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New Coating Technology for Graffiti Prevention

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Introduction

Without a doubt railroads have a lot of moving pieces. In the US alone, there are about 39,500 locomotives, 1,600,000 freight cars and 20,000 passenger cars. While many of us are enthralled to watch these marvels of transportation roll by, graffiti artists see the miles of metal as a never-ending canvas. Rolling stock has become a target of choice due to relatively easy access, large surface areas and the concept of a canvas-on-wheels. For years, much of the "tagging" was done on freight and tanker cars that sat unattended in the railroad yard or at a siding. But graffiti artists are becoming more aggressive in their tactics, painting the outside and even cabs of locomotives. Reporting marks that are painted over can result in identification issues and even fines.

Graffiti removal or re-painting is expensive and time consuming. While many types of anti-graffiti coatings have been employed in the past, an opportunity exists for new technology that can better address the issue of graffiti in the railroad industry. An advanced ceramic coating has been developed that combines three functions in one. 1) It is highly hydrophobic and oleophobic, meaning that oil-based or water-based paints will not stick 2) The ceramic coating acts as a hard topcoat with 9H hardness, protecting the underlying paint from scratches and marring and 3) Provides UV protection to underlying coatings and other surfaces.

*Although graffiti can be applied by spraying, rolling, brushing or other means, for the purpose of this presentation we will refer to spraying only.

Graffiti Removal

The processes currently used to remove graffiti are complex, expensive and time consuming:

1. **Pressure Washing:** Either hot water or solvent solutions added to water can be effective, but performance often depends on the type of graffiti paint that had been used. Pressure washing can also wear down or damage the underlying coating. When large amounts of solvents are used safety and environmental issues must be addressed.
2. **Chemical Removers:** This type of removal type will often etch, mar or otherwise damage the underlying surface, often leaving a haze or outline of the cleaning process.
3. **Spray Painting:** Graffiti can be covered over by re-painting or spot painting. MEK or other paint thinners may be used to first remove the graffiti, but this process carries inherent safety and environmental risks. Sandblasting can be used for removal but requires a large investment in time and resources.

Unfortunately, all re-painting methods can be viewed as a short-term solution since it leaves a fresh canvas for new graffiti.

Current Anti-Graffiti Coating Technology

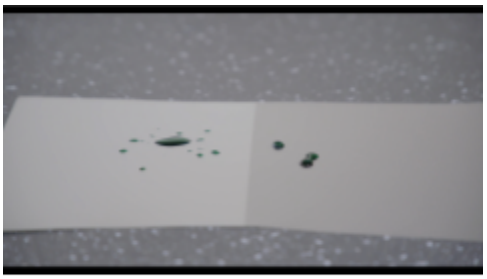
1. **Sacrificial coatings:** These coatings form a clear coat "barrier" over the surface being protected. If graffiti is sprayed on, the coating can be removed or "sacrificed," using a high-pressure washer. The graffiti goes away with the coating.

Materials used to make sacrificial coatings are usually inexpensive, optically clear polymers such as acrylates, biopolymers, and waxes. These polymers form weak bonds with the substrate in order to facilitate easy removal. They also often help protect against corrosion and certain types of environmental damage. Since sacrificial coatings must be reapplied right after removal to provide ongoing protection, long term cost can be substantial. Reapplication can be frequent.

2. **Semi-sacrificial coatings:** These act as a sealer to protect the pores of the underlying paint coating. If graffiti is sprayed over the coating, it can be removed using a combination of a solvent and pressure washer. Typically, these coatings need to be reapplied every other time graffiti is removed.

3. **Permanent clear coatings:** These provide a barrier so graffiti cannot permanently adhere to the underlying paint. This type of coating has been made from acrylics, polyurethanes, fluorinated hydrocarbons, or siloxanes and each one works a little differently. Since most of these coatings are made from "conventional" polymers they carry over drawbacks inherent in those polymers. For example, coatings break down from UV, they can degrade from temperature exposure and they can be affected by chemicals in the air. Typically, solvents or other solutions are used to remove the graffiti, often with a pressure washer. Over time, these can damage the clear coating.

New Technology


No Coating With Coating

New anti-graffiti coating technology has been developed that could offer many benefits to the railroad industry. It is based on a unique ceramic polymer technology that was developed for use in the electronics industry. At that time, there was a need for a coating that was 1) Extremely abrasion resistant 2) Resistant to practically all chemicals 3) Easy to apply and 4) Cost effective. Ceramic polymers are by definition, not carbon-based. In this case, the polymer is primarily silica and so has many of the performance benefits of silicon-based materials, such as inertness, temperature resistance and UV stability. Functional groups are added to the polymer to develop application specific properties. These coatings are engineered to be very hydrophobic and oleophobic, quantitively more than PTFE, yet they can be conveniently spray applied to form very thin clear coatings, that dry quickly and adhere to practically any surface.

From this platform chemistry a permanent anti-graffiti coating (hereafter referred to as slick technology,) was developed for use on unpainted or previously painted surfaces. General properties of this coating compared to other coating types are shown in Table 1.

	Slick Technology	Acrylic Paint (Typ*)	Epoxy Paint (Typ*)
Contact Angle (water) ASTM D7490	107	70	75
Contact Angle (n-hexadecane) ASTM D7490	63	-	-
Hardness ASTM D3363	9H	3H	4H
Adhesion D3359 (CRS)	5B (no loss)	4	5B (no loss)
UV Resistance QUV, ASTM G154	3000 hrs.	-	-
Yellowing/Cracking from UV	No	Yes	Yes
Salt Fog Resistance, ASTM B117, steel	Excellent	Good	Good
Number of Parts (1-part, 2-part)	1	1	2
Viscosity	Very Low	Mod	Mod-High
% Solids	23	40	75
Thickness	3-4 micron	100 micron	225 micron
Tack-Free Time	20 min	1 hour	7 hours
Cure Time (@73ºF)	12 hrs.	2 hours	7 days
Coverage, ft^2/gal	2200	400	400
VOC g/L	VOC Free	92	240

Table 1

*Typical Formulation

Preparation, Application and Equipment

The new coating requires no special surface preparation methods required beyond what would be needed for a clear topcoat. Bare metal surfaces should be thoroughly cleaned with a typical water-based alkaline cleaner, rinsed and dried. Previously painted surfaces should be prepared according to standard methods for any repainting operation. Any previously applied anti-graffiti coating may need to be removed of scuffed. Ventilation, PPE and other safety precautions typical for solvent-based paints should be used. The coating uses environmentally-friendly VOC compliant solvents i.e. solvents that are considered non-VOCs by the EPA and do not contribute to global warming. No coalescents, additives or amine neutralizers common to waterborne coatings are used.

The coating can be applied by conventional HVLP equipment set for fine atomization. It can be applied relatively quickly since only 3-4 microns dry film are required for full performance. Typically, other coatings require 50-200 microns or more (2-8 mils.) Coatings are tack-free in 20-30 minutes and begin to cure right away at room temperature. 7H hardness is achieved after 18 hours and 9H hardness after 72 hours. Coatings are rainproof in 12 hours or less.

How the Coating Works

The coating can be considered a hybrid coating because it integrates three functional layers that begin to structure upon application. At the substrate interface, there is a nanometer thick layer that chemically binds to the substrate through -OH groups. Above that is a ceramic layer that imparts hardness, chemical resistance, corrosion, and scratch resistance. The top surface imparts hydrophobicity, oleophobicity, and chemical resistance.

The ceramic backbone is unaffected by UV and thus resistant to degradation. No adverse effects are observed in over 3000 hours of ASTM G154 QUV testing. The coating can also be viewed as a UV protective barrier to the underlying paint. The coating is very hard at 9H and resists scratching, marring and scuffing that is seen with conventional coatings. It withstands pH of 2-14 for long periods of time as shown in immersion tests and is resistant to most solvents. This means greater efficiency, reduced maintenance, longer life and ultimately significant cost savings.

Spray Paint Will Not Wet Out

This technology offers a form of graffiti protection that is different from other approaches. Most anti-graffiti coatings permit graffiti to be painted on but allow for easier removal. In this new approach, the low surface energy and ceramic structure make the coating totally resistant to both water-based and oil-based materials, such as paints, markers and crayons. These materials cannot wet out on the surface and will simply bead up and fall off. When dry, any residue can simply be wiped off or removed with low pressure water spray. Since the coating prevents paint and inks from adhering, a tagger will quickly find his efforts useless and give up.

Another potential application is the selective protection of reporting marks. The coating can be easily applied using a small format HVLP gun or an aerosol can so that a car or locomotive's important marking can be rendered graffiti-proof in a few seconds. Locomotive cabs can also be coated, quickly rendering it graffiti-proof from markers, crayons and paint.

Finally, an important point is always cost. In considering this technology, both short and long-term costs should be evaluated. Although ceramic chemistry is inherently more expensive, coverage per gallon is typically 5-6 times higher. Because the coating is UV, chemical and scratch resistant it offers an overall paint upgrade and will offer graffiti repellency for many years.

Conclusion

Graffiti continues to be a major challenge for the railroad industry with significant dollars being spent on graffiti prevention and removal strategies. A new type of coating has been developed that prevents the graffiti artist from forming graffiti in the first place. If the tagger cannot form an image he will quickly move on. Important reporting marks as well as locomotive interiors can easily be protected. Because the coating is applied one time and is ultra-thin, it offers a cost-effective alternative for graffiti protection and deterrence. A high level of UV resistance offers additional protection to underlying coatings. We hope to report results from additional field testing in a future article.