Growth of Cu metal films at room temperature using catalyzed reactions

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Cu interconnects in semiconductor devices are manufactured by an electroplating technique with a thin physical vapor deposited (PVD) Cu seed layer. Electroplating requires a conductive substrate and, in principle, electrodeposition could proceed directly on top of the diffusion barrier; however, in practice, a thin Cu seed layer is first deposited on the barrier layer. This seed layer is important because, in addition to improving adhesion, it also influences the nucleation and crystallographic texture of the electrodeposited Cu. Hence, atomic layer deposition (ALD) of Cu has attracted considerable attention as an alternative. In this paper, we report a method for growing Cu metal films even at room temperature by catalyzing the surface reactions. The organic base pyridine was chosen as the catalyst because it strongly interacts with the Cu metal atoms in the Cu precursor molecules adsorbed on the surface and it is a stable molecule. We also performed density-functional calculations for a complete understanding of the theoretical bonding state or structural changes when a Cu metal in Cu $(hfac)_2$ interacts with pyridine (Lewis base) on the surface.