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The Effect of Residual Gas in Preparation of Cu Films by Ionized Cluster Beam

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ICB방법에 의한 Cu 박막 제작에 있어서 잔류 가즈가 박막 형성에 미치는 영향

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The preparation of high quality metal films is of great importance in the fabrication of microelectronic devices. Recent years, Cu film as a relatively high conducting materials, is actively investigated in the development of ULSI (the cell size is probably in the range of 1.4 $micron^2$ in 64Mbit DRAM). ICB(ionized cluster beam) as one of the method of fine film preparation have same significant advantages[1], and nearly epitaxial Al films on Si(111) and twin Al films on Si(100) by that method have been succeeded. Then in the present paper, the Cu films were prepared on the Si(100) substrates at room temperature, 10^{-6} torr by ICB, and morphology, preferred orientation as well as surface roughness were characterized. With those results, the effect of residual gas on the properties of Cu films was discussed.

The ICB equipment developed in our lab. have been reported in the 4th Conference of Korea Vac. Soc.(Feb. 1993). The Cu (99.99%, RARE METALLIC Co. LTD.) was put into the graphite curcible, which was pre-heat treated at 2000℃, 30min. Si(100) wafers used were pre-treated with HF solvent and heat treated at 850℃, 15min in HV chamber. The films were made in HV chamber with a base pressure in the $5x10^{-7}$ torr which increased to $1.5x10^{-6}$ torr during deposition. The deposition rate and total thickness were measured with crystal quartz monitor and α-step (TENCOR Co.), respectively, and TEM, AFM, X-ray deffraction were used to analyze the microstructure, surface morphology, preferred orientation, respectively. The ion beam current density was measured by Faraday Cup, which was located in the front of the substrate.

The deposition rate gradually increases from 20 to 38Å/min with the increase of acceleration voltage from 0 to 4kV. In order to find the effect of residual gas on the ion beam current density, the current density was measured without crucible heating. In this case, the measured values of ion beam current is mainly from the ions of residual gas which is ionized in the ionization part. The current density of residual gas linearly increases with acceleration voltage, and the slope of the line significantly decreases with the change of the partial pressure from 10^{-5} to 10^{-7} torr.

The growth rate, preferred orientation as well as the grain size are greatly affected by acceleration voltage, which increase with the acceleration voltage. This effect of acceleration voltage on the film deposition is mainly attributed to the bombardment effect of the ionized residual gas, this ionized residual gas assisted film deposition greatly improves the film properties.

[1]. Isao Yamata, Proceeding of the Thirteenth Symposium on Ion Sources and Ion-Assisted Technology: Special Seminar, ISIAT'90. Ed., Toshinori Takagi, pp1-26(1990)