MA1288 experiment report: Effect of annealing parameters on the global microstructure formation in copper pillars for 3D integration

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The experiment MA1288 aimed at doing transmission and scanning tomography of isolated copper pillars. 18 shifts have been allocated. Copper pillar are interconnections used in 3D microelectronics (3D integration). Typically, they are copper cylinder of 25 micrometers in diameter on top of which is a bump, having a hemispherical shape. In our case, the bump was made of Sn, Ag and Cu.

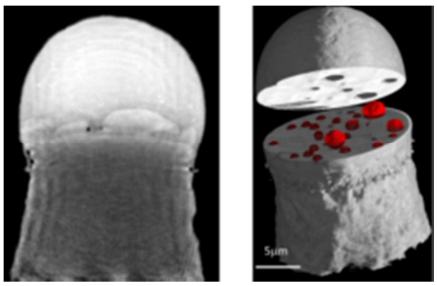

Fig.1: *2D sagittal slice through the 3D reconstruction (left), showing intermetallics and 3D volume rendering showing voids, in red (right)*

Using transmission tomography, voids could be imaged in 3D after a suitable phase retrieval, with the help of P. Cloetens, from ESRF. They are shown hereunder, in red (3D volume rendering). With the same technique, intermetallics could be imaged and their volume quantified (left image, which is a 2D sagittal slice). See reference 2 of this document.

Fluorescence tomography was also carried out, in 2D mapping and fluorescence tomography. The copper, nickel, tin and silver distribution could be imaged (in gray, blue, green and red, respectively) and are shown below.

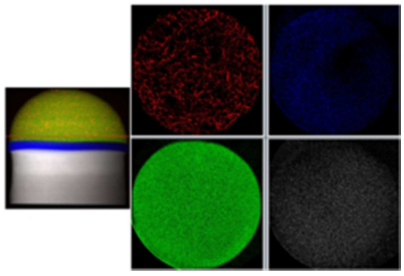

Fig.2: *2D fluorescence mapping of a copper pillar (left) and 4 fluorescence tomography slices. Color coding: copper, nickel, tin, silver are in gray, blue, green and red, respectively.*

Thanks to rapid examination times, 10 samples have been imaged by projection tomography, 5 2D fluorescence mapping have been measured, 9 fluorescence tomography slices have been measured, and a full 3D fluorescence tomography has been performed on a single bump. The detector used where a CCD Frelon and the Vortex fluorescence detector. The beam was stable enough for the experiment.

Overall, the experiment turned out to be efficient, for advanced users. Remaining phase contrast contribution (still visible on the left image of Figure 1) made it difficult to perform quantitative analyses.

Publications directly linked to this experiment:

1. N. Martin, J. Bertheau, P. Bleuet, J. Charbonnier, P. Hugonnard, D. Laloum, F. Lorut, J. Tabary, *3D imaging of copper pillars using x-ray tomography within an SEM: a simulation study based on synchrotron data*, Rev. Sci. Instr. **84**(2), 023708 (2013).
2. J. Bertheau, P. Bleuet, F. Hodaj, P. Cloetens, N. Martin, J. Charbonnier, N. Hotellier, *Reflow processes in micro-bumps studied by synchrotron x-ray projection nanotomography*, Microelectronics Engineering, accepted for publication (July 2013) http://www.sciencedirect.com/science/article/pii/S0167931713005625
3. J. Bertheau, P. Bleuet, F. Hodaj, P. Cloetens, N. Martin, J. Charbonnier, N. Hotellier, IEEE Electronic Components and Technology Conference, Las Vegas, 2013.