Electrodeposition of Indium Bumps and Under Bump Metallization for High Sensitivity Spectroscopic X-Ray Detectors

Yingtao Tian, Changqing Liu, David Hutt
Wolfson School of Mechanical and Manufacturing Engineering, Loughborough University
In collaboration with: Bob Stevens
Central Microstructure Facility, Rutherford Appleton Laboratory

The assembly of pixellated X-Ray detectors used in high-energy physics, (e.g. the PILATUS detectors at the Diamond Light Source) requires the direct interconnection of sensor and readout chips (both bare Si die) for which indium bump bonding has been successfully applied. In general, indium bump bonding is used as it does not interfere with the X-ray signal detection, offers ultra-fine pitch interconnections (<100 μm), is a low temperature process and can be carried out with a high yield (greater than 99%). The current state-of-the-art solution developed by the Paul Scherrer Institute (PSI) employs photolithography, sputtering and evaporation to produce the indium bumps with a Ti/Ni/Au under bump metallization (UBM) [1]. However the process requires many steps which makes it expensive for relatively large production volumes.

The aim of this project is to investigate alternative manufacturing methods for the deposition of the indium and UBM based on the use of electroplating rather than sputtering and evaporation (figure 1). Electroplating offers the potential for lower cost and higher productivity. However, for this to be successful, it is necessary to generate the indium bumps at fine pitch with a variation of bump height across the wafer of less than 5%. Therefore, a key challenge for the electroplating method is to control the current density and distribution across the wafer surface to ensure the bump uniformity. Due to the application of the electrical contact at the boundary of the wafer and the appreciable resistance of the thin seed layer, the current density will vary across the wafer (known as the terminal effect) leading to bumps of different heights.

A number of methods to ensure the uniformity of deposition will be investigated including the design of plating cells that lead to a more even current distribution. Pulse plating can also be used to control the deposition rate and deposit properties through the application of various waveforms of current and voltage. The bump uniformity will also be influenced by the rate of mass transfer in the plating process and therefore, ultrasonic agitation is also being considered as a promising approach to enhance or modify the mass transfer distribution. Through the research collaboration of Loughborough University and Rutherford Appleton Laboratory, computational modelling and experimental trials will be carried out to understand the fundamental issues in indium bump plating that will assist the further optimisation of the processing parameters and provide guidance in the actual plating practice for industry.

Reference:

Contact:
Dr C. Liu
C.Liu@lboro.ac.uk
Wolfson School of Mechanical and Manufacturing Engineering, Loughborough University.

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