Effects of Thermal Cycle on Fracture Strength Weibull Distribution of Carrier Glass Substrate for Flexible OLED

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Recently, flexible OLED displays are manufactured on polyimide film coated on a carrier glass substrate and detached from the subrate after the processing. The glass substrate undergoes repeated thermal cycles during various processing steps and that may influence its fracture strength. The fracutre strength of the the carrier glass substrates depends on various parameters including residual stress and micro-sized defects, especially at the edge of the substrate. For repeated use of the carrier glass substrate, its fracture strength must remain high in order to prevent the failuer during the processing.

In this study, effects of heat-treating conditions, including peak temperature, heating and cooling rate, on the Weibull distribution of fracture strength of the glass substrate were examined. The peak temperature was 450°C, heating and cooling rate was varied from 5°C/min to 50°C/min in this study. The 4-point bending glass samples were polished prior to the heat treatment in order to minimize the edge defects. Using the samples prepared under such conditions, flexural strength was measured using the 4-point beding test method. 60 samples were tested to evaluate Weibull distribution parameters as shown in Fig. 1.

$$P_f = 1 - e^{\left(\frac{\sigma_i - \sigma_u}{\sigma_o}\right)^m \Delta V_i}$$

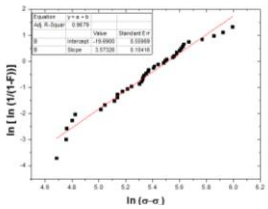
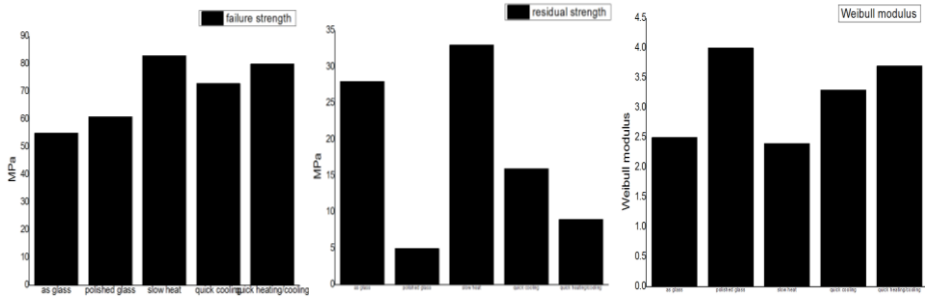


Fig. 1. Weibull distribution analysis of glass substrate

Figure 2 shows the effects of heat treating conditions on the fracture strength, residual strength, and Weibull modulus. The results indicate that the heating and cooling rates do not influence the average fracture strength of the glass substrate much. The Weibull parameter, which describes the distribution of fracture strength, is increased with the increase in the heating and cooling rate. This results suggest that the heating and cooling rate may need to keep high in order to prevent the premature failure of the substrate during processing of flexible OLED.



(a) **(b)** **(c)**

Fig. 2. Weibull distribution of mechanical properties of glass substrate after heat-treatment: (a) average fracture strength, (b) residual strength, and (c)Weibull modulus of each samples

References

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