Materials Science Forum Vols. 510-511 (2006) pp. 154-157
online at http://www.scientific.net

A Simple Reliable Method of Selecting Epoxy Molding Compounds for High Power Short Wavelength Light Emitting Diode Packages

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Keywords: Epoxy, LED, Package, Thermal stability, Molding compound

Abstract Epoxy molding compounds (EMC) with higher thermal stabilities are urgently needed as the light emitting diode (LED) becomes brighter and the wavelength of the its light becomes shorter. This paper proposes a simple reliable method of evaluating the thermal stabilities of commercial EMCs. The transmittances of most commercial EMC samples for high power short wavelength LED packages were decreased by heat treatment at 150°C for 200hr. Also the thermal stabilities of the samples were confirmed by measuring the weight losses through TGA. The experimental results suggest that employing a good heatsink is indispensable in highly bright short wavelength LED packages.

Introduction

As LED devices became brighter and the wavelengths of the light they produce became shorter recently, the thermal stability of the epoxy molding compound (EMC) has become a hot issue in packing LED devices [1,2,3]. If a short wavelength LED with high brightness is turned on for a long time, the temperature of the package materials increases up to almost 150 ºC [4]. The optical properties of most commercial EMC are significantly deteriorated at 150 ºC. As the turn-on time increases, the optical transmittance of the LED light decreases. Consequently, its brightness decreases and power consumption increases. Epoxy resin, which is a base material of EMC, has such advantages as low price and ease in forming, but it also has the disadvantage of having bad thermal resistance. The best thing to do for reliable LED packing is to choose the best one of commercial EMCs by comparing their thermal stabilities along with using proper heat sinks in a circumstance that it is indispensable to use EMC because of low princes. In this paper a simple reliable method of choosing a commercial EMC for LED package is offered.

Experimental

Three kinds of commercial EMC samples for LED packaging with the size of 20 ㎜×20 ㎜×1 ㎜ were prepared, which will be called A1, A2 and B hereafter. . They were heat-treated at three different temperatures 100, 125, and 150 ºC for different time periods, and then the optical transmittance, the refractive index, and the weight of the samples were investigated by using UV/VIS spectroscope, ellipsometer, and a balance. TGA analyses were also preformed to examine the changes in the weight of EMC by heat treatment precisely, since the weight loss was not closely detected by the experimental method described above.

Results and Discussion

Three kinds of commercial EMCs at room temperature are shown in Table 1. The blue light transmittances of samples A1 and A2 (87%) are higher than that of sample B (70%). On the other hand the ultraviolet (UV) light transmittance of sample A1 is the highest, that of the sample B is the next, and that of sample A2 is the lowest.

Table 1. Transmittances of three different type of EMCs at room temperature.

EMC SAMPLE NO.	SAMPLE A1				SAMPLE A2				SAMPLE B			
LIGHT	UV		Blue		UV		Blue		UV		Blue	
WAVELENGTH (nm)	375	365	490	440	375	365	490	440	375	365	490	440
LIGHT TRANSMITTANCE (%)	73	73	87	87	39	18	87	87	55	52	70	70

Figures 1(a), (b) and (c) are the transmittances of samples A1, A2 and B at 150 °C as functions of wavelength, respectively. For all three kinds of samples the optical transmittance tends to decrease in the entire wavelength range with the increase of holding time at 150 °C from 200 to 800nm as is expected.

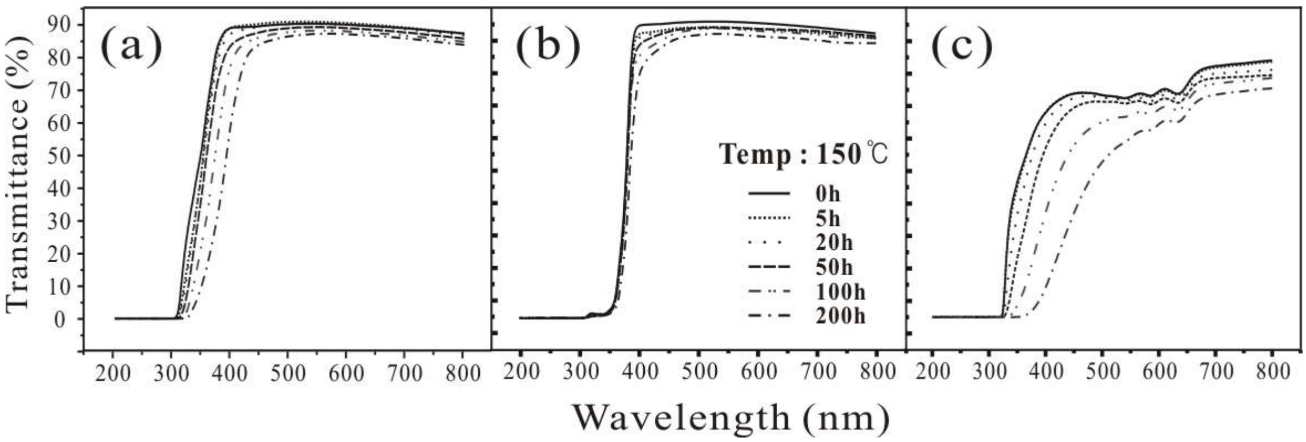

Fig.1 Transmittances of (a) sample A1, (b) sample A2, and (c) sample B at 150 °C as a function of the wavelength

Figure 2 is plots of the transmittance of the samples at the wavelength of 375nm versus the holding time at 150 °C. The transmittance values of these plots were obtained from figures 1(a), (b) and (c). The transmittances of samples A1 and B decreased by more than 50% by the heat treatment at 150

°C for 200hrs. Considering the transmittances at 150 °C together with those at room temperature it may be concluded that sample A1 is the best EMC for UV LED packaging since it has the highest transmittance and thus the highest thermal stability. Nevertheless it should be noted that the transmittance decreasing rate of sample A1 is much higher than that of sample A2 and that the transmittance of sample A1 is slightly lower than that of sample A2 after 200hrs heating. Therefore, it is anticipated that A1 will be unfavorable for a turn- on time longer than 200hrs than A2.

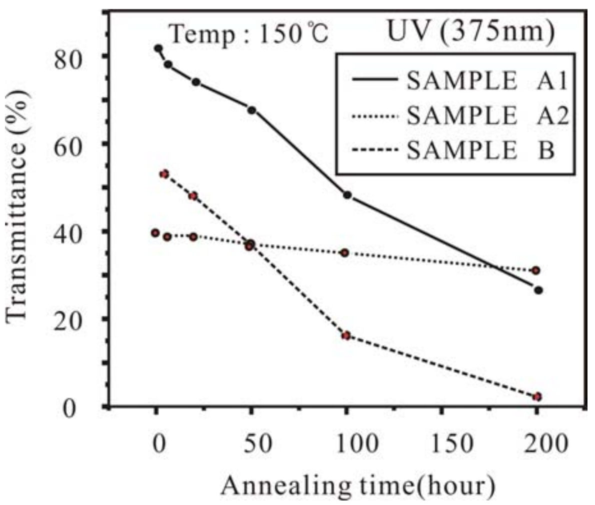

Fig.2 Changes in the UV light(λ=375nm) transmittances of samples A1, A2 and B with the holding time at 150 °C

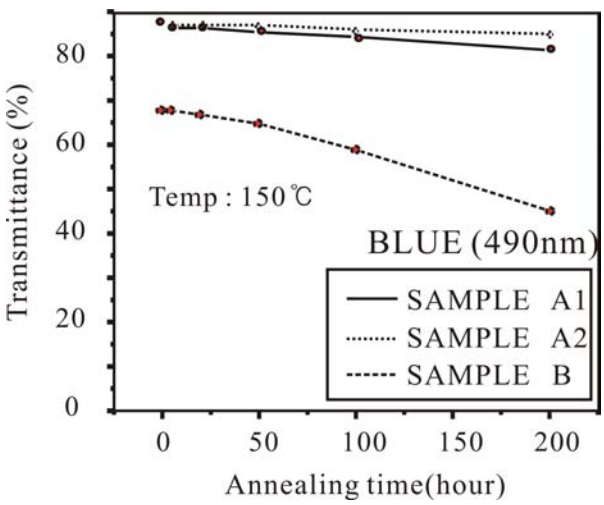

Fig.3 Changes in the blue light transmittances of samples A1, A2 and B with the holding time at 150 °C

Figure 3 is plots of the transmittance of the blue light at the wavelength of 490nm versus the holding time at 150 °C for samples A1, A2 and B from figures 1(a),(b) and (c). The transmittances of samples A1 and A2 decreased by no more than 7% and 2%, respectively after the heat treatment at 150 °C for 200hrs, whereas that of sample B decreased by 30-40%. Therefore, it may be concluded that sample A2 has the highest thermal stability among the three different EMCs for blue LED packages considering the transmittances at room temperature and 150 °C together. The same experiments as above were also performed at 100 and 125 °C to investigate the thermal stabilities of samples A1, A2, and B. The relative thermal stabilities of those three samples after heat treatments at 100 and 125 °C were more or less the same as those at 150 °C.

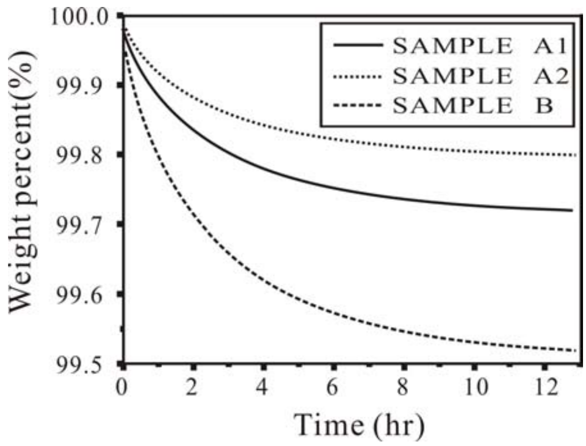

Fig. 4 TGA analysis results for samples A1, A2, and B

Figure 4 shows the TGA analysis results. The weight of sample B has decreased by approximately 0.5% after the heat treatment of 125 ºC for 12hrs, whereas the weights of samples A1 and A2 by 0.28 and 0.20%, respectively after the same heat treatment. Therefore, it may be said that the sample A2 has the best thermal stability. These experimental results for weight change with heat treatment are consistent with those on transmittance.

Conclusion

Several methods of evaluating the thermal stability of an EMC were investigated. The simple and most reliable method is to check the changes in the transmittance of an EMC with the increase of the heat treatment temperature and time.

Acknowledgment

This work was financially supported by Korea Institute of Industrial Technology Evaluation and Planning.

References

[1] Hyoung Yun Oh, Jung Keun Ahn, Sang Soo Yoon, Sungkoo Lee, Jung-Hwan Yang and Sung Tae Kim, J. Korea. Phys. Soc. 39, S 49(2001).

[2] Yuanping Sun, X. M. Shen, Z. H. Zhang, D. G. Zhao, Z. H. Feng, Y. FU, S. M. Zhang and Hui Yang , J. Korea. Phys. Soc. 42, S367(2003).

[3] C. S. Kim, R. J. Choi, H. S. Youn, S. J. Bae, H. K. Cho, B. K. Lee, D. S. Kang, Y. B. Hahn, H. J. Lee and C. H. Hong, J. Korea. Phys. Soc. 42, S367(2003)

[4] S. M. Kim and C. H. Lee, J. Microelectronics & Packaging Society. 6, 31(1999)