Atomic Layer Deposition of Metals on Dielectric Substrates

by

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The primary focus of this research is to develop novel strategies for low-temperature atomic layer deposition (ALD) of metals on dielectric substrates using metallorganic precursors. This work will enable solutions not only in the integrated circuit industry, but also will find application in areas of photonic crystals and fuel cells, where highly conformal coatings are required on multi-faceted three-dimensional structures. Two strategies have been developed to deal with the highly conformal coating of metals onto dielectric surfaces. The first involves the use of extended hydrogen pulses on oxidized metal surfaces, and the second involves the use of plasma to both serve as the source of reactive hydrogen and also to enable the chemical modification of the surface to promote chemisorption of the precursor. Extended hydrogen pulses are the basis for the development of a method to coat mesoporous materials with metal clusters. Here, proper tuning of the hydrogen pulse characteristics is critical for adequate removal of the reaction products. For plasma processing, conventional H_2 plasmas are shown to enable growth of superior quality films. In addition, N_2 / H_2 plasma species have been compared using an *in-situ* quadrupole mass spectrometer (QMS). The specific plasma species formed in one case have enabled the chemical modification of the surface of a poly(para-xylylene) (PPX) film without any etching of the film, allowing for enhanced chemisorption of the metal precursor. This same plasma is also compatible with metal ALD, enabling deposition with metallorganic precursors onto the PPX. For both strategies, film characterization techniques including X-Ray Photoelectron Spectroscopy (XPS), Rutherford Backscattering Spectrometry (RBS), Atomic Force Microscopy (AFM), and Reflection High Energy Electron Diffraction (RHEED) have been employed and have all shown consistent high quality metal film growth.