Study of pH-sensitive and reversible aqueous acrylic coatings for cultural heritage.

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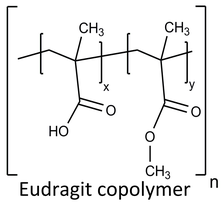
Abstract

Transparent coatings can provide additional stability and protection to outdoor heritage, such as historic buildings, public murals, and sculptures. Recent tightening of VOC (volatile organic content) regulations in the United States have limited the variety of coatings permitted for outside application and preservation use and impacted the use of solvents during conservation treatments. Coatings that are applied with the use of organic solvents, such as mineral spirits acrylics, may be "grandfathered in" for use by government officials, as was the case as the 2011 restoration of Michael Webb's *St. James Church*. Older solvent-based coating systems require the application of addition solvent to remove the aged, brittle, or physically degraded surface coatings, which can present a roadblock to receiving a VOC-exemption when conservation of cultural heritage is performed outside. VOC exemptions are gradually becoming more difficult to obtain and are often issued on a per treatment basis. The development and study of aqueous-based coating systems is in direct response to the increasing demanding path for approval of organic-coating systems on conservation work sites.



Eudragit copolymer

pH-sensitive methacrylic acid and methyl-methacrylate co-polymers from the medical coating industry are combined with different ratios of plasticizers and UV protective additives to create stable, non-yellowing, reversible coatings. The coating can be applied in a slightly basic aqueous solution and then can be removed using an aqueous solution within the pH sensitivity range. The manipulation of copolymer concentration and other additives result in a range of pH sensitivity (pH 5.0-7.5) that may prove useful as a sacrificial or protective coating for artworks, particularly outdoor public murals that require coating renewal every 10-15 years.

Coating Use on Outdoor Cultural Surfaces

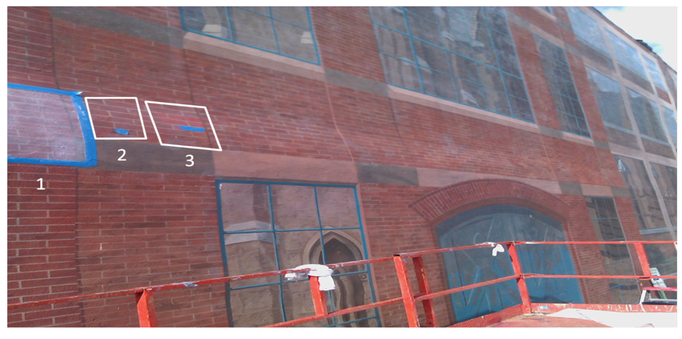
Coatings can help fortify the surfaces they cover, but they can also add stress and hinder water transport if an unsuitable coating is selected for a project or building. Investigations such as this poster are intended to determine which coatings are compatible with historic or painted surfaces and which aged coatings can be safely removed. For example, more damage (e.g. peeling, flaking, yellowing) was done to public murals in the 1990s through improper or incompatible coating application than would have been caused by caused by actual graffiti. Similarly, coatings on historic brick or granite buildings have caused significant visual and structural defects, such as spalling, as a direct result of insufficient vapor transmission after coating application. These unintended negative effects were often due to a lack of research and consensus on the quality and efficacy of the materials promoted as protective architectural coatings.


Kent Twitchell, *Bride and Groom*, Los Angeles, 1972-76, as seen in February 2009.

Guidelines for Coating Selection

Guidelines for selecting optimal coatings for outdoor heritage can vary program to program and conservator to conservator, but several generalizations can be made to aid in the decision-making process. Coating selection is dependent on the results expected with use of the coating: retreatability/reversibility, re-saturation, gloss adjustment, graffiti protection, and chemical, fade, or scratch resistance. Selection of coating class may also be based upon ease-of-application, and safety of personnel, and intended maintenance schedule. Other factors must be considered when choosing a protective coatings, such as:

1. substrate applicability (film flexibility and strength, adhesion)
2. surface aesthetics (color, clarity,, surface morphology)
3. time-appropriate film formation
4. thermally stable and non-yellowing
5. offers significant barrier protection, yet allow for water and vapor transmission



Coating tests on Michael Webb's *St. James Church*, Philadelphia, 2011.

Legend for above:
1. Fresh application; 2. One coat, dried; 3. Two coats, dried

Coating Formulations

An added factor for the environmentally-friendly formulations being developed was that the coating must be reversible using aqueous methods, with the intended pH-sensitivity for removal to be above pH 8.5. Evonik's L100 (MA-MMA copolymer (1:1) and S100 (MA/MMA copolymer (1:2)) resins were selected due to their pH-sensitivity above pH 6.5-7.0. This means that if the coating could be manipulated to a sensitivity range above pH 8.5, the coating would be soluble in basic conditions, yet would not be soluble during wet weather conditions, as rain and snow in urban environments typically ranges from pH 4.5-6.5.


To vary the strength and elasticity of the coatings and the ability to form a clear, transparent coating, the amount and type of plasticizer and anti-tacking agent were adjusted. However, some formulations using triethyl citrate as a plasticizer tended to become less basic with aging and was partially solubilized with rainwater in outdoor trials. Formulations mixed with proprietary Evonik FS 10 plasticizer/anti-tacking agent solution performed best in the application and removability trials, and these coatings were able to be modified with added UV stabilizers for enhanced UV protection.

Conclusions

With the intent to develop a new conservation coating that was transparent, matte, stable, outdoor UV-protective coating with optimal adhesion, hydrophobicity, environmental compliance, and aqueous cleaning potential, the polymeric base for the project was selected due to its pH-sensitivity above pH 6.5. However, there are still some portions of the formulation that needs to be further developed, such as sustained pH-sensitivity above pH8.5, before the coating is ready for conservation treatments.

Acknowledgements

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