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Preparation of Textured Ag Thin Films by Using Mixed Monomolecular Layer Spread at Air/Solution Interface

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A textured Ag skeleton film was fabricated by using a heterogeneous monolayer spread at an air/solution interface as a support. The mechanism of the formation of the textured film was discussed based on the difference of the rate of Ag deposition in the amphipatic molecules.

The monolayer spread at air/solution interface has attracted recently scientific and technical interests.[1-3] We have reported in previous papers that the metal thin films of Ag[4,5] and Pb[6] can be obtained at an air/solution interface by using a spread monolayer of amphipatic molecules as supporting substrate of electroless plating. In the present paper, we describe the preparation of textured thin skeleton Ag film by using a mixed monolayer as a template.

Experimental procedure was similar to that reported previously. Stearylamine and stearylalcohol were used as amphipatic molecules for the monolayer formation. The electroless solution, on which the monolayer was spread, was 3×10^{-2} moldm^{-3} $AgNO_3$ with 10^{-1} moldm^{-3} $C_4H_4KNaO_6$ as a reducing regent. Pure or mixed amphipatic molecules was spread from benzene solution (10^{-1} wt%) onto the electroless plating solution. The monolayer was kept under the constant surface pressure of 29.5 mNm^{-1} by using a piston oil (oleic acid). Surface morphology of the Ag film was observed with a SEM, after the Ag thin film was transferred from the air/solution interface onto a clean brass substrate after reaction time of 120 min.

Rates of the Ag deposition markedly depended upon the type of amphipatic molecules spread at the air/solution interface.[5] As shown in the SEM photograph of Fig 1a, a uniform Ag thin film deposited on the homogeneous monolayer of stearylamine. However, in the case of the homogeneous monolayer of stearylalcohol, no Ag deposition could be observed. This dependence of the Ag deposition rate upon the type of the amphipatic molecules is thought to arise from the difference in the interaction

between the amphipatic molecules and Ag ions or Ag fine particles.

Figure 1b, and 1c show the change of the surface morphology of the Ag thin film obtained on the heterogeneous monolayer of different mixture ratios of stearylamine ($StNH_2$) to stearylalcohol (StOH). Since the formation of the Ag film on the heterogeneous monolayer was not completely uniform over the entire part of the trough, the Ag film of average thickness was sampled. From the results in Fig. 1a and 1b, it can be confirmed that open area in the Ag skeleton film increased with the ratio of stearylalcohol. This implies Ag deposited selectively on the part of stearylamine in the heterogeneous monolayer, and resulted in the fabrication of the textured Ag film. However, further examination is required to clarify the relationship between the structure of the mixed monolayer[7] and that of the Ag film.

This method will be useful for the preparation of the textured metal thin films with dimensions of submicron or less. In addition, formation of the thin Ag film may be applicable to the fabrication of the in situ replica of the heterogeneous monolayer at the air/solution interface.

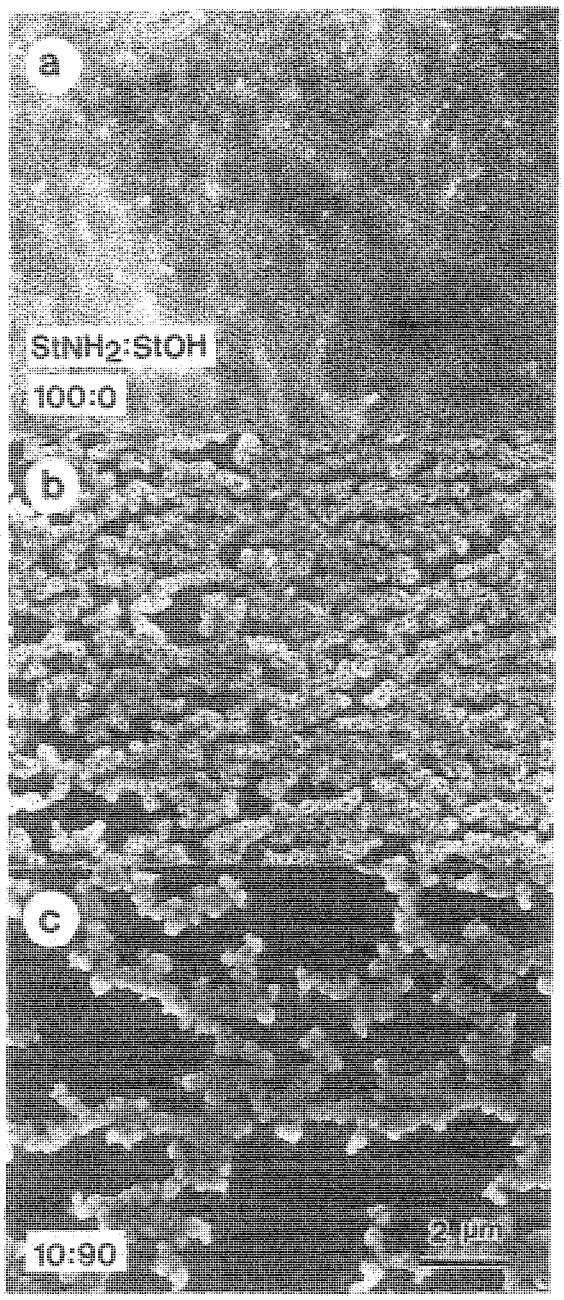

Fig.1. SEM photographs of Ag films.

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