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Evaluation of surface morphology of Pb-In alloy films for superconducting bumps utilized in a three-dimensional packaging structure of X-ray detector

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Superconducting tunnel junction (STJ) is one of the candidates as an x-ray detector because of high energy resolution. In order to obtain a two-dimensional image of detected x-ray, it is necessary to array a large number of STJs on a chip. However, the integration density of STJs is limited by the wiring area when the STJ-array is enlarged. To solve this problem, we have proposed an "embedded STJ" (e-STJ) with a three-dimensional packaging structure [1].

A Pb-In alloy bump is one candidate for using the superconducting connections in the three-dimensional packaging structure. We found some roughness on the bump surface in the previous research. In order to realize multi-pin connection technology, it is necessary to flatten bump surface to reduce bonding force. Thus, we investigated the surface of superconducting Pb-In alloy bumps to clarify the effect of surface morphology on the superconducting Flip-chip Bonding (FCB) connection.

A Pb and In films were deposited on an oxidized Si wafer by evaporation sequentially to make Pb-In stacking films with various mass concentration of In in Pb. Total thickness of the stacking film was made to be 4 μm. The calculated average roughness (Ra) and the maximum height (Rz) of Pb-In stacking film surfaces were measured at room temperature after annealing time of over 100 hours for alloying. Ra and Rz of the Pb-In stacking films are plotted as a function of the mass concentration of In in Pb in Fig. (a) and (b), respectively. The roughness of Pb-In stacking film surfaces increased after alloying than the pure Pb and In films as shown in the figures. The details will be presented.

[1] T. Ishizuka et al., 74th the Japan Society of Applied Physics, 17 p-C10-20 (2013).

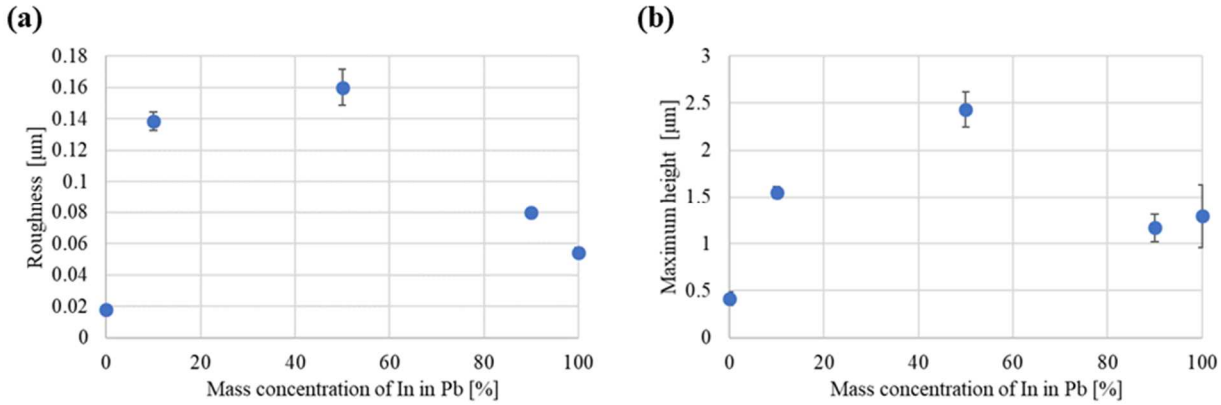

Fig.(a) Ra of Pb-In stacking film surface (b) Rz of Pb-In stacking film surface

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