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Ultrathin Polymer-Clay Nanocomposite Films as Conformal Corrosion Barriers

Layer-by-layer (LbL) assembly is a simple deposition method that takes advantage of intermolecular attractions between different components to grow self-assembling, highly structured films. Studies have shown that ultrathin polymer-clay nanocomposite (PCN) LbL films exhibit excellent gas-barrier properties that are superior to conventional polymer films. Here we aim to take advantage of the highly impermeable nature of these films to create protective corrosion barriers. In this study, we examine the corrosion barrier efficiency and protective mechanisms of PCN films on copper in a sulfudizing environment. The particular PCN architecture under study consists of alternating layers of polyethylenimine (PEI), poly(acrylic acid) (PAA), and highly aligned montmorillonite clay platelets (MMT). Copper substrates were dip-coated to grow films of varying thickness, from 20 nm to 1 μm. Samples were then exposed to an environment of 10 ppb H_2S gas, 70% RH at 30°C for up to 800 hours. In between exposure periods, gravimetric measurements of the coated samples were used to follow corrosion rate. The results indicate that PCN films greater than 200 nm reduces the corrosion rate of copper by a factor of 10^3, comparable to commercial Parylene coatings of greater thickness. Electrochemical methods along with film permeability measurements are being utilized to understand the protective mechanisms, namely charge transfer inhibition by the polymer and gas barrier performance of the film, respectively. Our initial results show promise for PCN films as low-cost, conformal corrosion barrier coatings with exceptional performance.