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Tiffany Metalwork Relies on High-Performance, Environmentally Safe Coating System

by Vince Casmirri and Kurt Wood



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By Vince Casmirri and Kurt Wood, Arkema, Inc.

Outdoor sculpture and architectural ornamentation represent a significant part of our artistic and cultural heritage. Although copper and iron alloys used in many of these objects are known to be long-lasting, their appearance and longevity can be adversely affected by exposure to increasing environmental pollution.

With decreasing maintenance budgets, caretakers of our outdoor monuments, sculptures, and high-value architectural metalwork face formidable preservation challenges. In response to this urgent issue, the conservation community is continuously searching for more durable, low-maintenance coatings that provide longer-lasting

protection against corrosion and degradation. Equally important, these new coating systems need to be environmentally safe, as increasingly stringent restrictions on volatile organic compound (VOC) emissions and solvents limit available materials that can be used.

In a collaborative research project, conservators at the Philadelphia Museum of Art (PMA), industrial scientists at Arkema Inc., and academic scientists at Portland State University, are developing and evaluating state-of-the-art coatings that meet the critical needs of the conservation and architectural communities. Their four-year research study is showing very promising

(Opposite page): Close-up view of Tiffany light grille following cleaning, repatination, and coating.

Photo courtesy of Philadelphia Museum of Art.

(This page): View of the bronze Tiffany light grilles in the ceiling

of the portico over the main entrance to the Philadelphia Museum of Art.

The lower grilles have not been restored, while the upper grilles have been through the restoration process.

Photo courtesy of the Philadelphia Museum of Art.





After thousands of hours in an accelerating weathering apparatus, metal panels treated with the new protective coating system were analyzed by Dr. Lasseter Clare for any film degradation.

Photo courtesy of www.brucemacgregorphotography.com.

results with new and improved protective coating system that not only will save museums time and money, but also will reduce hazards to conservation staff.

Architectural Treasures

Established in 1877, the PMA has grown to house one of the largest collections of art in the United States and is, in fact, the third-largest of its kind. One of its greatest treasures is the building itself, a resplendent, beautifully proportioned structure modeled after ancient Greek temples, but of more massive Roman proportions. Considered one of the crowning achievements of the "city beautiful" movement in early twentieth century architecture, the building was constructed circa 1925 to 1928 of Minnesota dolomite and features detailed friezes adorned with rich color. Of special interest on the building's exterior are the polychrome terracotta sculptures on the tympanum of the north wing's pediment. Executed in brilliant colors and gold glazes, the tympanum is seventy feet wide at its base above the supporting columns, rising to twelve feet in height at the center.

The historic Rodin Museum, which is administered by the PMA and located just a few blocks away, is also renowned for both the beauty of its grounds and its architec-

ture. Occupying a beautiful neoclassical Beaux Arts building that opened in 1929, the museum displays one of the world's largest collections of works by the celebrated French sculptor Auguste Rodin. As visitors approach the front gate, they are greeted by one of the artist's most famous works, *The Thinker*. The massive Gates of Hell sculpture, a 21-foot-high sculpture with more than 100 human and animal figures, stands at the museum's entrance.

In need of conservation, both the Rodin Museum and the PMA participated in the coatings research study.



The scale, intricacy, durability, and high level of craftsmanship of the bronze window grilles at the Philadelphia Museum of Art are an important and beautiful part of the building's aesthetics.

Photo courtesy of PMA.

World-Renowned For Conservation

The Conservation Department of the PMA is one of the most comprehensive in the world and it is internationally recognized for its advanced research and scholarly contributions to the field. Its experienced conservators provide the critical care necessary for the museum's collections, while also providing oversight and advice for the care of many of Philadelphia's public sculptures and historic architecture. Andrew Lins, senior conservator of decorative arts and sculpture at the museum and a leading expert in the field of metal corrosion, is a consultant for the conservation of some of the nation's greatest treasures, including the Statue of Liberty, the Lincoln Memorial, and the Liberty Bell.

In 2005, Andrew Lins served as oversight conservator for the groundbreaking project to enhance and preserve the eight monumental bronze sculptures created by Alexander Milne Calder that adorn Philadelphia's City Hall clock tower. Using state-of-the-art laser technology, never before applied in the United States on anything of this scale, workers cleaned and treated the eight bronze sculptures for the first time since their installation in 1894. "The use of laser technology on a project of this scope was a game changer in that it opened up the door for conservators to consider [the use of] protective coatings, [which was] not previously feasible because their removal was so difficult," said Lins.

Research Grants

In 2006, with a post-doctoral grant from the National Science Foundation, Dr. Tami Lasseter Clare started working with Lins at the PMA in search of a viable, long-term protective coating to safeguard the bronze Calder sculptures. She contacted Arkema Inc. to inquire about the company's highly durable polyvinylidene fluoride (PVDF) latex technology.

Fluorinated protective coatings, based on



A close-up of the bronze window ornamentation at the Rodin Museum shows how badly weathered it was prior to restoration.
Photo courtesy of the Rodin Museum.

polymers such as Kynar Aquatec® PVDF latex, can offer greater resistance to UV light, weathering, and degradation, and their expected lifetime is often significantly longer than organic coatings. In addition to providing improved performance, these water-based coatings often have reduced VOC components to meet government regulations. "It's an important need in the profession to get better performance and longevity out of the materials used in a restoration project in order to justify the cost of the renovation process, as was the case with the Philadelphia City Hall project," said Lins. "Accordingly, the long-term durability of a protective coating is what we are most interested in and the fluorocarbon latex technology can be expected to last not just five or 10 years but 15 to 20 years. We hoped to develop the product to the point where we could use it in the City Hall renewal project but, unfortunately, we couldn't finalize our evaluation in the short a period of time we had to complete the work."

As part of a 10-year master plan, the PMA and the Rodin Museum have been undergoing major renovations, which are essential components of a larger project to re-imagine and renew the entire Benjamin

Franklin Parkway as a preeminent artery for arts and culture. In 2007, work started on dramatically expanding and restoring the PMA's iconic neoclassical building. From 2008 to 2011, the exterior of the Rodin Museum was also completely rejuvenated, including the restoration of original metalwork and the façade of the building, as well as

the return of sculpture to the garden.

As work progressed on the renovations, the PMA was awarded a National Leadership Grant in 2008 by the Institute of Museum and Library Services (IMLS) to investigate protective coatings for the conservation of outdoor architectural and sculptural metalwork. Under the leadership of Andrew Lins and Dr. Tami Lasseter Clare,

who was by then an Assistant Professor of Chemistry at Portland State University, students in Dr. Clare's laboratory evaluated the performance of water-based coatings against traditional solvent-based acrylic coatings. Their comprehensive approach included accelerated and natural weathering studies, architectural metalwork applications at the museums, and a study of the candidate coatings by a group of experienced metal conservators throughout the country.

Museum Applications

The weathering studies of various candidate coatings on bronze and iron samples revealed that the coating based on the Kynar Aquatec® PVDF latex is highly resistant to damage by UV exposure and would increase the working lifetime of protective coatings. Following further scientific analysis, it was concluded that the best coating approach, one that could last three to four times longer than traditional methods, was a system using an acrylic primer base coat and a fluorinated (PVDF) top coat. "This hybrid coating system offers a



The Rodin Museum underwent a major renovation from 2008 to 2011 to completely rejuvenate the exterior of the building and its surrounding garden in the spirit of its original 1929 design.
Photo courtesy of the Rodin Museum.

much longer service life due to its extremely durable top coat," said Clare. "We tried to degrade the PVDF top coat, but it was so durable that we had to expose it to thousands of hours of weathering tests in an attempt to break it down."

With an optimum protective coating system now identified, the team moved to the next phase of the study – application to historic architectural metalwork that was being restored during renovations of the museums. At the PMA, the applications involved bronze Tiffany window frames and sashes, large ornamental bronze Tiffany window grilles, and bronze Tiffany light grilles. "All of these historic building components are very significant in that they are a rare example of the high-quality architectural metalwork designed and produced by the renowned Louis Comfort Tiffany and Tiffany Studios in Corona, NY," said Lins. Additional applications included bronze window frames that were being restored at the Rodin Museum, which were designed by Paul Cret.

Based on the high level of skill involved, Historical Arts and Castings, a company that specializes in large-scale historic metalworking and casting techniques, was selected to perform the restoration work on the PMA Tiffany metalwork. After the architectural metalwork was removed from the buildings and shipped to the company's facility in Utah, the pieces were restored following the process specified by the museum's conservators.

They first removed the interior support steel bars for the bronze extrusions and replaced them with silicon bronze rods, which are stronger than steel and have a lower galvanic coupling potential. The pieces were cleaned, patinated, dried, and coated with the acrylic base coat and a fluorinated (PVDF) top coat. "The reinstalled architectural Tiffany metalwork is now restored to an appearance very close to what it looked like when it was made in the 1920s," said Lins.



Workers reinstall the bronze windows at the Rodin Museum following cleaning and repatination.

Photo courtesy of the Rodin Museum.

Looking to the Future

As part of the IMLS grant, independent testing of the new coating system is now underway by other conservators who will provide feedback on its ease-of-use, appearance, and workability. Concurrently, weathering studies of the highly durable protective coating are continuing at the Science of Cultural Heritage Conservation at Portland State University, which focuses on improving performance, reducing environmental impact, and facilitating commercialization of new materials to make them widely accepted and available for use by conservators worldwide.

Ultimately, it is hoped that this investigative work will serve as a guide to conservators, caretakers, and preservation professionals in implementing new strategies for optimizing the protection of artistic and historic metalwork. "We are now in the final stages of the study and await final feedback from other conservators," said Clare. "If their findings are positive, which is what we expect based on our experience;

I would certainly recommend this new and improved coating system to other professionals who are looking for a very long-lasting, low-maintenance protection of outdoor metalwork applications."

About the Authors



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PVDF latex. He holds a B.S. in mechanical engineering from Drexel University and a business certificate from The Wharton School of the University of Pennsylvania. In his 31 years at Arkema, Vince has been market manager and technical service engineer for the Plexiglas® acrylic and Tuffak® polycarbonate sheet products and he has held positions in acrylic coatings manufacturing and R&D.



Kurt A. Wood is a principal scientist in Arkema's Fluoropolymers R&D Division. He received a Ph.D. in physical chemistry from the University of California at Berkeley.

Dr. Wood has worked in the polymers and coatings area since 1989 and has worked on the development of new coating systems based on Kynar® PVDF since 1996. Areas of interest include waterborne coatings, cross-linking technologies, and weatherability prediction for coatings.

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Spaceport America,
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Tiffany window
frames and grilles,
Philadelphia Museum of Art.

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