TFT LCD Panel Manufactured by Roll-to-Roll Process

12 08, 2008 20:15
Shinichi Kato, Nikkei Microdevices

A 3.5-inch TFT LCD display made by using the roll-to-roll method (left). The LCD panel is only 0.49mm thick (right).

The film that constitutes the TFT LCD panel is 300mm wide and 50m long.
Four panels were assembled as one set.

The Technology Research Association for Advanced Display Materials (TRADIM) made a TFT LCD panel with a roll-to-roll method using a TFT array and a color filter formed on film substrates.

The panel was made from a 3.5-inch amorphous Si-TFT and a color filter formed on 300 (W) x 50m (L) film substrates.

In August 2008, TRADIM announced a technology to continuously form a TFT array on a film substrate for use in the roll-to-roll production of LCD panels (See related article). Combined with the technologies developed earlier than August, TRADIM developed a technique to mount LCD panel components consisting of 14 glass substrates, optical films, etc on five film substrates.

This technique enabled to produce all the LCD panel components other than oriented film and liquid crystal material by the roll-to-roll method. The LCD panel announced this time used such film substrates and was assembled by the roll-to-roll method.

The roll-to-roll assembly process of a TFT LCD panel consists of the following procedures. Materials are coated and bonded on a film substrate that isn't moving, using four panels as one set. Two rolled film substrates, one with a TFT and the other with a color filter, are set on the roll-to-roll assembly equipment.

The color filter substrate is applied with a sealing material and then with a liquid crystal material using a dispenser. The TFT substrate and the color filter substrate are turned to face each other, aligned, and brought into contact with each other. Then the seal material is hardened under UV irradiation.

**Positioning accuracy within ±10μm**

The key aspect of the assembly process is the positional accuracy of the TFT substrate and the color filter substrate. For the assembly of this 3.5-inch TFT LCD panel, positioning accuracy within ±10μm was realized. TRADIM did not disclose the measures used for the improvement of the position accuracy, only referring to the following two points.

First, the institute employed a film substrate with a low coefficient of thermal expansion and a seal material that can be hardened by UV irradiation alone, without heating treatment. The same film substrates are used for the TFT and the color filter. This is because the film substrates are distorted due to heat in the manufacturing process, causing displacement, if film substrates of the same material are not used for both the TFT and the color filter.

Meanwhile, by sealing with a UV-hardening resin alone, TRADIM prevented heat deformation of the structures that form the TFT and the color filter, reducing warping and variations in cell gaps.

However, the parts that do not transmit UV rays, such as the metal wiring, are not hardened when the LCD panel is sealed using the UV-hardening method. For this reason, a method that combines UV hardening and heat hardening is currently used for the mass production of TFT LCD panels with a glass substrate. The institute added a new twist to the UV hardening method in order to harden the areas under metal wiring, etc.

Second, TRADIM developed equipment and processing methods that reduce tensile load on the film substrate and warping during the assembly process.
The institute said it plans to develop an optical rubbing process and an thin TFT element applicable to roll-to-roll processing by March 2010. As for the rubbing process, it uses a polyimide oriented film, which is also used in existing TFT LCD panels.

The institute uses a cold-setting polyimide material that is hardened at 150°C to limit the effects of thermal expansion. The hardening temperature for polyimide materials used for oriented films in existing TFT LCD panels is 230°C or higher.

The new technology was developed in the "Super Flexible Display Parts Technology Development Project" of the New Energy and Industrial Technology Development Organization (NEDO).

Shinichi Kato, Nikkei Microdevices