Analysis on the Reason of Blistering Delamination of Copper Clad Laminate

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Abstract. Copper clad laminate was delaminated after producing. In order to found out the invalidation reason, scanning electron microscope was employed to analyze the samples. It was showed that the invalidation reason was different as the invalidation had happened at the different position of the laminate. On the delamination of the central section of copper clad laminate, a smooth boundary was seen and no crack initiation formed so it was clear that there was no bonding between substrate board and copper film. While the delamination position was situated on the border of copper clad laminate, tearing crack was very clear. It was indicated the delamination was due to unreliable bonding.

Introduction

Copper clad laminate was composed of substrate board and copper film. Substrate board was insulator, which was often made of resins and cloth bodies [1]. The substrate had been used for half a century and its production yield was about 0.3 billion square meters a year. phenol-formaldehyde resin had been employed to produce the substrate materials of copper clad laminate in 1943. From that time, substrate materials developed very fast. In 1977, BT resins were taken as new substrate materials [2]. From then on, more and more new materials were found to be fit for making substrate materials. In addition to resins, cloth bodies were also the main materials in copper clad laminate. Resins were added to the surface of the cloth bodies, and then were heat-treated and became prepreg [3, 4]. In order to bond the substrate and copper films, prepreg films of epoxy resins were employed. Substrate, prepreg film and copper film were pressed together, and then heated to about 130-200 °C, last copper clad laminate was finished [5-6].

Blistering delamination was the main invalidation pattern of copper clad laminate. A company of producing copper clad laminate found copper clad laminate was delaminated. In order to found out the invalidation reason, in this paper scanning electron microscope was employed to analyze the samples.

Experimental Details

The samples of both the good copper clad laminate and the invalid were provided by a circuit-board manufacturer.

Glass transition temperature(Tg), conversion rate and residual amount of carbon were analyzed with DSC and DTA. DSC type was DSC-60 Plus, which was made by SHIMADZU company, Japan, with a heating temperature ranging from 20°C to 500°C at a heating rate of 10°C/min with a temperature precision of 0.05°C. Calorimetry precision was 0.1%. DTA type was DTA-60, which was made by SHIMADZU company, Japan, with a heating temperature ranging from 20°C to 500°C at a heating rate of 10°C/min with a temperature precision of 0.05°C. Calorimetry precision was 0.1%. The type of scanning electron microscope is SNE3000NB made by SEC company.
Results and Discussion

Analysis on the Delamination of the Central Section of Copper Clad Laminate

Figure 1. SEM morphology of the central invalidation of copper clad laminate.

(a) and (b) surface of substrate board, (c) and (d) surface of copper film

Figure 2. SEM morphology of the central position of normal copper clad laminate.

(a) and (b) surface of substrate board, (c) and (d) surface of copper film

Scanning electron microscope (SEM) was employed to analyze the invalidation samples of copper clad laminate. The results were shown in figure 1. In order to contrast with SEM morphology of the invalidation samples, the normal samples were forcibly ripped and the morphology of the normal samples was also provided (shown in figure 2). From figure 1, there were a lot of glass fibre sticking on the copper films, and fracture mark was very clearly seen. However, the other surface of the
substrate was very smooth and the tear crack was very little. From figure 2, the surface showed much glass fibre on the copper films but a little on the substrate surface, and the tear crack was very vivid and regular. There were many small dimples forming on the surfaces during ripping process.

The invalidation reason was as follow: the invalidation position showed very smooth and no tear crack was seen. It was suggested that there was dirty matter on the surface of copper films or substrate board before bonding. The dirty matter could be dust, which would mixed with the epoxy resins when they were heated on the production of copper clad laminate. Therefore, from the SEM images, it was difficult to distinguish the dirty matter from the epoxy resins.

![Figure 3](image)

**Figure 3.** SEM morphology of the fringe invalidation of copper clad laminate.

(a) and (b) surface of substrate board, (c) and (d) surface of copper film

![Figure 4](image)

**Figure 4.** SEM morphology of the fringe position of normal copper clad laminate.

(a) and (b) surface of substrate board, (c) and (d) surface of copper film
Analysis on the Delamination of the Fringe of Copper Clad Laminate

SEM was used to analyze the delamination of the fringe of copper clad laminate. The results were shown in figure 3. In order to contrast with SEM morphology of the invalidation samples, the ripped surface morphology of the fringe of the normal samples was also provided (shown in figure 4). From figure 3, there was tear crack on the invalidation surface and small dimples were very vivid. However, some position also showed smooth surface, indicating the bonding of that place was bad. From figure 4, tear crack was more vivid than that of figure 3. There were more small dimples on the surfaces.

The invalidation reason was as follow: during heating on the production of copper clad laminate, the bonding of the invalidation fringe formed but sticking force was not secure. There were three reasons. One reason was partly polluting. Secondly, when cooling, pressure was not evenly added to copper clad laminate. Thirdly, stress formed on the fringe.

Conclusion

Copper clad laminate was delaminated after producing. In order to found out the invalidation reason, scanning electron microscope was employed to analyze the samples. It was showed that the invalidation reason was different as the invalidation had happened at the different position of the laminate. On the delamination of the central section of copper clad laminate, a smooth boundary was seen and no crack initiation formed so it was clear that there was no bonding between substrate board and copper film. While the delamination position was situated on the border of copper clad laminate, tearing crack was very clear. It was indicated the delamination was due to unreliable bonding.

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References

[1] T. Xea, J. Zhang, Situation and development of epoxy resins for electronic packaging, China Chemical Trade, 10 (2013) 320-320.
[2] D.T Zhu. New development of production and technology of copper clad laminate all over the world. Information of Copper Clad Laminate, 4 (2019) 30-35.
[3] Z.L. Yang, Research progress of no flow prepreg, Printed Circuit Information, 10 (2018) 9-12.
[4] S. Tsuchkawa, T. Kotake, M. Akiyama, Thermosetting resin composition and prepreg and laminate obtained with same, U.S. Patent 2012715607A1 (2017).
[5] J.Y. Liu, X.L. Liu, X.S. Duan, Study on mechanical properties of epoxy resin structural adhesive modified by nanosize CaCO₃ and silicon powder, Journal of Shandong Agricultural University (Natural Science Edition), 49(2018) 805-808.
[6] M. Cizmecioglu, A. Gupta, R.F. Fedors, Influence of cure conditions on glass transition temperature and density of an epoxy resin, Journal of Applied Polymer Science, 32 (1986) 6177-6190.