Role of a passivation layer in superconformal copper gap-fill by chemical vapor deposition

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In this work, we investigated role of a passivation layer in superconformal Cu gap-filling of the nano-scale trench with atomic-layer deposited (ALD)-Ru glue layer. It was found that the nucleation and growth of Cu during metal-organic chemical vapor deposition (MOCVD) were suppressed on silicon oxide layer as a passivation layer for copper deposition. Specifically, as the plasma pretreatment time expands, Cu nucleation is inhibited proportionally. XPS and Thermal Desorption Spectroscopy showed that the thin film of silicon oxide was formed on the Ru surface, which leads to suppression of Cu nucleation owing to prevention of adsorption of Cu precursor molecules. It applied in the superconformal copper gap-fill of sub 60-nm ALD Ru trench. The silicon oxide layer was formed on the top surface of the ALD Ru trench during plasma pre-treatment. With this passivation layer, superconformal gap filling of the nano-scale trenches was achieved due to the suppression of growing Cu near the entrances of the trenches. Even the plasma pretreatment with bottom bias leads to the better gap-filling properties.