Development of the MCPET Reflector for Edge-light LCD TV

1. INTRODUCTION

Micro Cellular Plastic (MCP) is the foam with 0.1 to 10 μm of micro cells and closed cells whose cell density is 10^9 to 10^{15} cells / cm^3. The foam has been developed by professor Suh and others at MIT in USA. Initially this material has received a lot of attention as the cells have been very fine and the material weight has been reduced without loosing mechanical characteristics (relative mechanical strength). Furukawa Electric Co., Ltd. (FEC) started basic research in 1990 and developed the superior optical performance. And then, MCPET optical reflector was launched to the market, a first in the world.

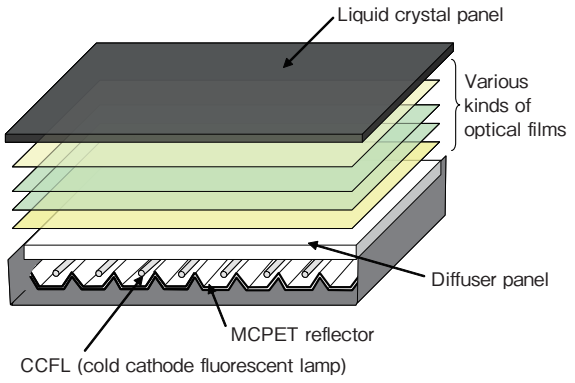

Figure 1 Structure of direct type liquid crystal display (LCD) TV.

Figure 2 Mountain folded MCPET reflector (inside back light).

In 1997, starting by its adoption to the sign boards of the underground railway stations, MCPET has been widely utilized such as sign boards in department stores, convenient stores and lighting equipments etc.. In 2001, MCPET was adopted to the optical reflector of Direct type LCD TV for the first time. In 2002, utilizing the superior bendability, MCPET with mountain folded between CCFL lamps was adopted. Refer to Figure 1 and Figure 2.

After that, according to the expansion of larger, thinner and energy saving type of LCD TV, light source position of back light has been modified from direct type to edge light type, placed at both lateral edge, using light guide plate. And light source itself has been changed to lower power consumption Light Emissive Diode (LED). Refer to Table 1.

Table 1 Feature of various systems for back light unit.

	CCFL Direct type	LED Direct type	LED Edge light type
Brightness	○	◎	○
Energy saving	×	○	◎
Thinner	×	×	◎
Cost	○	×	○

◎: Very good ○: Good ×: No good

LCD TV with edge light type LED light source, especially larger than 40 inches type, has superior feature in energy saving, also in adaptability to thinner type. Furthermore, screen brightness and cost performance are maintained at better level than conventional products. So, change to edge light type LCD TV is definitely expanding. Edge light type LCD TV already had 38% of market share by the end of 2011. It is expected that the market share will reach to 80% in 2014. (surveyed by NPD Japan LTD.)

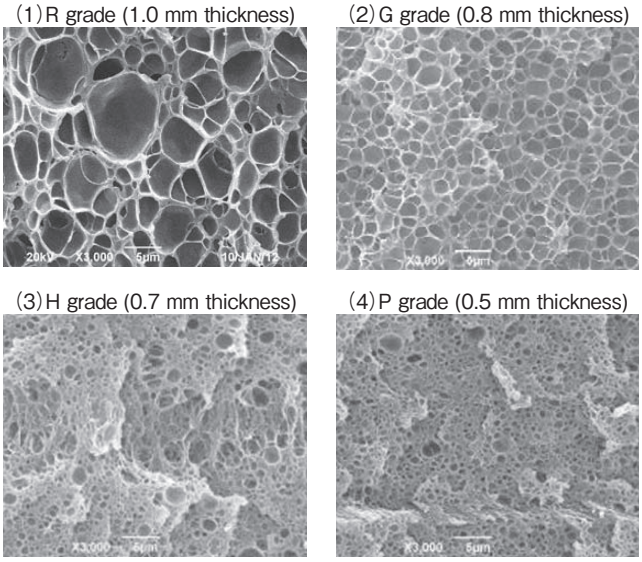

Figure 3 SEM photos for each grade.

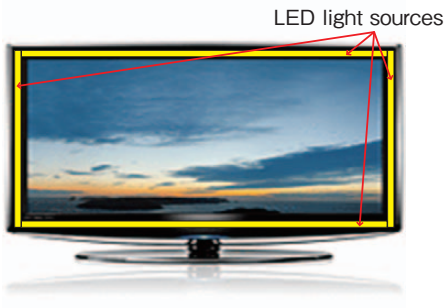

Figure 4 Light source position.

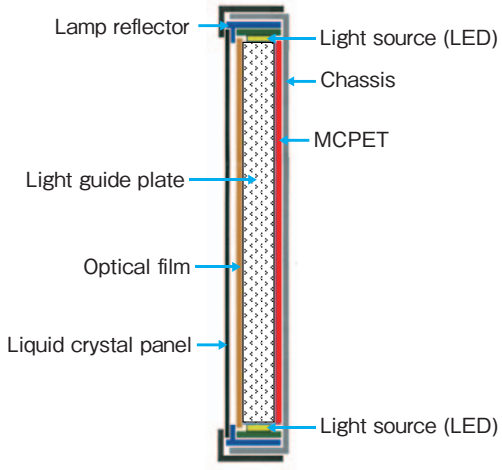

Figure 5 Structure of edge light type LCD TV.

2. FEATURES OF MCPET REFLECTOR

2.1 Cell Structure and Optical Characteristics

Cross section SEM photographs of various grade of MCPET are shown in Figure 3. According to the expansion of thinner type of LCD TV, demands for thinner type of reflection sheet are increasing. FEC has been developing the reflectors that meet the demands. The thickness of the first developed R grade product was 1.0 mm. The newest P grade product succeeded to reduce the thickness almost by half to 0.5 mm. Generally, if only the sheet thickness is reduced without changing the cell structure (the cell diameter), the reflection reduction problem occurs as the light reflective surface is simply reduced. FEC has reduced the cell diameter, simultaneously the thickness was reduced by using the original material technology, and were able to increase the reflective surface. Thus, not reducing but increasing reflectivity, the thinner sheet was successfully developed. Refer to Table 2.

Table 2 Optical properties for each grade.

	R grade	G grade	H grade	P grade
Thickness (mm)	1.0	0.8	0.7	0.5
Total reflectivity (%)	99.4	99.5	100.9	100.8
Diffuse reflectivity (%)	96.0	96.7	96.9	97.3

※Total reflectivity is Barium sulfate white board relative value at 550 nm.

2.2 Sheet Stiffness and Heat Resistance

Initially, light sources were placed at 4 points around edge light type TV screen. Refer to Figure 4. After that, the positions evolved to both top and bottom ends or both right and left ends of the screen. Refer to Figure 5. But, in these days, according to the progressing cost reduction of light sources, the construction is changing to 1 end of the screen. Because of this change to one light source, light has to be guided for longer distance and thus requires a higher power light source. Due to the higher power, higher heat is generated and higher heat resistance is required for materials. MCPET is the material that meets to this requirement.

Table 3 shows the differences in characteristics compared with the product of other manufacturers. MCPET is a foam product, so density is lower (lighter weight) than the other company products and yet it has excellent rigidity and heat resistance.

Table 3 Stiffness and heat resistance of MCPET.

	MCPET P grade	Film A (Laminated)	Film B
Thickness (mm)	0.50	0.50	0.35
Density (g/cm^3)	0.45	0.75	1.15
Stiffness (Bending strength)	◎	○	×
Heat resistance (60℃)	○	×	×

◎: Very good ○: Good ×: No good

3. CONCLUSION

The internal structure of LCD TV is evolving day by day. Accordingly, requirements to reflectors are changing in wide varieties. MCPET is the material that can meet the wide variety of requirements. At this moment, after 20 years of the first development, cell miniaturization and peripheral developments are proceeding.

Usage of MCPET is not limited to the reflector for LCD TV. Since the very beginning, MCPET has been used in the field of lighting equipments. In these few years, according to the expanding usage of LED, high diffuse reflectivity of MCPET attracts attention for its ability to diffuse a linear light source. And implementation in the moldings for LED down light modules and others are increasing. MCPET can be formed to various shapes by thermo molding.

Furthermore, the MCPET manufacturing technology can be applied not only to Polyethylene Terephthalate (PET) resin but to Polycarbonate resin, Polyphenylene Sulfide (PPS) resin and a wide variety of engineering plastics resins. Then, this technology can be developed to many other usages.

In the near future the structure of TV itself will be changed significantly. FEC will keep making proposals on solution for a wide variety of requirements helped by our overall strength in material technology.

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