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(Late-News Paper)

Infrared Mirror Film for Outdoor Display Application
Protection from Solar Heat

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ABSTRACT

The Multilayer Optical Film (MOF) technology is the basis for the IR mirror film solution targeted for outdoor displays which are exposed to direct sunlight. The IR mirror film can lower display device temperature by reflecting near IR from sunlight and protect the device from heat damage by solar energy absorption. It provides minimum display quality impact with high visible ray transmission and neutral color performance.

1 Introduction

1.1 Outdoor Display Requirements

Traditionally display device has been installed indoor for consumer usage. However, outdoor display demand is increasing for public information display, commercial, residential and automotive.

LCD is the most common display technology for outdoor display application due to its performance and reliability. It would be superior to OLED for outdoor display but still has thermal durability and display quality retention concern in case display device temperature spikes by solar energy absorption.

Thus, outdoor display directly exposed to sunlight must have functions can protect the display device from heat damage.

1.2 Conventional Solutions

Solar energy consists of UV (Ultraviolet) ray, Visible ray and IR (Infrared) ray and most of heat energy is coming from visible ray and IR wavelength band. Solar heat prevention solution for the display application should not impact display quality so the solutions usually cover IR wavelength band.

Conventional solar heat prevention solutions for outdoor display are metal sputtering or IR absorption/reflection method using inorganic material coating. In case of metal sputtering, it reflects over 20% visible ray so deteriorates display quality and could interferes electric signals due to metal material. The other method using inorganic material coating could not controls wavelength precisely near red color wavelength band.

2 Experiment

2.1 MOF based IR Mirror Film

The MOF (Multilayer Optical Film) technology is the film technology having hundreds of polymeric layers alternating in different refractive indices precisely constructed. The structure determines the wavelength to be reflected according to quarter wave constructive interference physics.

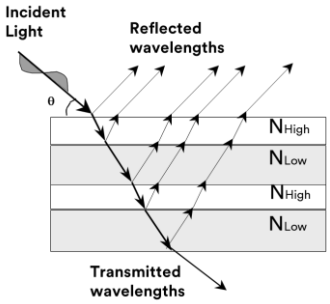


Fig.1 MOF (Multilayer Optical Film) Technology

We manufactures functional film that can reflect near IR wavelength ray without influencing display performance by precise wavelength control at visible ray

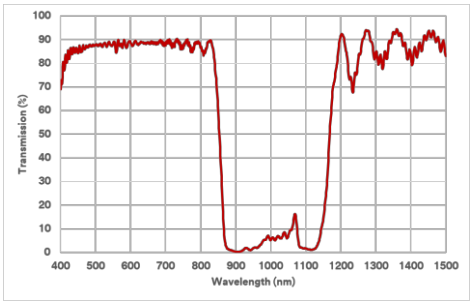


Fig.2 The IR mirror film spectral data

2.2 Optical ray transmission and Solar power transmission

Required property for the functional film is high visible ray transmission and low IR transmission. In the test data

of optical ray transmission shown in Fig.3 , The IR mirror film showed 90% visible ray transmission at 400-700nm wavelength and 4% IR ray transmission at over 700nm wavelength while IR reflection coating glass commercialized and evaluated in the test showed 47% IR ray transmission.

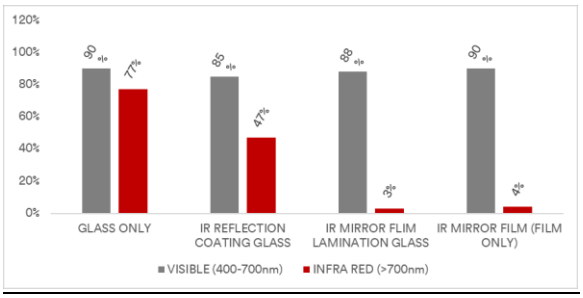
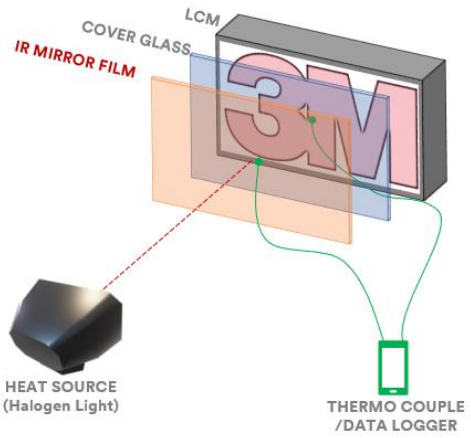


Fig.3 Optical ray transmission (%)
(Measured by transmission meter SD2400)

2.3 Thermal performance

General outdoor displays are being designed together with the cover glass to protect device from physical damage. Heat energy from sunlight passing through cover glass is accumulating in the display module so the display temperature is generally higher than cover glass surface at outdoor display application under direct sunlight condition. In the thermal performance evaluation, it replicated the display application with cover glass (Fig.4) and IR mirror film was compared with IR reflection coating glass (Fig.5). Temperature change by heat from light source was measured at cover glass and inside of display module.



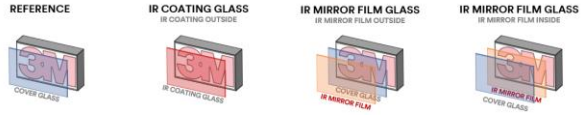


Fig.4 Performance evaluation test bed
(Heat source : Halogen light (1,000W/ 3,000K)
Measurement point :
#1-Outside (air side) #2-Inside of LCM)

In the test result, The IR mirror film test bed showed 6.3℃ lower at cover glass surface and 11.6℃ lower inside of display module in comparison with bare cover glass. When comparing with IR reflection coating glass, it showed 3.5℃ at cover glass surface and 5.0℃ in side of display module. (Fig.5)

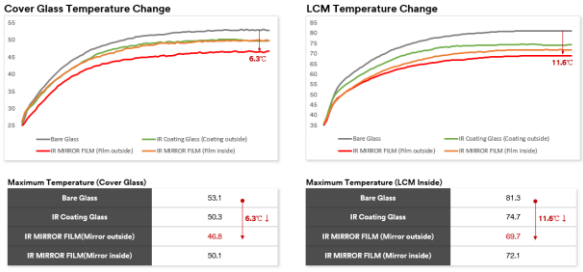


Fig.5 IR mirror film thermal performance test result

2.4 Optical performance

Another advantage of The IR mirror film utilizing MOF technology would be neutral display color. Conventional IR reflection/absorption solutions would not control

visible ray wavelength precisely that it sometimes brings display color shift. In case of IR reflection coating glass used in the test, overall display luminance is similar to The IR mirror film laminated glass on the display. But we confirmed there was blue color shift with IR reflection coating glass in the optical performance test, which might offer display device color change from original one to the viewers. (Fig.6)

However, the IR mirror film solution controlling wavelength precisely could provide original color to the viewer although it's laminated on the cover glass or display itself.

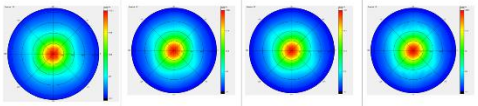
	REFERENCE	COVER GLASS	IR COATING ON COVER GLASS	IR MIRROR FILM ON COVER GLASS
Luminance (Nits)	232.0	209.0	203.9	203.8
Luminance(%)	100.0%	90.1%	87.9%	87.9%
Color change (Dx,Dy)	0,0	-0.005,+0.005	-0.009, -0.012	-0.003,+0.004
FWHM (U/D/L/R)	28/29/30/29	29/30/29/28	28/30/29/28	29/30/30/28
Cono plot				

Fig.6 IR mirror film optical test result

3 Conclusion

The IR mirror film provides superior optic performance with high visible ray transmission (>86%@430nm-700nm range) and neutral color. Furthermore, it would protect device from heat damage by reflecting near IR ray with >90% reflection @ 860nm-1100nm. This would help to enhance range of outdoor display application exposed to direct sunlight and could benefit longer term display system reliability.

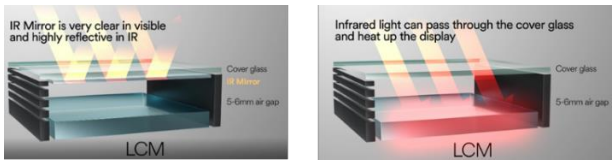


Fig.7 IR mirror film function comparison in display system (Left: Display system with IR mirror film on cover glass / Right: Display system with cover glass only)