Substrate effects on SnAgCu solder joints

Citation for published version (APA):
Erinc, M. E., Schreurs, P. J. G., Zhang, G. Q., & Geers, M. G. D. (2004). *Substrate effects on SnAgCu solder joints*. Poster session presented at Mate Poster Award 2004 : 9th Annual Poster Contest.

Document status and date:
Published: 01/01/2004

Document Version:
Publisher’s PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

• A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
• The final author version and the galley proof are versions of the publication after peer review.
• The final published version features the final layout of the paper including the volume, issue and page numbers.

Link to publication

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the “Taverne” license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy
If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

Download date: 08. Feb. 2024

TU/e technische universiteit eindhoven

Substrate Effects on SnAgCu Solder Joints

M.Erinç, P.J.G.Schreurs, G.Q. Zhang and M.G.D.Geers
Eindhoven University of Technology, Department of Mechanical Engineering

Introduction

Demand of increasing functionality in smaller space is termed as "miniaturization" in microelectronics. Miniaturization led to the development of ball grid arrays (BGA), replacing lead-frame assemblies. The pads on both chip and print circuit board side contain thin films of lamellar metallic layers, the so-called under bump metallization (UBM) with the purpose of:

- ☐ Preventing oxidation of copper,
- ☐ Wetting of solder to the pad,
- ☐ Wetting between individual metal layers.

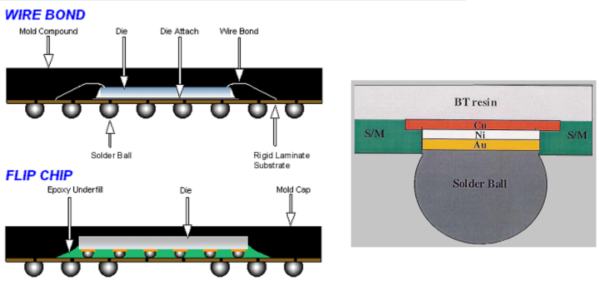


Figure 1 *BGA layout and the UBM.*

Objective

Characterizing the interfacial metallurgy and corresponding damage propagation in SnAgCu solder with the substrates Cu and the UBM configuration Ni/Au.

Interface Metallurgy

Fig.2 shows SnAgCu solder paste reflowed on Cu and Au coated Ni plate at 260^{o}C. The solder reaction immediately forms a number of intermetallic layers at the interface. The morphology changes from layerwise to scallop type from substrate towards solder [1]. Air cooling results in excessive diffusion of substrate atoms into the solder matrix, thus leading to precipitation of large primary intermetallic crystals. Voids are often encountered.

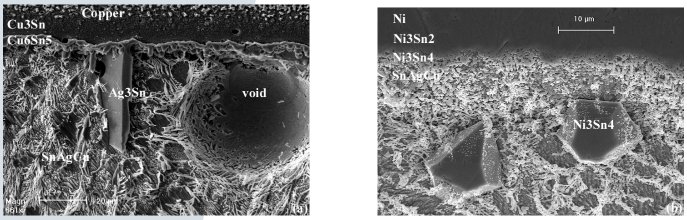


Figure 2 *(a) Cu-SAC interface, (b) Ni/Au-SAC interface.*

Crack Paths at Solder/Substrate Interface

The prepared specimens are loaded under pure tension and pure shear(Fig.3,4). In all four schemes, localization of damage is observed at the interfacial regions. With both Cu and Ni/Au, primary cracking occurs at the substrate/IMC/solder interfaces. Due to the strong adhesion between Ni based interfacial layers and Ni substrate, brittle cracking in the IMC layers is more pronounced in Ni than Cu. Under shear loading, primary crystals act as stress concentrators and cracks start from the edges, which in turn coalesce and failure occurs.

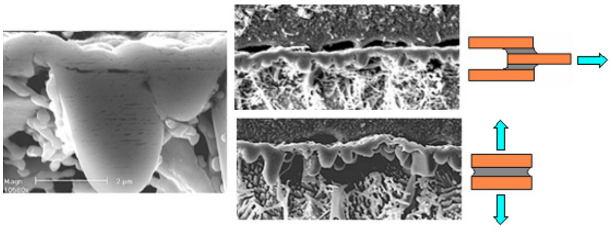


Figure 3 *Cu-SnAgCu (a) Voids at Cu/Cu$_3$Sn interface, (b) Brittle cracking in Cu$_6$Sn$_5$ layer under shear loading, (c) Delamination at Cu$_6$Sn$_5$/SnAgCu interface under tensile loading.*

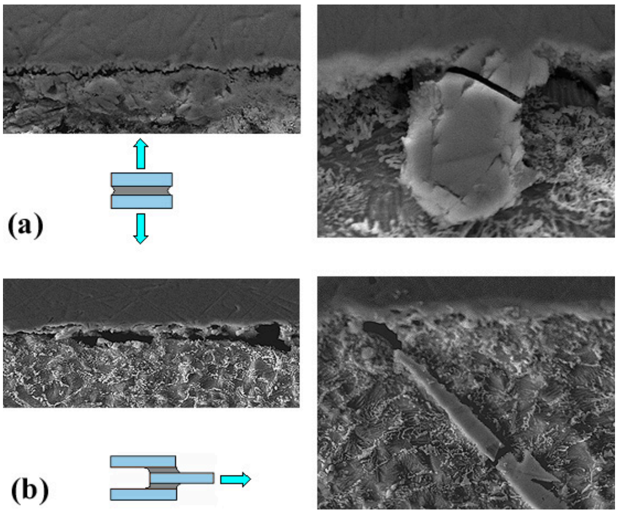
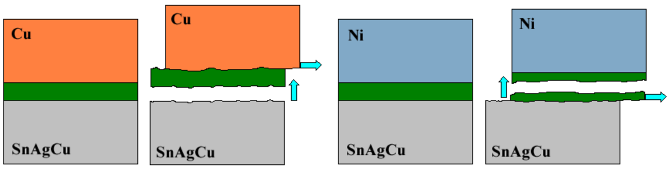


Figure 4 *Ni/Au-SnAgCu (a) Brittle cracking in the intermetallic layers between solder and Ni under tensile loading, (b) Decohesion of Ni and Ag based primary crystals from the matrix under shear loading.*

Conclusions

The dominant crack paths at the SnAgCu on Cu and Ni/Au substrate interfaces under tensile and shear loading, corresponding to normal and tangential tractions, can be represented in the following separation schemes:



References:

[1] Erinç, M., Schreurs, P.J.G., Zhang, G.Q., Geers, M.G.D.: *Microelectronics Reliability* (44:1287-1292, 2004)