

## Atomic Layer Deposition Diffusion Barriers for Silver Art and Cultural Heritage Objects\*

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Atomic layer deposition (ALD), a technique developed for encapsulation of microelectronics, is finding new and interesting applications in a variety of fields. In this talk I will discuss the application of ALD to the conservation of Cultural Heritage objects, specifically those crafted from heritage metals. In addition to the usual requirements of conformality and contiguity, art conservation requires a high degree of transparency across the visible spectrum, better effectiveness than polymeric lacquers, and most importantly: reversibility. I'll show examples illustrating the optical quality, corrosion barrier effectiveness and reversibility of ALD metal oxide films, determined on silver substrates with prior surface treatments, such as polishing abrasive and cloth, chemical dip, and nitrocellulose lacquer. Reflectance spectra quantified the optical quality of the ALD multilayer metal oxide films, structurally engineered to minimize the apparent color change on sterling silver. ALD barrier film lifetimes were determined by accelerated aging in an elevated H<sub>2</sub>S chamber. The effectiveness of ALD on pre-treated silver substrates was determined by porosity calculations using electrochemical impedance spectroscopy (EIS) and linear polarization measurements. X-ray photoelectric spectroscopy (XPS) depth profiling was used to determine the depth of etching caused by ALD film removal.

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