Effect of grain refinement species on the gold electroplating in a non-cyanide bath

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This work focuses on the effect of grain refinement species for the gold electroplating. Physical and electrochemical analyses have been carried out with grain refinement species such as Bi^{3+}, In^{3+}, Sn^{2+}, etc. A mixture of Bi^{3+} and Sn^{2+} showed the highest performance in the hardness and deposition rate among the experimental combinations.

Gold electrodeposition has been used in the electronic material fields because gold has advantages of chemical safety, high electrical and thermal conductivity, excellent corrosion resistance.

Cyanide based gold bath has high stability compared with non-cyanide bath, however cyanide ions dissolves photoresist material in the semiconductor processes. Thus, non-cyanide bath is required in the semiconductor processes.

Grain refinement has functions of controlling particles size in its reduction. Conventional grain refinement were Ta, Pb, As species[1].

In this research, the effect of grain refinement species on the electroplating behavior was investigated. Tin(Sn^{2+}), bismuth(Bi^{3+}) and indium (In^{3+}) were used as a grain refinement and these components were compared with thallium, lead and arsenic species.

Non-cyanide gold solutions were prepared with sodium sulfite gold (0.06M), grain refinement (15ppm) and other chemical species. Temperature of the cell was controlled by water jacket at 60℃. Electrochemical characterization was carried out with a RDE (Rotating Disk Electrode). Physical characterization was done with measuring hardness and surface with SEM. To measure the hardness gold was deposited to be 50μm thickness on the nickel plate. The hardness was measured by Vickers hardness method.

Figure1 shows reduction currents with grain refinements such as Bi^{3+}, In^{3+}, $Sn^{2+}$and a mixture of Bi^{3+} and Sn^{2+}. The Bi^{3+} and Sn^{2+} mixture showed higher reduction current than other species. Fig. 2 shows hardness of the electroplated gold at the various points on the surface before annealing. Average hardness of the points were 98 Hv (In addition), 113 Hv (Sn addition), 105 Hv (Pb addition) and 85 Hv (Bi+Sn addition). A mixture of Bi^{3+} and Sn^{2+} addition had a lowest hardness among them.

From the results the mixture of Bi and Sn had the highest reduction currents and lowest hardness. Therefore, the gold bath with Bi and Sn mixture can be a possible candidate for non-cyanide gold electroplating bath.

Acknowledgement

This work (Grants NO. 000482410112) was supported by Business for Cooperative R&D between Industry, Academy, and Research Institute funded Korea Small and Medium Business Administration in 2011.

Table1 RDE experiment condition.

potential range	-1.5 V~0 V vs SCE
scan rate	50 mV/sec
Rotating Speed	200 rpm~800 rpm
Counter electrode	Platinum sheet
pH	8
Operation Temperature	60^0C

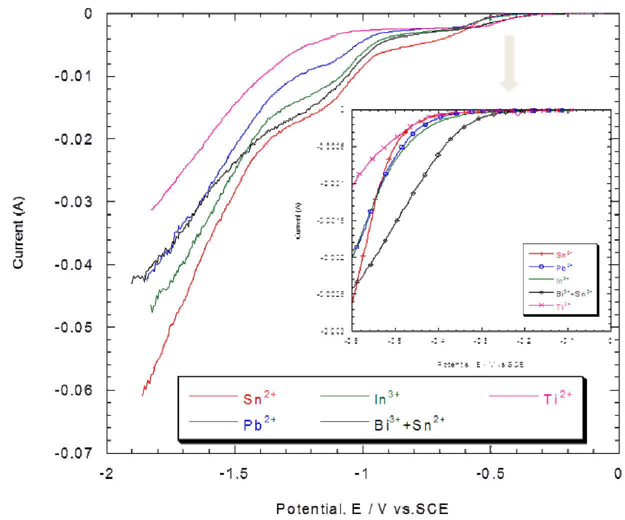

Fig. 1 Current-potential behaviors with various grain refinement of Sn^{2+}, Bi^{3+}, In^{3+}, Ti^{2+}, mixture of Bi^{3+} and Sn^{2+} at rotation speed of 200 rpm, pH 8, 60 ℃.

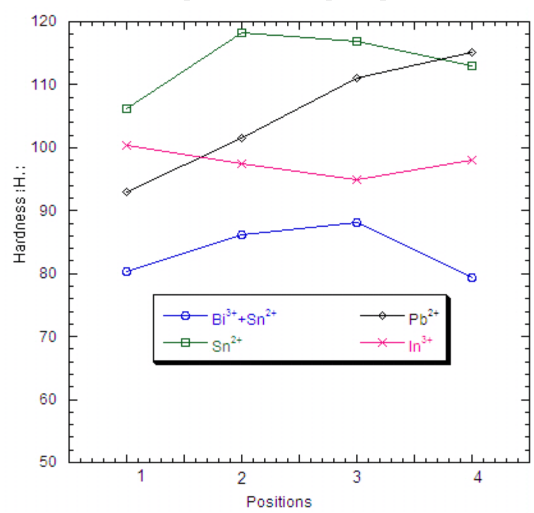

Fig. 2 Vickers hardness of the electroplated gold with various grain refinement at the various points on the surface at pH8, 60 ℃.

Reference

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