EFFECT OF THE INTERMETALLIC COMPOUNDS ON THE JOINT STRENGTH OF THE OPTICAL MODULE

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Intermetallic compound (IMC), formed during the reflow process for the formation of solder bump and practical operating temperature, is grown at the interface between solder and the under bump metallurgy (UBM). The IMCs at the interface of the solder and the UBM causes cracks at the solder joint area owing to the brittleness, and weakens the overall joint strength.[1-4] The joint strength and sheared fracture surface of photo diode packages after isothermal aging testing were studied experimentally.

Al/Au stud bumps and Cu/Sn-Pb solders were adopted, and aged for up to 900 hours to analyze the effect of IMCs. Also, to analyze the effect of aging temperature, the samples were aged at isothermal temperatures of 100□ and 150□. As the result of thermal aging, the joint strength tended to decrease with aging time and temperature, and these decreases were due to the growth of Pb-rich from the reaction of Cu and Sn.[5-6] And the relation between the joint strength and the displacement was investigated by shear test. The displacement also decreased with aging time because of the growth of Pb-rich, a microstructure of solder.

Microstructures of the solder and the IMCs layer were clearly observed. The samples aged for 300 hours displayed two distinct intermetallic layers of Cu_3Sn and Cu_6Sn_5.The diffraction patterns of Cu_6Sn_5, scallop-shape IMCs, and planar-shape Cu_3Sn were observed by transmission electron microscopy (TEM). IMCs between Au stud bump and Al pad was identified as $AlAu_2$. The formation of Kirkendall voids with the growth of IMCs at the solder was found to be a possible mechanism for joint strength reduction.

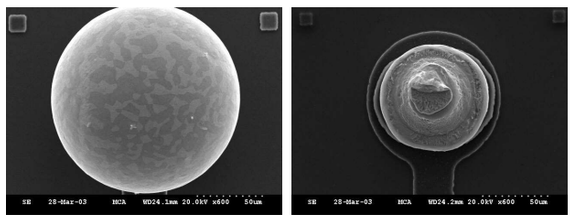


Fig. 1 Shape of a solder bump and a stud bump.

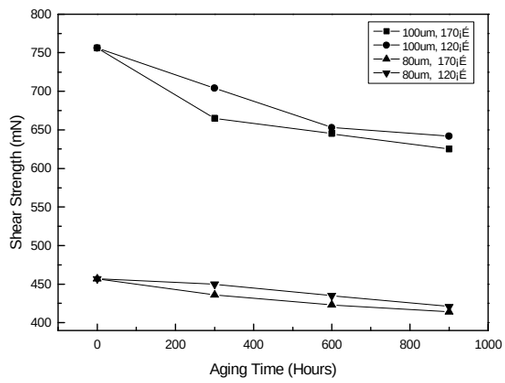


Fig. 2 Relation between aging time and shear strength on variable aging time and pad size.

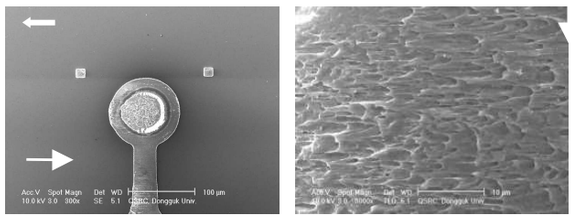
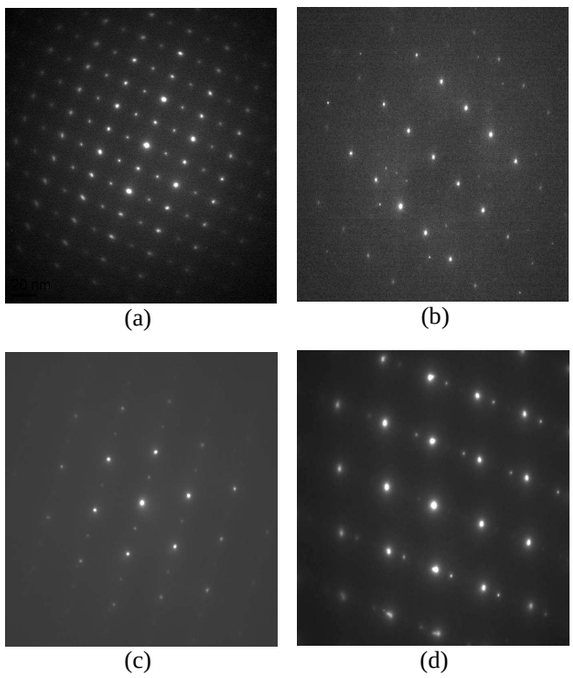


Fig. 3 Fractured surface of a sheared solder bump after aging at 150□ for 900 hours.



(a) (b)

(c) (d)

Fig. 4 Diffraction patterns (a) Sn (b) Cu_6Sn_5 (c) Cu_3Sn (d) Cu.

Reference

1. Xingjia Huang and S.W. Rickly Lee, ECTC, 968 (2002).
2. C.H. Yu, K.S. Kim, and N.K. Kim, Trans. JIM 43, 3234 (2002).
3. Satoru Zama, Daniel F. Baldwin and Toshiya Hikami, ECTC, 1111 (2000).
4. Atsuko Lida, Yukio Kizaki and Yumi Fukuda, ECTC, 101 (1997).
5. D. R. Frear, The Mechanics of Solder Alloy Interconnects(New York: Van Nostrand Reinhold Wiley, ch. 3 1994).
6. Barry K. Gilbert and G.W. Pan, IEEE Trans. Microwave Theory Tech. 45, 1819 (1997).