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Cover photo: An exhibition of photographer Werner Feldmann presents the R&D activities of the SCHOTT Group from an unusual and impressive perspective. The photo shows – greatly enlarged – "Zerodur" glass ceramic being cut. For more information on "Fascinating Innovation" see pages 24-25.

Photographer: SCHOTT/Werner Feldmann

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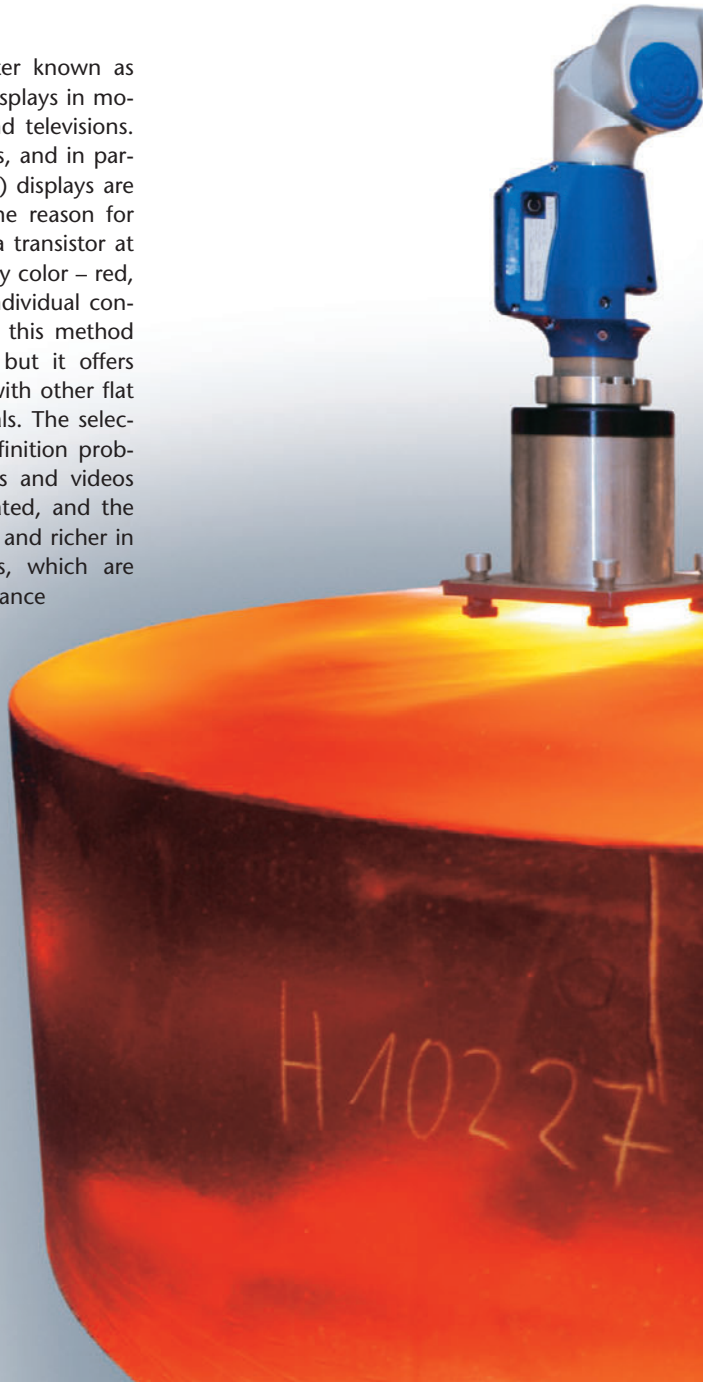
Large Components for Small Structures

For the further development of LCD lithography devices, highly precise **glass ceramic components** are used to apply transistors to display glass for monitors and televisions.

Liquid crystal display, better known as LCD, technology is used for displays in mobile telephones, computers and televisions. So-called active matrix displays, and in particular thin film transistor (TFT) displays are now gaining in popularity. The reason for this is that TFT displays have a transistor at each pixel and for each primary color – red, green and blue. Due to the individual construction of millions of pixels, this method requires a far greater effort, but it offers major advantages compared with other flat displays based on liquid crystals. The selection of the pixels is faster, definition problems such as blurred graphics and videos because of streaks are eliminated, and the screen presentation is brighter and richer in contrast. Unlike passive LCDs, which are used in smaller displays for instance for mobile telephones and pocket calculators, active matrix technology is more suitable for large-format displays.

As a consequence, the market share of TFT displays in computer monitors, notebooks and televisions is growing by 20 percent per year. Experts say that the main growth in demand is

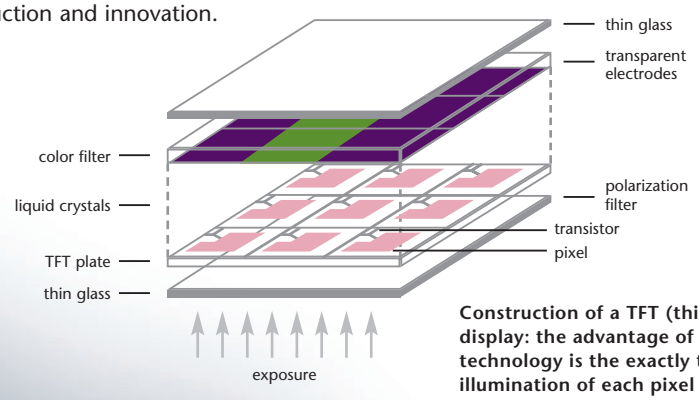


for larger displays. Most users prefer TFT monitors with diagonal screen dimensions of 17 inches and larger. The visible surface of these devices is comparable to that of a 19-inch screen with conventional picture-tube technology. In the case of TFT television monitors, which are expected to become the decisive technology in the TV display market, large formats of between 20 and 40 inches are becoming increasingly more popular.

This has two consequences for TFT production. Firstly, the manufacturing capacities for TFT modules must increase significantly. It is thus predicted that by 2007 leading manufacturers will have doubled their total production volumes to 183 million TFT units. Unfortunately, even this output will not completely cover demand, which experts estimate will be around 192 million TFT units. Secondly, the trend is toward ever larger manufacturing facilities because the aim is to produce greater quantities of increasingly bigger displays in a single operating cycle. This will improve cost efficiency and increase the tempo of production and innovation.

Canon is the leader in LCD lithography systems

A common process used in the production of large TFT displays is LCD lithography. Ultrafine transistor structures are applied to coated display thin glass by exposure and etching. With a world market share of some 80 percent, Canon is the leading supplier of LCD lithography systems for TFT displays. The Japanese company hopes to fabricate even more sophisticated lithographic tools with the corresponding precise optical components made with special glasses and



Construction of a TFT (thin film transistor) display: the advantage of this display technology is the exactly triggered illumination of each pixel by a transistor. Millions of pixels on large-format displays allow an outstanding brilliance and a high contrast of the reproduced image.

Highly precise, large-format optical components made from "Zerodur" glass ceramics are the prerequisite for more sophisticated LCD lithography devices.

SCHOTT/Thomas Bauer

other optical materials. "Zerodur" has long proved its worth in such applications. This glass ceramic, which has made a name for itself among astronomers worldwide as a mirror substrate material for large-scale telescopes, also has decisive advantages for application in LCD lithography. Among these advantages are its zero thermal expansion, its good processability and its very low surface roughness.

SCHOTT supplies Canon with, among other things, pressings of optical glass for use in cameras, projectors, webcams, mobile phone cameras and digital cameras for surveillance systems. Canon has also received "Zerodur" components for its LCD lithography tools for more than 20 years. And in the spirit of a true partnership, the German technology company has taken a major step in response to the Asian company's increase in output because of the market situation: SCHOTT has set up and expanded its production capacities. At an investment in the two-digit million-euro range, a new melting tank including installations for further processing was constructed. "We can now react quickly to the fast tempo in the market for flat displays. This will help Canon strengthen its market position, and we can build a long-term partnership," explains Dr. Thomas Kessler, Director, Marketing & Sales, Europe, Japan & Korea in the Optics for Devices Business Segment.

Highly precise components

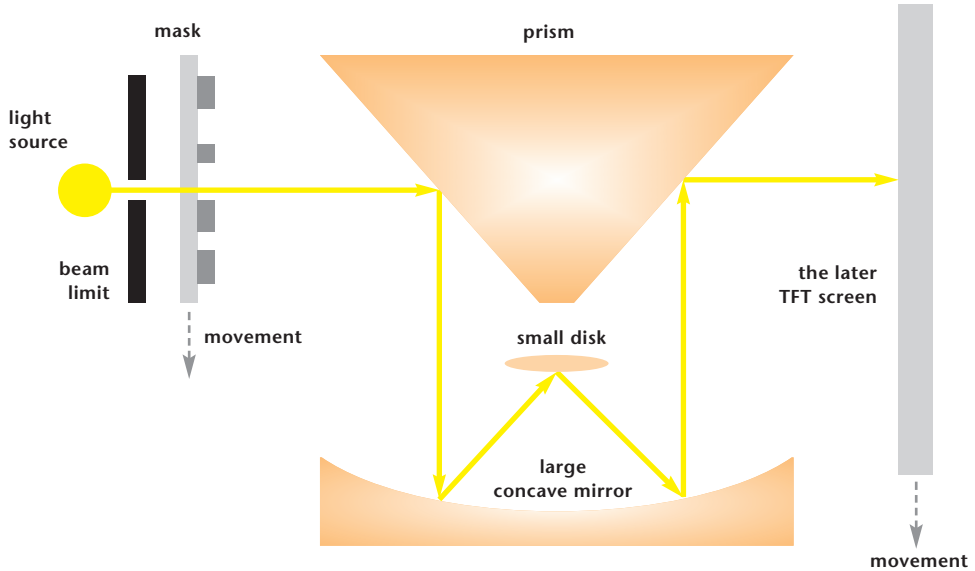
The dimensions have indeed grown in every respect. For a current project, Canon received, for example, a prism weighing some 520 kilograms as well as a 1.2-metric ton mirror blank. "With optical components in such dimensions, it is also possible to expose large-format displays in a single operating cycle. In this sense, LCD lithography is becoming more and more complicated," says Dr. Kessler. But this effort is justified by the success in the market: using large "Zerodur" components, Canon was able to fabricate the world's largest high-precision concave mirror for LCD panel production – with a diameter of 800 millimeters. With this mirror it is possible to produce 32-inch widescreen television displays.

Both partners had to expand their fabrication capabilities to realize this project. "We can now also cast large rectangular 'Zerodur' dimensions as near as possible to the application's final format – in other words directly geared to market needs," explains Dr. Volker Wittmer, Optics for Devices/Engineering. With the help of new machines in the production process, both the surface quality and the dimensional tolerance have been improved, which ultimately saves the customer preparatory work. The Japanese manufacturer itself does the high-precision polishing and coating of the optical components, i.e. vaporizing metal onto the mirror surface. The precision of the finished products speaks for itself: for example, the processing exactness of the concave mirror surfaces after polishing results in an average tolerance of 0.015 micrometers. To put this into perspective using an object the size of the Earth, the largest bumps or indents, in other words deviations from the ideal surface, would measure a maximum of ten centimeters.

LCD lithography: a trend toward larger formats

LCD lithography technology was developed at the end of the 1980s for the production of the first TFT displays in the United States. The leading display manufacturers in Japan, Korea and Taiwan now mainly use lithography tools for the optical application of transistors with whose help the individual pixels of active LCDs or TFT displays are triggered to illuminate. These exposure tools function according to projection technology. Light is conveyed through an optical system and directed through a mask. The mask exposes ultrafine microstructures onto the display glass plate to be processed, which has been coated with a photosensitive resist and moves simultaneously with the mask. After this photolithographic exposure, an etching process is used to fix the transistor circuits.

The optical components for directing the light are composed of special glasses and other optical material. In Canon's system



Path of light in an LCD lithography tool

During exposure, the light strikes three "Zerodur" components made of temperature-stable glass ceramic (colored orange).

High-quality television displays are becoming increasingly larger. Experts predict annual growth rates of more than 20 percent for the TFT technology used in computer monitors and notebook screens.

SAMSUNG

(see illustration), which makes use of "Zerodur" components, the light first strikes a prism with a triangular cross section after passing through the mask. From here it is deviated onto a large concave mirror, then onto a small convex round disk, before it reaches the display via the concave mirror and the prism.

This procedure follows the general rule that the larger the surface of the concave mirror, the better the dimensions of the display glass to be exposed can be defined. This is the way to expose the targeted large-format TFT displays in a single operating cycle and thus to realize next-generation processes for the fabrication of still larger TFT formats. In the meantime, the generation 5 for TFT formats, which measures approximately 1,100 by 1,250 millimeters, is increasingly becoming the production standard. Leading manufacturers are already tackling the challenge of generation 6 (1,500 x 1,800 millimeters), while generation 7 (1,800 x 2,100 millimeters) will be the objective of the next two to three years.

This trend towards large-format TFT displays has led to high-volume exposure facilities weighing some 18 metric tons and more. They are fully automatic and integrated into production lines. The fabrication process requires the highest levels of precision and cleanliness. This is why LCD lithography tools are encapsulated in special casings and fabrication takes place in clean rooms. ◂

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