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Superior performance and reliability of copper wire ball bonding in laminate substrate based ball grid array

Abstract

Purpose - The purpose of this paper is to provide a systematic method to perform long-term reliability assessment of gold (Au) and copper (Cu) ball bonds in fineline ball grid array package. Also with the aim to study the apparent activation energies (Eaa) and its associated wearout mechanisms of both Au and Cuwire in semiconductor device packaging. This paper discusses the influence of wire type on the long-term reliability and mechanical performance after several component reliability stress tests. Design/methodology/approach – A fineline ball grid array (FBGA) package with Cu and Au wire bonds was assembled with green molding compound and substrate. Samples are subjected for long-term high temperature storage bake test at elevated temperatures of 150°C, 175°C and 200°C. Long-term reliability plots (lognormal plots) are established and Eaa of both ball bonds are determined from Arrhenius plots. Detailed failure analysis has been conducted on failed sample and HTSL failure mechanisms have been proposed. Findings - Reliability results show Au ball bond in FBGA package is observed with higher hour-to-failure compared to Cu ball bonds. The Eaa value of high temperature storage life (HTSL) reliability for Au ball bond is lower than Cu ball bond. Typical HTSL failure mechanism of Au ball bond is induced by micro-voiding and AuAl intermetallic compound (IMC) micro-cracks while CuAl IMC micro-cracking (induced by Cl- corrosion attack and micro-cracking) caused wearout opens in Cu ball bond. These test results affirm the test-to-failure data collected is a useful method for lifetime prediction and Eaa calculation. Practical implications - The paper reveals higher reliability performance of Cu ball bond in FBGA flash memory package which can be deployed in flash memory FBGA packaging with optimised package bill of materials. Originality/value - The test-to-failure methodology is a useful technique for wearout reliability prediction and Eaa calculation.

Keywords

Apparent activation energy (Eaa); BGA package; High temperature storage life; Lognormal plot; Long-term reliability; Reliability management; Storage