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Characteristics of ultrasonic bonding joint between metal PCB and flexible PCB

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1. Abstract

The purpose of this paper is to find bonding parameters of electrodes between the metal printed circuit board (PCB) and flexible PCB using ultrasonic vibration. The electrodes of FPCB were electroless-plated with electroless Ni / immersion Au (ENIG) and those of metal PCB were also electroless-plated with ENIG..

The peel strengths of the joints were investigated with various parameters, such as bonding pressure and time. This study showed that the electrodes between the metal PCB and FPCB were successfully bonded without any adhesive at a low temperature during a short time, compared to other bonding methods: adhesive bonding and thermo-compression bonding.

2. Introduction

The complexity of light emitting diode (LED) designs as it relates to the printed circuit board (PCB), which contains hundreds of components, has increased the difficulty of not only maintaining compatibility of component placement and mechanical layout but also increased thermal concerns. Increasingly, thermal reliability and planning is a critical part of the design process especially when talking about IC and high power LED. As the LED heat escalates, several key characteristics may become apparent, which demonstrate the importance of LED thermal management. The forward voltage will begin to decrease. The decreasing voltage can impose an increased load on related LED driver components causing their temperature to increase as well.

Thermal management company has a thermal issue facing the solid state lighting industry specifically in metal PCB applications. Metal PCBs with efficient through plane thermal conductivities are important for high heat generating LEDs. Although high thermally conductive metals are used, metal PCB performance is dependent upon the contact area, material thickness and thermal resistance of each material located between heat source and the atmosphere.

The demand for flexible PCB (FPCB), which has low weight, high glass transition temperature and superior flexibility, continues to expand with market growth of the multimedia portable electronics.[1)] The electrical and mechanical bonding technique of electrodes on PCBs is essential for use two different PCBs in a product. Ultrasonic bonding process is one of the most suitable bonding methods, because of its high mechanical and electrical performance, high reliability, short processing time, low processing temperature and environment-friendly process.[2,3)] In this study, therefore, the micro structural evolution and mechanical property of the metal PCB to FPCB joint bonded using ultrasonic vibration were investigated with increasing bonding pressure and time.

3. Experimental Procedure

In this study, the thickness of FPCB and metal PCB was 18 μm and 1 mm, respectively. The Cu electrodes of FPCB and metal PCB were electroless-plated with electroless Ni / immersion Au (ENIG).

The FPCB was bonded with metal PCB after wet cleaning with 10 vol.% H_2SO_4 solution. The substrate was fixed using a fixture to prevent mis-alignment during bonding. The electrodes were bonded with different bonding time and pressure using ultrasonic energy. Upon completion of ultrasonic bonding, the samples were mounted in cold epoxy, ground using 100, 800, 1,200, 1,500 and 2,000-grid SiC papers through a row of electrodes and polished with 0.3 μm Al_2O_3 powder. The microstructure of the sample was observed using scanning electron microscopy (SEM) in back-scattered electron imaging mode (BEI). Elemental analysis was also carried out using energy dispersive X-ray spectroscopy (EDS). To investigate the effect of bonding conditions on the bonding strength, the peel test was carried out at ambient temperature and humidity. The testing speed and angle were 100 μm/s and 90 °, respectively. The fracture surface was observed and analyzed using SEM and EDS. To investigate the reliability of ultrasonically bonded PCBs, electric resistance of electrode joints was monitored during

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the environmental reliability test. The bonded PCBs had been placed in a thermal shock testing chamber (TSA-101S, ESPEC, Japan) to undergo 1000 thermal cycles in the range -40 °C to 125 °C. The dwell time at high and low temperatures was 15 min and the total time for one cycle was 30 min. The PCBs were isothermal aged at 125 °C for up to 500 hours in an oven.

4. Results and Discussion

Figure 1 shows the relationship between the peel strength and bonding time. The peel strength increased from 0.6 kgf/cm to 1.3 kgf/cm with increasing bonding time. It is suggested that increasing bonding time increased the diffusion between the atoms of electrodes.

Figure 2 shows the relationship between the peel strength and bonding pressure. The peel strength increased from 0.7 kgf/cm to 1.2 kgf/cm with increasing bonding pressure. Since the surfaces plated on an electrode are rough, intimate contact between two electrodes is required for successful ultrasonic bonding. As electrodes are deformed more easily at higher pressures, the increased joint area and strength could be obtained with higher pressure.

Based on the peel testing results, higher pressure and longer time increased the joint strength. Excessive conditions led to the damage in case of rigid PCB. However, there was no damage on the metal PCB. Therefore, even though the excessive energy applied on bonding joint, peel strength showed better bonding property. More studies and results were discussed in this presentation.

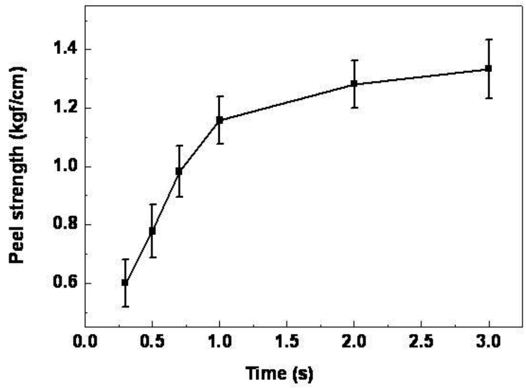

Figure 1 Peel strength of RPCB-to-FPCB joint with increasing bonding time.

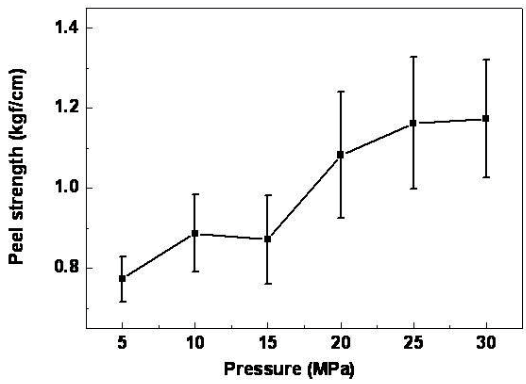

Figure 2 Peel strength of RPCB-to-FPCB joint with increasing bonding pressure.

Acknowledgment

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