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窒素雰囲気下でのRF 駆動大気圧プラズマジェットによるポリイミド基板への高導電性銅薄膜堆積

Deposition of highly conducting Cu thin film on polyimide substrate using RF-driven atmospheric pressure plasma jet in nitrogen atmosphere

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For fabrication of future flexible electronic devices and depositing highly-conducting Cu thin films on polyimide substrate, an Ar/H_2 atmospheric pressure plasma jet (APPJ) driven by a 13.56 MHz radio frequency (RF) power is developed for depositing highly-conducting Cu thin films on polyimide substrate. In previous studies, we found that by adding a fractional amount of H_2 gas into Ar APPJ, quality of Cu film was significantly improved. But under air atmosphere, the oxidization of deposited film is inevitable because of existence of oxygen. So we developed the technology in nitrogen atmosphere.

1. Experimental Procedure

A plasma jet was set up in a chamber and working in nitrogen atmosphere in order to avoid oxidization, as shown in Fig.1. The plasma jet was jetted out from a quartz nozzle (3 mm outer diameter). A Cu wire 1 mm in diameter was employed as a source for the deposition and inserted into the quartz nozzle. A 4-turns solenoid coil made of Cu tube was wound around the quartz tube. The plasma was ignited by applying RF power of 300 W to the coil after plasma-gas introduction (Ar: 1000 sccm or Ar: 1000 sccm/H_2: 10 sccm). The inserted Cu wire was heated and evaporated by plasma, and then Cu film was deposited on polyimide substrate from the nozzle tip of 1 mm.

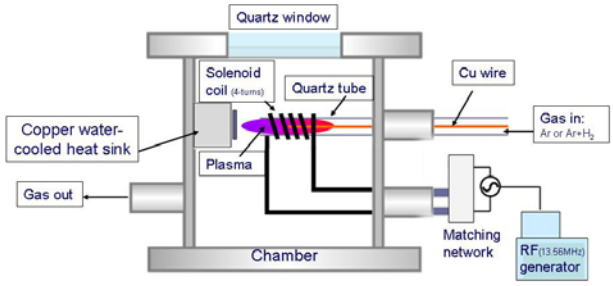
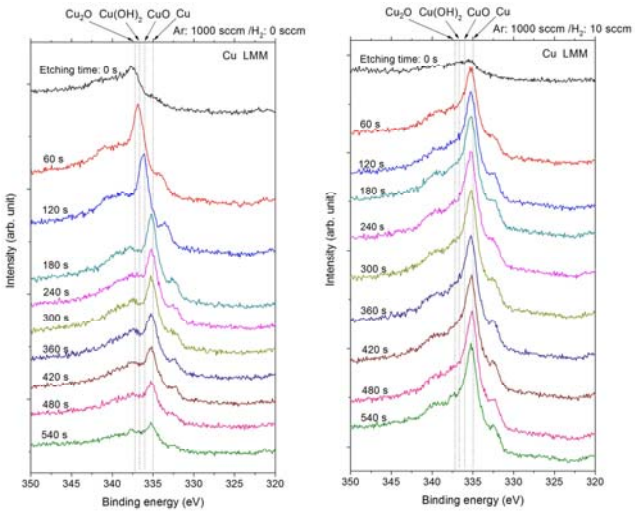


Fig. 1 The schematic of the RF-driven APPJ in chamber.

2. Results and Conclusions

To discuss the effect of nitrogen background gas on plasma characteristics, the OES measurement was performed. The effects on Cu films quality were studied by means of XPS and SEM. By replacing air to nitrogen, it was confirmed by XPS that a high purity Cu film by Ar/ H_2 jet was synthesized without the oxidization, as shown in Fig. 2. The thickness of Cu film was also verified to be increased by stylus profiler. All the plasma properties and the results of Cu film would give us an insight on the mechanism and the possibility of improving the process.



(a)　(b)

Fig. 2. LMM Auger spectra of Cu films on polyimide deposited by (a) Ar and (b) Ar/H_2 APPJs.