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Structural property of Cu thin films grown by Ionized cluster beam deposition

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Ionized cluster beam deposition(ICBD) of Cu thin films at system pressure of $5 \times 10^{-6} \sim 7 \times 10^{-6}$ torr range were conducted in order to fabricate Cu metallization with high quality Cu/Si interfaces. In order to prevent diffusion of the Cu toward the Si and silicide formation, the depositions with various acceleration voltages were performed at room temperature. X-ray diffraction patterns showed the all as-grown films having $\langle 111 \rangle$ Cu direction normal to the (100) Si plane regardless of the acceleration voltage. Auger electron spectroscopy demonstrated that there was no residual carbon detection in bulk of the as-grown films. The thickness of the all as-grown Cu films was 2000 Å as confirmed by low magnitude cross-sectional transmission electron microscopy (XTEM), that is, growth rates of the Cu film by the ICBD at room temperature were almost independent on the acceleration voltage. Furthermore, the XTEM showed sharp Cu/Si interface and large-grain polycrystalline Cu films with twin defect. Furthermore, there were some damages at the interface of Cu/Si, which might be influenced by the acceleration voltage. Lattice matching between the Cu and Si will be shown. Scratch test showed good adhesion in all the films. These results indicate that the ICBD at room temperature can be used for Cu thin film without any interdiffusion at the interface.