Al2O3-CxHy Multilayer Thin Films Manufactured by Plasma-Enhanced Atomic Layer Deposition and Plasma Polymerization for Moisture Barrier Film

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Organic-inorganic multilayer thin films are alternately deposited on a colorless polyimide substrate (CPI) for mitigating its poor moisture barrier performance. Organic layers, CxHy, are deposited using n-C4H10 as a precursor in a plasma polymerization (PP) chamber. Inorganic layers, Al2O3, are deposited using TMA [Al(CH3)3] and He/O2 as a precursor and a reactant, respectively, in a plasma-enhanced atomic layer deposition (ALD) chamber. The interface plays an important role in many materials composed of a heterogeneous dyad. As such, experimental analysis is focused on the physical and chemical properties for the Al2O3-CxHy interface. The time-resolved emission intensities of CO molecule are measured for different numbers of ALD cycles, by using optical emission spectroscopy (OES). The thickness and morphology of the Al2O3 films on the CxHy layer are examined with a transmission electron microscope (TEM). The concentrations of Al, O, C, Si atoms at the Al2O3-CxHy interface are analyzed by using X-ray photoelectron spectroscopy (XPS) depth profiling. Growth mechanism of the Al2O3 film on an organic layer is explained by using the OES, TEM, and XPS results in early ALD cycles. Then, Al2O3/CxHy multilayers are deposited on the CPI and their moisture barrier performances are evaluated in terms of the water vapor transmission rate (WVTR). Finally, we show that deposition of three Al2O3-CxHy dyads can lower the WVTR less than 10-3 g/m2day.