The solid state reactions in powder soldering mixtures of Cu-Sn system

Oleksii Liashenko1,2, Serhii Derevianko2, Vladyslav Morozovych2, Didier Bouvard3, Yurii Lyashenko2

1 Empa, Swiss Federal Laboratories for Materials Science and Technology, Switzerland
2 Physics Department, Cherkasy National University, Cherkasy, Ukraine
3 Univ. Grenoble Alpes, CNRS, SIMAP, Grenoble, France

Introduction

Soldering technology in microelectronics has faced a lot of difficulties during last two decades due to the ban of well-developed lead-based solders and significant miniaturization of the interconnects. One of the new approaches is a transition-liquid phase bonding (TLP) method. TLP method application involves different shortcomings while being applied in the microelectronic industry: the heat treatment cycle should be sufficiently long (up to few hours at 400-500°C) and the ambient atmosphere should be chosen in order to control the oxidation of the metallic surfaces.

In this work we present a method of production of massive samples of intermetallic compounds of Cu-Sn system, namely δ-Cu41Sn11 powder and solder mixtures production from these bulk compounds. We described a new experimental method of sintering Cu plates by using powder intermetallic mixtures for the times much shorter than in conventional TLP method.

Experimental procedures

1. Powders’ production
   a. Growth α-phase (solid solution of Cu and Sn) between powder mixture and copper.
   b. Complex solid-state interfacial reactions (metastable phase decomposition, Kirkendall voiding during)

2. Solder paste production
   a. Production of massive samples of intermetallic compounds of Cu-Sn system, namely δ-Cu41Sn11.
   b. Grinding of powder with size less than 40 μm.
   c. Mixing with conventional RMA flux

3. Joining of copper plates
   a. Optical microscopy
   b. Common for samples 1 and 2
   c. Time-Temperature dependence of sample annealing

Conclusions

• We proposed a technology of solder paste mixtures sintering that can be used to for copper joining.
• Annealing times of ~1.5 hour are much shorter than for conventional TLP.
• Interfacial reactions are complex as far as they include phase growth, decomposition, competition, Kirkendall voiding and should be studied more accurately.
• Further refining of powder size should improve the density of the joint.

Acknowledgement

The authors gratefully acknowledge financial support from the Ministry of Education and Science of Ukraine (state registration number: 0117U000577).

Poudres’2019. Grenoble

Contact: Oleksii.Liashenko@empa.ch