420 材料接合過程の観察・評価に関する研究

Study on Observation and Evaluation of Bonding Process

○ ムハマド ロシド リドロ (埼玉大院) 正 加藤 寛 (埼玉)
 正 蔭山 健介 (埼玉) 正 李 鎮伊 (埼玉)

M.Rosyid Ridlo, Hiroshi KATO, Kensuke KAGEYAMA, Jin Yi LEE
 Dept. of Mechanical Eng., Saitama University, Shimo-Okubo 255, Urawa, Saitama 338-8570

The interface layer was observed with the ultrasonic method during bonding process. The experiment was performed at about 180 °C with a waveguide. The waveguide of 80 mm in length and 15 mm in diameter of waveguide was fixed between the ultrasound probe and the bonding material. A copper plate was used as substrate and the SnBi alloy as solder material. The immersion method was applied in this experiment, with grease as medium. The ultrasound data was compared to the observed interface layer through the optical microscope. The analysis in frequency domain was also performed.

Keywords: bonding process, waveguide, interface layer, ultrasound probe, immersion method

Introduction

As a part of NDE (Non Destructive Evaluation) method, the ultrasonic measurement was widely used in inspection of material defects, joint material quality and in another fields. The observation was performed at room temperature. At present, the study was done to know the change in the ultrasonic signal reflected from the interface layer during bonding process. Because the experiment was carried out at a high temperature, the waveguide was fixed between the ultrasonic probe and the specimen. To get the proper signal, the grease was placed between the waveguide and the specimen as medium in the immersion method.

The main objective of this research was to observe and evaluate the interface layer between substrate materials and solder during bonding processes with pulse echo ultrasound data.

Experimental Procedure

A high carbon steel rod SKD11, 80 mm in length and 15 mm in diameter was chose as a waveguide. The noise generated at side surface was decreased by machining the side surface to be rough. The easy technique is to make screw on it.

To concentrate the echo wave on waveguide (line focusing), the concave form of the bottom of waveguide was created. Because of low attenuation and high S/N ratio, the plane form was chosen as waveguide in this experiment. At 100 °C the grease became liquid like. At that temperature, waveguide and specimen surface make contact with grease more easily. And the echo intensity was higher at 150 °C (Fig. 1).

Fig.1 S/N ratio in grease and oil

Fig.2 Experimental set up

Experimental set up

The thickness of copper as substrate and SnBi as solder was 2mm and 1 mm, respectively. Bonding process was

done at about 180 °C for 60 minute of bonding time. In every 15 minute, the ultrasound data was measured with probe of 1 MHz in frequency and of 10 mm in diameter and then recorded. There are three echoes, and they were reflected from the waveguide bottom, the copper surface and the bonding interface. The these echo were transformed by fast fourier transform (FFT). In frequency domain, the change in waveform was observed easily. The sample was polished and etched by (ethanol+HCl) solution in about 3 minute.

Results and Discussion

Figure 3 shows echoes reflected from the waveguide bottom (D), the copper surface (A) and the bonding layer (B). In time domain, the change in waveform was hardly observed, all data fell on a single curve. But the significant changes occurred on the FFT spectrum of B echo (fig.5). The FFT spectrum of A echo was almost uniform (fig.4).

Fig.3 Ultrasound data at different heating time

During bonding, the peak frequency of the echo reflected from the interface shifted about 2 MHz around probe frequency but the shape of the spectrum did not change largely. Figs. 6 and 7 show the growth of the interface layer. During bonding process, the substrate element Cu would diffuse out and dissolve into liquid solder continuously until the liquid is saturated with this element. Also the Sn element in SnBi compound became richer at the substrate interface. The formed interface layer can affect the shape of B echo. Because the thickness of interface layer was not equal in all area of interface, the relation of the B echo shape and interface layer thickness was not obtained.

Conclusion

The present work shows the ultrasonic pulse echo method is possible for observing and evaluating the interface layer. For accurate observation, it is needed that focused ultrasonic wave was focused on a limited area of interface.

Fig.4 FFT of A echo at 60 min bonding time

Fig.5 FFT of B echo at 60 min bonding time

Fig.6 Optical micrograph in 30 min of bonding time

Fig.7 Optical micrograph in 60 min of bonding time