

***Analysis of the Effect of Cu Addition on the Physical and Mechanical
Properties of Lead-Free Solder Alloy Sn-7Zn-4Ag***

By : Nurkholis Majid
Student Identity Number : 06221023
Supervisor : Andromeda Dwi Laksono, S.T., M.Sc., Ph.D.
Co-Supervisor : Dr. Eng. Yunita Triana, S.Si., M.Si.

ABSTRACT

The rapid development of the electronics industry has increased the demand for solder materials used in printed circuit board (PCB) assembly. However, conventional Sn-Pb solder contains toxic lead that poses serious risks to human health and the environment, thereby encouraging the development of environmentally friendly lead-free solders. In this study, Sn-7Zn-4Ag-xCu lead-free solder alloys ($x = 0\%$, 0.5% , 1% , and 1.5%) were investigated to evaluate the effect of Cu addition on the physical and mechanical properties of the alloy. The alloys were fabricated through a melting process at $500\text{ }^{\circ}\text{C}$ using a muffle furnace, followed by characterization through density testing, X-ray diffraction (XRD), optical microscopy, SEM-EDS, Differential Scanning Calorimetry (DSC), and Vickers hardness testing. The results showed that Cu addition up to $1.5\text{ wt.}\%$ increased the density from 7.32 g/cm^3 to 7.40 g/cm^3 and refined the grain size from $13.74\text{ }\mu\text{m}$ to $8.51\text{ }\mu\text{m}$. Phase characterization results indicate the formation of β -Sn, Ag_3Sn , and Cu_5Zn_8 phases. DSC analysis Liquidus Temperature (TL) increased from 221.3°C to 222.9°C ; 224.8°C ; and 227.5°C ; with the narrowest melting range of 5.7°C at the addition of $1\text{ wt.}\%$ Cu, indicating more stable melting characteristics. In addition, the Vickers hardness value increased from 16.7 HV to 19.27 HV due to the formation of the Cu_5Zn_8 intermetallic phase and a grain size refinement mechanism. The results indicate that the addition of Cu can improve the physical and mechanical properties of the lead-free solder alloy Sn-7Zn-4Ag, making it potentially used as an environmentally friendly solder material for electronic applications.

Keywords: Sn-Zn-Ag-Cu; lead-free solder; IMC Cu_5Zn_8 ; DSC; Hardness Vickers.