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Effects of average energy of depositing atom on the preferred orientation and surface roughness of Cu films by PIB

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The preferred orientation and surface roughness of Cu films are discussed in terms of the average energy per deposited atom in the partially ionized beam deposition. In PIB system, the average energy can be controlled by adjusting acceleration voltage(Va) and ionization voltage(Vi). In order to understand the effect of the average energy on the properties of Cu films, experiments were performed through two methods. The first, Cu films were deposited at fixed ionization volatege with acceleration voltage. That is, the acceleration voltage is increased under fixed ionization condition, resulting in increasing the average energy. The second, Cu films were depositied at fixed acceleration voltage by changing the ionization current. Cu films were deposited on Si substrate in range of 8×10^{7} -4×10^{6} Torr by partially ionized beam. In first experiment, Cu films were prepared at fixed ionization voltage of 400 and 450 V with acceleration voltage. In second one, Cu films were deposited at average energy of 60 and 120 eV. The preferred orientation plane of all Cu films was (111). For Cu films at fixed ionization voltage of 400 V, as the acceleration voltage increased, the degree of preferred orientaion increased. However, Cu films at ionization voltage of 450 V showed the highest degree of preferred orientation at the acceleration voltage of 2 kV. At fixed average energy of 60 eV, the Cu films at Va=3 kV have higher preferred orientation than that at Va=1 kV. From these results, it is considered that the Cu films with highly preferred orientation could be obtained by controlling the optimum acceleration voltage as well as the average energy. The surface roughness of Cu films at Vi=400 V decreased with the acceleration voltage. However, in the case of Cu films at the fixed acceleration voltage of 3 kV, the surface roughness increased with increasing the average energy of 60 to 120 eV. These results represent that there may be the optimum energy and ion flux to get smooth Cu surface.