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Wei-Yu Chen, Jenq-Gong Duh

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Suppression of Cu_3Sn layer and formation of multi-orientation IMCs during thermal aging in Cu/Sn-3.5Ag/Cu-15Zn transient liquid-phase bonding in novel 3D-IC Technologies

Wei-Yu Chen[a], Jenq-Gong Duh[a*]

[a]Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan

[*]Corresponding author: Room 429, No. 101, Section 2, Kuang-Fu Road, Hsinchu, Taiwan 30013, R.O.C. Tel.: +886 3 5731164. jgd@mx.nthu.edu.tw

Abstract

The evolution of grain structures and microstructures in Cu/Sn-3.5Ag/Cu-xZn (x=0 or 15 wt%) TLP bonding before and after aging were investigated. Cu-Sn intermetallic compounds (IMCs) with a strong [001] orientation rapidly form from the Cu pads and cause impingement in TLP bond, allowing cracks to easily propagate. During aging, the Cu_6Sn_5 becomes one layer with a homogeneous structure, thick Cu_3Sn layers form, and Kirkendall voids occur at bonding interfaces, causing degradation of bonding strength. This study demonstrates that doping Zn into one of the Cu substrates efficiently retains the multi-orientation structure of Cu-Sn IMCs and suppresses the formation of Cu_3Sn during lone-time aging. The Cu/Sn-3.5Ag/Cu-15Zn TLP bonding is potentially useful in strengthening the interconnections for novel 3D-IC technologies.

Keywords: Crystal structure; Electron microscopy; Intermetallic alloys and compounds; Metals and alloys; Electronic materials; Semiconductors

1. Introduction

For high quality wafer bonding in 3D-IC technologies, transient liquid phase (TLP) bonding provides a bonding scheme with a low bonding temperature, yet the bonded layer can tolerate high