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2007
World's first OLED TV launched
(Sony)

~ Discrete Semiconductor/Others ~

In 1997, Pioneer commercialized the first green monochromatic OLED flat panel display in the world using an aluminum quinolinol complex (Alq3) (host) doped with quinacridone (guest) as the light-emitting layer [(1)]. The emission color of the OLED was able to change by combining the guest and host materials. Various combinations of host and guest materials that emit the three primary colors of light (RGB) required for full-color displays were found, and the development of full-color displays was actively advanced by many companies, including Idemitsu Kosan and TDK. Initially, the luminescence efficiency of the OLED was as low as 5% because it used fluorescent luminescence. In 1998, S.R. Forrest discovered that phosphorescent emission was possible by using platinum porphyrin derivatives or iridium complexes as dopants [(2)], which led to the development of various materials emitting phosphorescence in the three primary colors of light with luminous efficiencies exceeding 20%.

In 2001, NEC's 2.2-inch full-color passive matrix OLED display (120 x (RGB) x 160 pixels) was installed in the main display of NTT DoCoMo's N2001, which was the first handset compatible with the world's first commercial 3G (3rd generation mobile communication: W-CDMA standard) service, FOMA [(3)]. The panel was manufactured by Samsung NEC Mobile Display, a company jointly established by Samsung and NEC. It was the world's first OLED display used in a cell phone handset. (There is an uncertain information that an OLED display was installed in Motorola's cell phone in 2000.) However, due to various problems such as "difficulty in seeing the display in bright places" and “an appearance of dark spots (black dots)", all products were recalled and replaced with liquid crystal displays (LCDs).

Pioneer, in collaboration with UDC and Nippon Steel Chemical, has succeeded in developing a high-brightness red phosphorescent material, overcoming the weaknesses of conventional fluorescent materials [(4)]. In November 2003, the world's first OLED panel (passive matrix type, 1.1 inch size, 96 x RGB x 72 pixels, brightness: 100 cd/m^2) using phosphorescent materials was installed in the back (sub) display of NTT DoCoMo's MOVA 505iGPS mobile phone [(5)]. The panel was consisted of juxtaposition of RGB light-emitting layers, and the OLED layer was deposited by vacuum deposition using a metal mask.

Sanyo Electric and Kodak succeeded in developing the industry's first active matrix full-color OLED display by utilizing the low-temperature polysilicon TFT technology of the Liquid Crystal Display

(LCD). In March 2003. Kodak released a digital camera (LS 633) equipped with an active full-color OLED display [6]. The display panel is 2.16 inches (58 mm diagonal) and can display images with a resolution of 521 x 219 pixels. The panel was manufactured by SK Display Corporation, which was jointly established by Sanyo Electric and Kodak.

Sony launched world's first OLED TV, "XEL-1" on December 1, 2007 [7].
The OLED display was an 11V-type (251 mm (w) x 141 mm (v), 287 mm diagonal) active matrix display capable of displaying QHD (960x540 pixels) resolution. The thickness of the display panel was extremely thin, only 3 mm at the thinnest point. The panel used a low-temperature poly-Si TFT substrate. The brightness deviation was reduced by installing a correction circuit to compensate for TFT characteristic variations in each pixel circuit. The panel adopted the top emission type as shown in Figure 1. It used a side by side RGB light-emitting layers for full-color display in which the three primary colors of light were emitted independently in parallel, and was manufactured by vacuum deposition using a metal mask. The micro-cavity structure utilizing the multiple reflection interference of light between the semi-transparent cathode and anode electrodes was adopted to improve light emission efficiency and color purity. The thickness of each organic layer was adjusted for each color to put out most brightly. Color filters were used to reduce the reflection of external light instead of the conventional circular deflector plate [8]. Sony called the unique combination of the top-emission type, the micro-cavity structure, and color filter the "Super Top Emission" structure, which achieved a high contrast image of 1 million to 1 with a peak brightness of 600 cd/m^2.
The price was 200,000 yen, which was several times more expensive than other TVs of the same size.

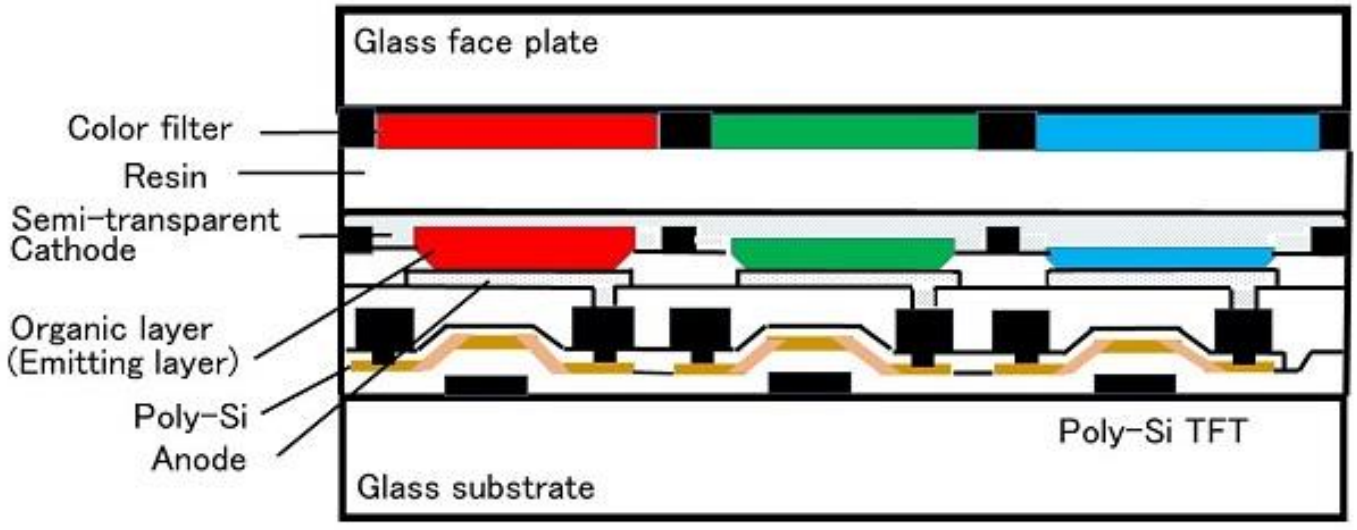

Figure 1 Cross-sectional structure of “Top-Emission” OLED display

(front view) (Side view)

Figure 2 FM teletext multiplex receiver GD-F1（By courtesy of Pioneer Corporation）
(Courtesy of Sony Corporation)

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