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Deposition of Cu films on Si substrate by Partially Ionized Beam deposition and Ion beam sputtering

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In metallization for the future ultra large scale integration (ULSI), downward scaling of feature size is required. When interconnect feature size decreases, RC time delays become the major limitation in achieving high circuit speeds. The RC time delay can be decreased by using metal films with low resistivities. Al and its alloys have been used for interconnects in integrated circuits. However, their resistivities are not low enough to operate ULSI circuits with high speed. There have been many reports that Cu is the most attractive one among metals to replace Al and its alloys because Cu has lower bulk resistiviy (1.67 $\mu\Omega$ cm) than that of Al and its alloys (2.74 - 3.5 $\mu\Omega$ cm).

In this study, Cu films were prepared on Si substrate by partially ionized beam deposition(PIB) and ion beam sputtering. In PIB, Cu films were deposited as a function of acceleration voltage and ionization potential. In case of Cu films by PIBD, crystallinity and roughness of (111) oriented Cu films were changed with average energy per depositing atom which was controlled by adjusting acceleration voltage and ionization potential. Cold-hallow-cathod ion gun was used in prepartion of Cu films by ion beam sputtering. Resistivity, grain size, crystallinity, surface roughness and impurity concentration of Cu films by two deposition technique were analyzed. Electrical resistivity of Cu filmswas investigated in terms of impurity, grain size and surface morphology.