Silver saver: Nanotechnology keeps the shine on silver

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Some artworks, such as Winslow Homer's For to Be a Farmer's Boy and Vincent van Gogh's The Bedroom, are painted with colorants that are sensitive to light. In museums, they are called 'fugitive,' meaning they quickly vanish if exposed to too much light. Fading can dramatically change the color balance of fragile works of art and go so far as to obfuscate, in part, the artist's intended effect. After peering at Homer's painting through binocular microscopes, art conservators working behind the scenes at the Art Institute of Chicago (AIC) discovered some microscopic particles of colored pigments trapped in the artwork's paper fibers. Now, art historians and art conservators have one more tool in their arsenal to preserve cultural treasures: Surface Enhanced Raman Spectroscopy (SERS). Although this technique has been around for almost 30 years, only recently has SERS fully realized its potential, thanks to the nanotechnology boom. SERS is an ideal technique for art analysis--it is highly sensitive and can detect vanishingly small amounts of organic pigments that have long eluded identification by other approaches. Credit: © The Art Institute of Chicago

(PhysOrg.com) -- Anyone who's ever polished silver knows that keeping the tarnish at bay is never ending work. But, you may not know that polishing also rubs away some of the precious metal, whether it's your grandmother's silver bowl or a 19th century museum treasure.

"We're always looking for some kind of barrier that will protect the surface so we don't have to keep polishing it," says Terry Drayman-Weisser, director of conservation and technical research at the Walters Art Museum in Baltimore.

Twenty miles from the museum, materials scientist Ray Phaneuf and his team at the University of Maryland are working on a small solution to this big problem. With support from the National Science Foundation (NSF), they're producing and testing a protective coating so thin, you can't see it with the naked eye.

"The method that we use to apply it is called atomic layer deposition. So, literally, we're able to control the thickness of the film at a sub-nanometer level," explains Phaneuf.

Using a special reactor inside a clean room, they apply nanometer thick films of aluminum oxide to a sample silver wafer about the size of a silver dollar. Phaneuf says the films conform to the recesses and protrusions of the silver, creating a protective barrier.

Art conservators say atomic layer deposition, or ALD, will have to pass rigorous testing before they use it to protect irreplaceable treasures.

At the lab, the coating is put through a series of tests. Using a spectrometer the research team measures how light reflects off the surface of a test wafer, and how the ALD coating affects the wafer's color.

Another test measures how quickly sulfur penetrates the coated wafer. Sulfur is what tarnishes silver. The test will help determine how many layers of coating will be needed to keep the silver shiny. In another controlled chamber, the team heats a coated wafer to speed up the tarnishing. Phaneuf says this helps scientists figure out how long a barrier will last.

"Part of the challenge is to determine what the optimal thickness is that keeps sulfur off the silver surface. Eventually, thermodynamics tells us that the sulfur will diffuse through any layer we put down. The denser the layer, the slower the diffusion," explains Phaneuf. "So we'll start with films that may be a few nanometers thick and investigate the efficacy of these films all the way out to maybe a few hundred nanometers. If we can increase the lifetime of these films to a century, you may not need to do this very often."

Art conservators won't give ALD a thumbs-up until they can show that it works better than the lacquers they are using now, which have to be reapplied every decade or two. The conservators also will have to be able to remove the coating without damaging the piece.

"When it comes to art objects, the less treatment the better," says Glenn Gates, a scientist at the Walters Art Museum. "The standard treatments that use lacquers or nitrous cellulose coatings can give off a plastic look. The ALD coating is very, very thin, and orders of magnitude thinner than the wavelength of light; the idea being that it's going to impact the aesthetic presentation of the object much less than a thick organic lacquer coating that we generally apply these days."

If ALD proves a shining success, silver works of art will remain at their best for future generations to enjoy. And for many of us, it may mean never polishing silver again.

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