Techno World

Sony's Combined Mode Color LCD Sparkles in Brightness and Shines Through Darkness

Low-Temperature Polycrystalline Silicon TFT Combined Mode Color LCD

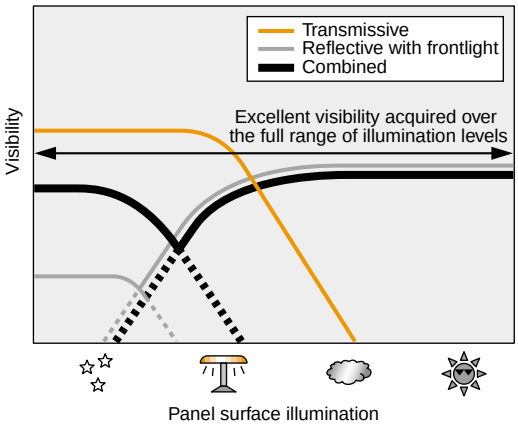
- **The reflective system operates as the main mode under bright ambient light, and the transmissive system operates as the main mode in darker environments.**
  —Sony has created a truly mobile LCD with this combined mode technology.—
- **Low power consumption achieved by emphasizing reflective mode operation at the design stage.**
- **RMP*1 structure diffuse reflecting electrode**
  —Clear images with no blurriness—
- **MIXed BDM*2 technology**
  —New viewing angle compensation film allows this LCD to achieve the industry's highest contrast level and wide angle of view with no image reversal in an ultrathin 1.58 mm*3 panel.—

*1: Random Multi Profile
*2: Birefringence Dispersion Matching
*3: The thickness of the panel plus optical film has been reduced by 34% from conventional products.

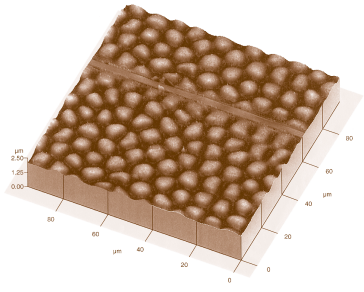
Due to the increasing speed of contemporary data communication systems and improvements in image compression and transmission technologies, rapid advances are occurring in the multimedia capabilities of mobile equipment that is used outdoors. In this context, there is now demand for the ability to display not only data images but also high picture quality color moving picture that communicates all its subtleties in any environment in the displays that form the core of the human interface in this equipment.
However, since conventional transmissive LCDs use a backlight, these devices have the problem that the visibility degrades with brightness in bright outdoor light. To resolve this problem, development focused on increasing the transmittivity and the brightness of the backlight so that the pictures displayed could at least be recognized in bright outdoor light. The result has been panel brightness levels that appear excessive in darker environments.
Reflective LCDs on the other hand are superlative for use outdoors in sunlight, but the contrast is lower and they have difficulty providing images that give a feeling of depth due to reflections from the grooved structure of the frontlight that must be lit in darker environments.

Sony's Combined Mode Color LCD

Sony has developed a new combined mode color LCD that combines, at a high level, the image quality of transmissive LCDs with the low power technology of reflective LCDs. (See table 1.) By operating so that the main mode is reflective in bright environments and transmissive in dark environments, this new LCD promises brilliant color images when watching summer fireworks displays or when on a snowy sunlit mountain. (See figure 1.) Forming the reflective system and the transmissive system within the limited pixel area results in the transmittivity becoming lower than that in transmissive LCDs, but Sony was able to acquire a transmittivity of 2.3%, which allows comfortable viewing in dark environments to normal environments. Furthermore, by using Sony's unique RMP structure diffuse reflection technology (see figure 2), Sony achieved a high reflectivity of 28%, which allows this LCD to be used with the normal lighting in an office environment even with the backlight turned off. This powerfully supports efforts at reducing end product power consumption.



■ Figure 1 Panel Illumination vs. Visibility (concept illustration)



■ Figure 2 RMP Structure Diffuse Reflecting Electrode

RMP Structure Diffuse Reflecting Electrode

This LCD incorporates Sony's RMP (Random Multi Profile) structure diffuse reflecting electrode technology. (See figure 2.) In this technology, reflecting electrodes that have a fine-grained random roughness are formed on the TFTs. This allows the LCD to form clear images with no blurriness. Furthermore, by using simulation to optimize this rough surface form, Sony was able to create an optimal balance between the following properties required of the diffuse reflecting electrodes, and achieve the high reflectivity of 28%, which is equivalent to that of Sony's reflective LCDs that use frontlight unit.

(1) A pure white color with no sense of metallic glint or coloration
(2) A strong ability to collect light
(3) Low depolarization
(4) An absence of interference fringes

MIXed BDM Technology

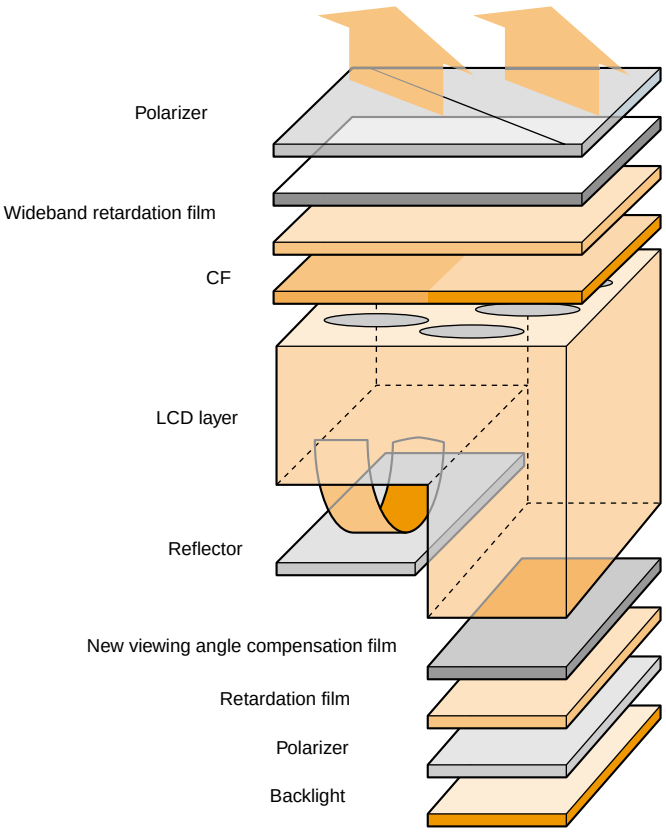
Sony has now developed the new MIXed BDM (Birefringence Dispersion Matching) liquid crystal and retardation film that has ideal retardation characteristics achieved by matching the axis directions of the polarizer and retardation film, the LCD twist angle, and the orientation directions independently for the transmissive and reflective systems. The retardation characteristics are as follows.

- Reflective system–– when off: λ/2, when on: λ/4
- Transmissive system–– when off: λ, when on: λ/2

This results in a reduction of light leaking over the whole range of wavelengths and the achievement of clear images with a contrast ratio of 60:1 for transmissive mode and a contrast of 30:1 for reflective mode, which are the industry's top performance levels for LCD displays.
Additionally, Sony designed an optimal polymer viewing angle compensation film for this new LCD structure using a unique Sony-developed LCD simulation program. This achieves a wide viewing angle with minimal reversals in an ultrathin panel + film system only 1.58 mm thick (34% thinner than conventional products).

Future Developments

Sony began mass production of products based on this new technology in July 2001. In the future, Sony will support a wide range of market needs in AV equipment, PDAs, cellular phones, and other electronic equipment with a new lineup that adds combined mode color LCDs to Sony's existing lines of transmissive and reflective LCDs based on low-temperature polycrystalline silicon TFT technology.
Keep your eye on Sony's forward-looking leading-edge low-temperature polycrystalline silicon TFT LCD technology.



■ **Figure 3 MIXed BDM Technology**

■ **Table 1 Development Specifications (panel only)**

Item		3.8-type, 230K dots
Number of active dots (H×V) *		320 × 240 dots
Pixel arrangement		Stripe
Dot pitch (H×V)		80 × 240 µm
Panel + optical film thickness		1.58 mm
Reflective system	Reflectivity	28.0 %
	Contrast ratio	30 : 1
Transmissive system	Transmittivity	2.3 %
	Contrast ratio	60 : 1
Number of colors		6 bits for each of RGB (262,144 colors)
Display format		1/4 VGA

* One dot corresponds to 3 individual R, G, or B dots.