Application of Supercritical Carbon Dioxide in Electroplating of Gold Materials Used in MEMS Devices

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Recently, gold materials have attracted much attention and are commonly used in micro-electrical-mechanical systems (MEMS) devices due to their excellent electrical and mechanical properties [1,2]. Electroplating (EP) is often used in preparation of the gold materials because the morphology, crystal structure, and deposition rate of the deposited gold materials could be easily controlled by varying the EP parameters [3]. On the other hand, mechanical strength of gold materials is relatively low when compared with other metallic materials, which is always concern in practical applications in MEMS. In previous studies, grain refinement effect was observed in the nickel films prepared by the EP with electrolyte containing supercritical carbon dioxide ($scCO_2$) [4,5], which then leads to a significant enhancement in the mechanical strength due to Hall-Petch relationship [6]. $ScCO_2$ is CO_2 at temperature and pressure above its critical point, which are 31.1℃ and 7.38 MPa. In this work, feasibility of the EP with the $scCO_2$ for preparation of gold films would be evaluated and reported.

The gold electrolyte used in this work was commercially available non-cyanide sulfite-based electrolyte. For the EP with the $scCO_2$, 20 vol.% of CO_2 and the temperature at 40℃ were used. The pressure was the ranged from 5–15 MPa. The current density was varied from 3 to 8 mA/cm^2. Properties of the electroplated gold films were evaluated by a digital optical microscope (OM), scanning electron microscope (SEM), X-ray diffraction (XRD), and atomic force microscope (AFM).

The gold films fabricated by the conventional electroplating (CONV) and the EP with the $scCO_2$ showed bright surfaces. The preferential crystal growth orientation is usually highly dependent on the current density as confirmed in the gold films fabricated by the CONV. However, the current density was found to have limited influence on the preferential crystal growth orientation when the $scCO_2$ was applied.

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