High Mechanical Strength in Gold Films Electroplated with Supercritical Carbon Dioxide for MEMS Applications

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Recently, electroplated gold films have attracted much attention because of their desirable properties for micro-electrical-mechanical systems (MEMS) devices [1]. However, it is known that mechanical strength of gold materials is relatively low when compared with the other metallic materials, which is always a concern in practical MEMS applications especially for the movable components. On the other hand, an alternative electroplating (EP) method employing supercritical carbon dioxide ($scCO_2$) in film deposition was proposed to be effective on the grain refinement as demonstrated in electroplating of Ni and Cu [2]. Based on the Hall-Petch relationship, finer grain would result in strengthening of the metallic materials. It is expected that the mechanical strength of electroplated gold could be enhanced by employing $scCO_2$ in the EP process.

Two kinds of thick gold films (~50 um) were prepared by electroplating method with a commercially available sulfite-based gold electrolyte: one is fabricated by using the conventional electroplating (CONV-EP) method without employing $scCO_2$; the other is electroplating with the $scCO_2$ contained electrolyte (SCE). Evaluation of the mechanical properties were conducted by micro-compression tests. The specimens were micro-pillars fabricated by focus ion beam (FIB). Fig. 1 shows the engineering strain-stress (SS) curves of the CONV-EP and the EP-SCE micro-pillars. The yield strength of the EP-SCE pillar is 520 MPa, and it is far larger than the strength of the CONV-EP pillar, which is 380 MPa. The high strength is mainly attributed by the effect of grain refinement in the EP-SCE, which resulted gold film with finer grains than the CONV-EP. More details will be shown and discussed in the conference.

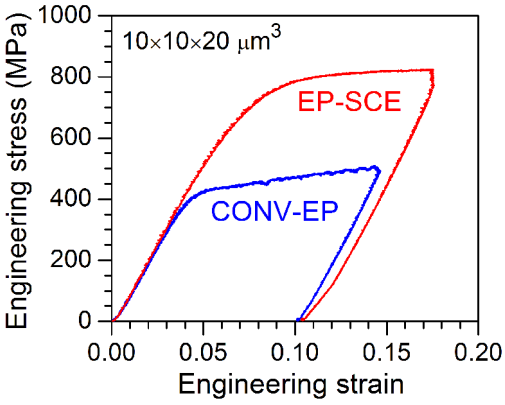

Fig. 1. The engineering SS curves of the CONV-EP and the EP-SCE pillars with same dimension of 10×10×20 μm^3.

Reference

[1] D. Yamane, T. Konishi, T. Matsushima, K. Machida, H. Toshiyoshi, and K. Masu, *Appl. Phys. Lett.* **104** (2014) 074102.

[2] T. Nagoshi, A. Shibata, Y. Todaka, T. Sato, M. Sone, *Acta Materialia.* **73** (2014) 12–18.