.
- LCD manufacturers are developing a variety of new technologies to improve the portability and power consumption of LCD panels. Portability is improved mostly by extending the battery operation time through lower power consumption. Beside the issue of batteries, it is important to reduce the power consumption of LCD panels themselves. There are three points in power consumption reduction; improvement of the transmission of light through the LCD panel, improvement of the efficiency of the backlight unit, and reduction of power consumption of the driving circuits. Moreover, the development of a reflection-type panel with no backlight is currently pursued.
- Low reflection is required for use in the outdoor environment. The application to the panel surface of anti-reflection coating prevents the infusion of the external light. The multi-layer film is usually deposited on the LCD's light polarizing panel. For conventional LCD panels for office equipment, just anti-glare processing has been applied so that the rough surface of the panel scatters the reflected light. However, this technique alone can not damp the powerful glare sunlight.

Other advances in full-color panel and high-intensity backlight technologies, used in car navigation systems, measuring equipment, and airplanes, will provide a technological platform for innovation of large-screen TFT-LCDs.

In summary, among a variety of flat panel displays, TFT-LCDs are the most promising products, based on their performance. Besides the reduction in cost, thickness, weight, and power consumption, technological advances that realize large-screens and higher definition are still in progress. The continued development of materials and components, such as new substrates, color filters, LC materials, optical plates, and driving ICs, will promise the success of the next generation LCDs needed in the information era.