

Towards quantitative depth profiling of Sn/Cu solder bumps

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Progress in flip-chip technology, a vital element of semiconductor industry, is emerging and constantly bringing along novelties on the material science side. One important innovation for solder bumped flip-chips is the use of Sn/Cu double layer bumps, which serve to make direct contact between devices and circuit boards. The quality of the resulting interconnects strongly depends on the degree of organic contamination in the Sn/Cu bump. To shed light on the amount of incorporated impurities, depth profiling of the two layers before being annealed is required. This is a challenging task, as there is no quantitative method that would allow analysis of the laterally highly confined bump arrays. Furthermore, the very distinct material characteristics of Sn and Cu (e.g. color, hardness, electrical and thermal conductivity) are demanding for the analysis method.

In this report, a miniature reflectron time-of-flight mass spectrometer (LMS) combined to a fs laser ablation/ionization source¹ is applied to approach the complex problem via investigation of a simplified model system: electrodeposited Sn/Cu bilayers. These bilayers are much thinner and laterally more extended than the target Sn/Cu bumps. This makes their analysis straightforward and allows to focus on the main challenges faced when trying to obtain a depth profile of a multi-component entity with rather different physical characteristics as well as the unknown influence of the interface separating the two layers. To our knowledge, this is the first dedicated report on fundamental studies on these aspects for Sn/Cu bilayers.

[1] Andreas Riedo et al., *J. Anal. At. Spectrom.*, **2013**, 28, 1256-1269