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, an Ar/H₂ atmospheric pressure plasma jet (APPJ) driven by a 13.56 MHz 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 H₂ gas into Ar APPJ, quality of Cu film was significantly improved. But under air atmosphere, the oxidization of deposited film is inevitable because of the existence of oxygen. So we developed the technology in nitrogen atmosphere. [1, 2]

1. Introduction
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2. Experimental setup
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. 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. 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.

3. Results and discussion
To discuss the effect of nitrogen background gas on plasma characteristics, the optical emission spectroscopy (OES) measurement was performed. The effects on Cu film quality were studied by means of X-ray photoelectron spectrometry (XPS), stylus profiler and scanning electron microscope (SEM). By replacing air to nitrogen, it was confirmed by XPS that a high purity Cu film was synthesized, without the oxidization of Cu film. 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.

References