ASTM A-1055 Innovative Research

Sherwin-Williams Rebar

October 28, 2020

SHERWIN-WILLIAMS®

Sherwin-Williams Protective & Marine Overview

SHERWIN WILLIAMS

GLOBAL SEGMENTS

Oil & Gas

Civil Infrastructure

Petrochemical

Water / Wastewater

Flooring

Fire Protection

Food & Beverage

Power

Functional Coatings

Pharma

REGIONAL SEGMENTS

Freight Rail

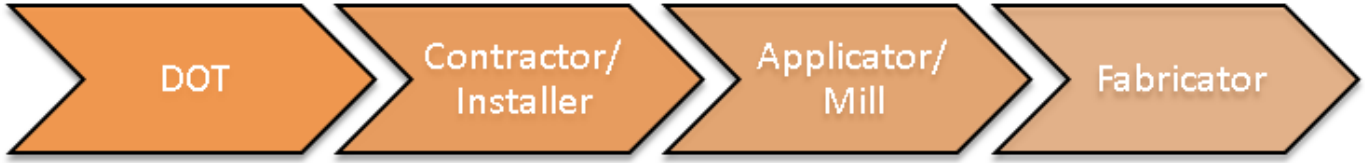
Mining

Bridge & Highway

Pulp & Paper

Marine

Rebar Supply Chain



Epoxy Coatings

- Fusion Bonded Epoxy
  - Greenbar (ASTM A775)
  - Purplebar (ASTM A934)
- Epoxy over Continuously Galvanized Rebar (ASTM A1055)
- Rebar Patch Materials

ASTM A1094 (Continuous Galvanized Reinforcement)

Designation: A1094/A1094M

Standard Specification for Continuous Hot-Dip Galvanized Steel Bars for Concrete Reinforcement

- Continuous Galvanizing process yields consistent, formable zinc coating
- Thicker pure zinc coating increases corrosion initiation threshold
- Bending, fabricating with no special equipment

ASTM A775 (GREENBAR Epoxy)

Designation: A775/A775M

Standard Specification for Epoxy-Coated Steel Reinforcing Bars

- Epoxy Coating provides consistent, formable epoxy film coating
- Epoxy coating is barrier coating which provides excellent corrosion resistance
- Epoxy supply is easily available through multiple coaters in the existing supply chain

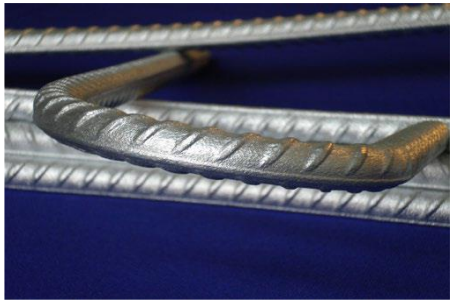
ASTM A1055 (GREENBAR Epoxy over Galvabar Continuous Galvanized)

Designation: A1055/A1055M

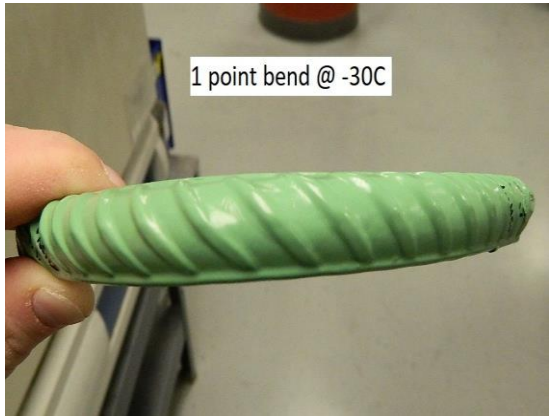
Standard Specification for

Zinc and Epoxy Dual-Coated Steel Reinforcing Bars

- Both technologies provide consistent, formable coating through a formable epoxy coating over zinc coating
- Both technologies increase corrosion resistance through a barrier coating and sacrificial coating
- Both technologies can be easily available through multiple coaters in the existing supply chain



Rebar Powder- Innovations, Epoxy over CGR



Bend test @ -30C

180° Bend on 2.5” Pin

- High Performance product to testing for 100+ year life cycle
- Exhibits superior adhesion over continuous galvanized rebar compared to existing powder technologies
- Cost-effective coating in high performance applications
- Collaboration with DOTs & TAMU for independent evaluation

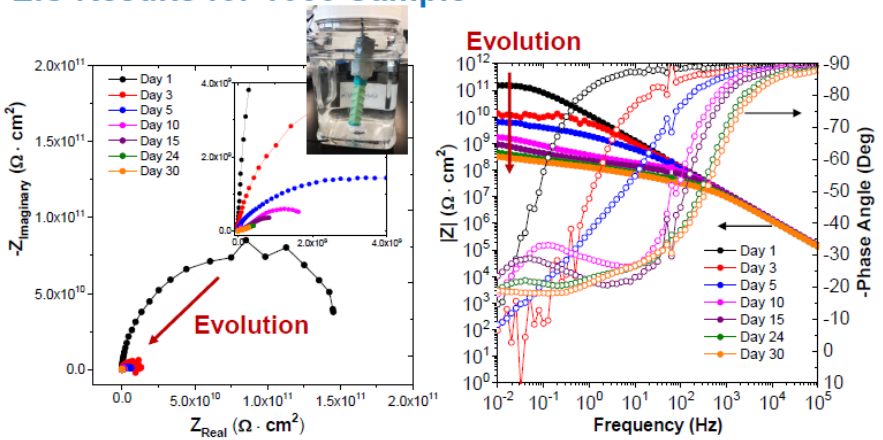
Texas A&M CIR Research in Progress

ASTM A1055 Continuous Immersion Test

Continuous Immersion Test

MATERIALS SCIENCE & ENGINEERING
TEXAS A&M UNIVERSITY

EIS Results for 1055 Sample



Cyclic Fog Chamber Test

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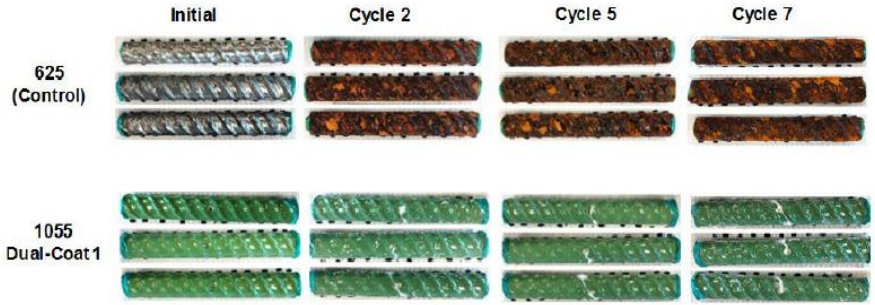
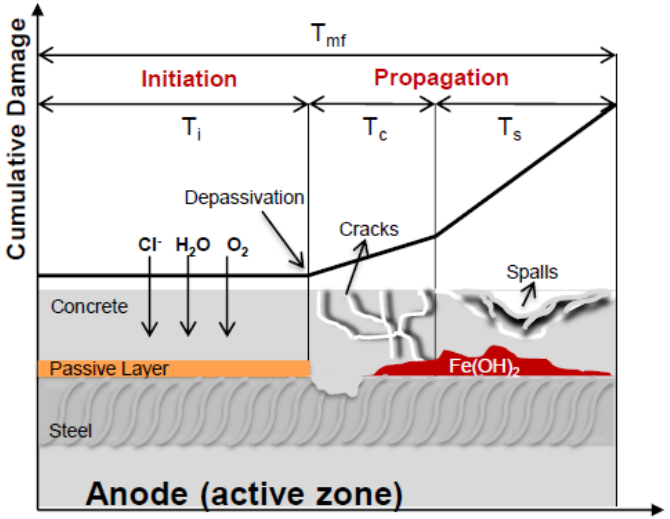


High impedance values due to excellent barrier protection, however impedance decreased overtime as a result of water penetration and initiation of corrosion processes at the carbon steel substrate (presence of a second time constant after 10 days of immersion)

A1055 Protection model Long-term



Anode (active zone)

$$Fe \rightarrow Fe^{2+} + 2e^-$$

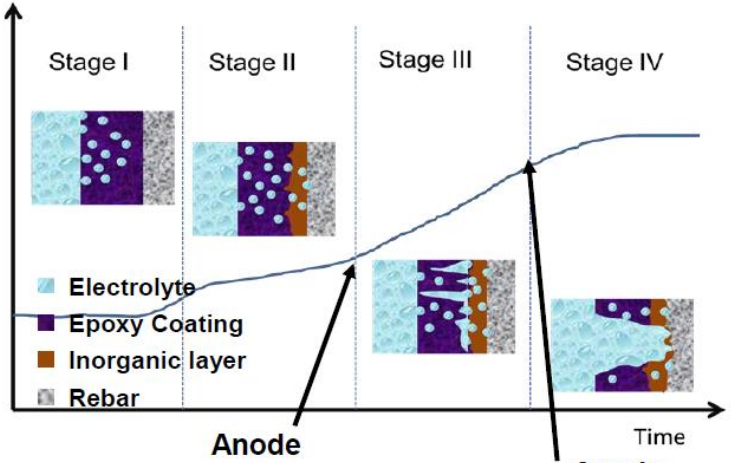
$$Fe^{2+} + 2Cl^- \rightarrow FeCl_2$$

$$FeCl_2 + 2H_2O \rightarrow Fe(OH)_2 + 2H^+ + 2Cl^-$$

Cathode (passive layer)

$$2H_2O + O_2 + 4e^- \rightarrow 4OH^-$$

Rebar 1055 Protection for long-term



Anode

$$Zn \rightarrow Zn^{2+} + 2e^-$$

Cathode

$$2H^+ + 2e^- \rightarrow H_2$$

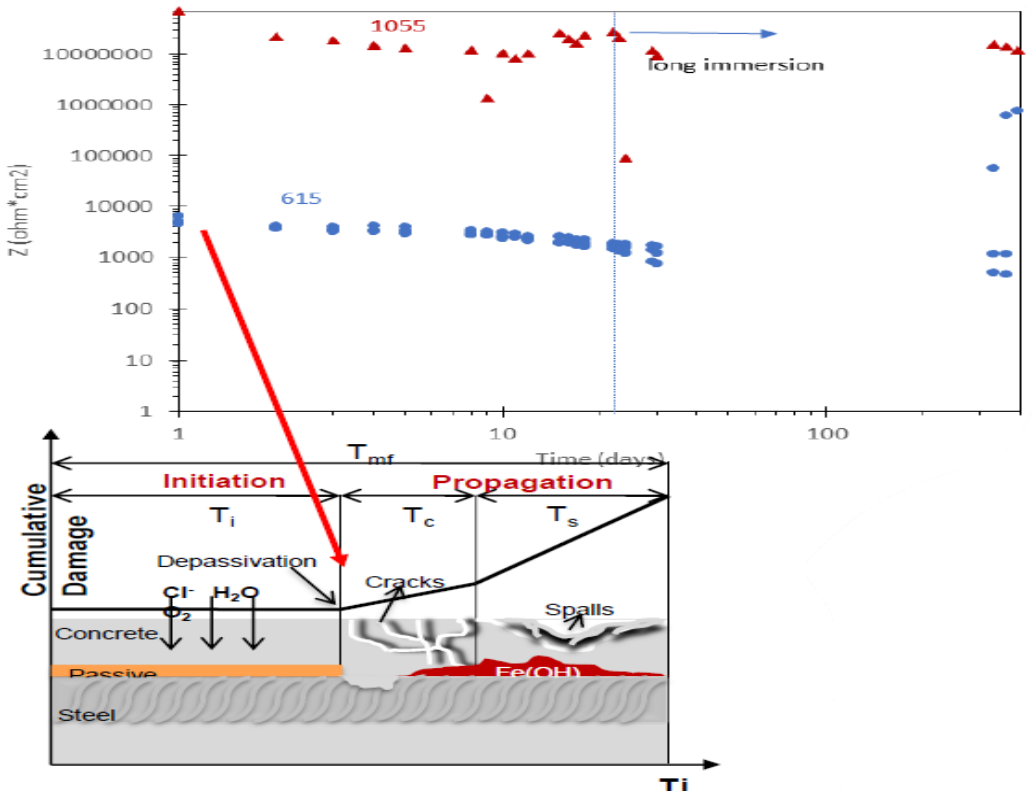
Anode

$$Fe \rightarrow Fe^{2+} + 2e^-$$

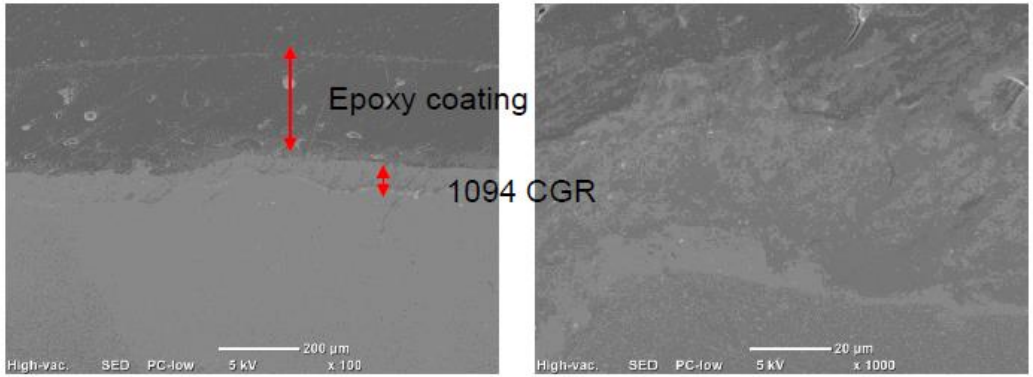
Cathode

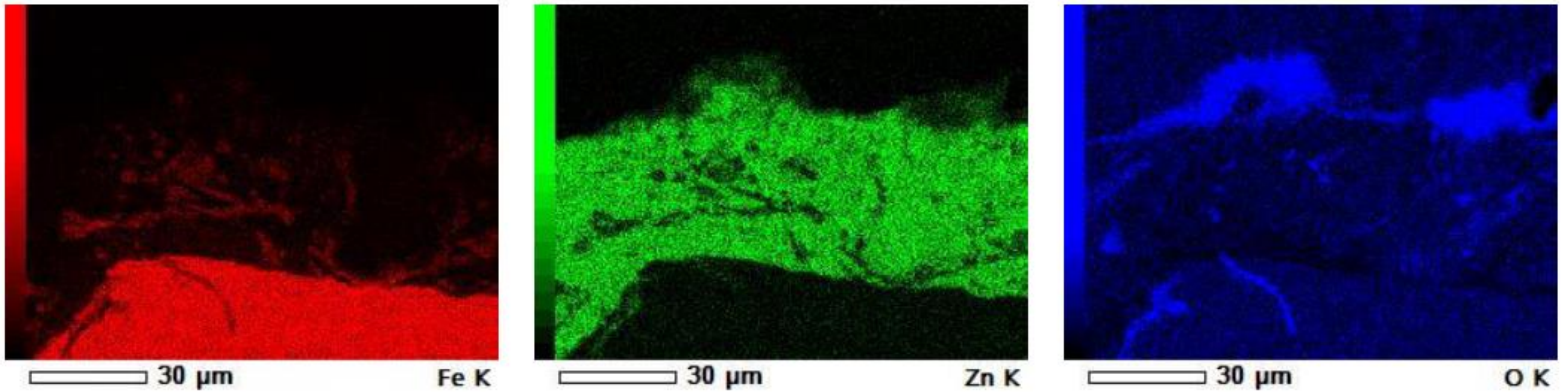
$$2H_2O + O_2 + 4e^- \rightarrow 4OH$$

Continuous Immersion Test



Cyclic Fog Chamber Test w/ out damage

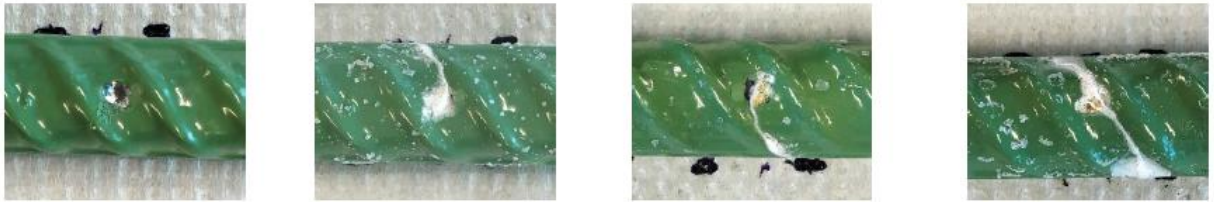


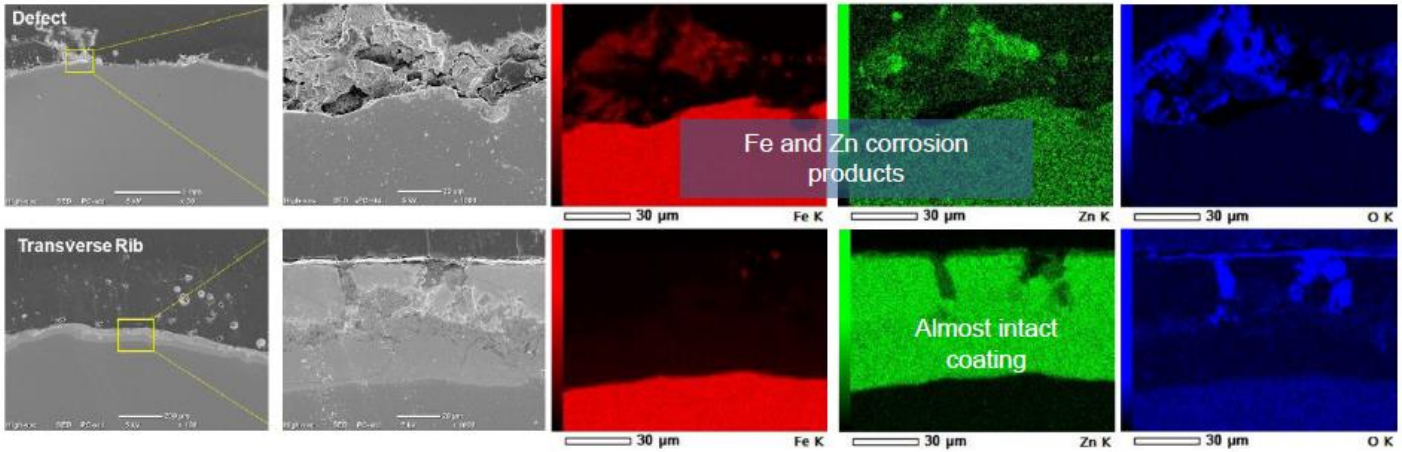


Cyclic Fog Chamber Test w/ damage

Effective barrier protection and sacrificial protection for defect

1055 Dual-Coat





Conclusion

- Highly innovative product that raises the performance bar to new standards
- Internal results show significant corrosion enhancements from epoxy over CGR
- Enhanced barrier resistance from an added layer of epoxy coating
- Sherwin-Williams' powder product shows superior adhesion and flexibility over CGR compared to existing powder technologies

- Compiled results so far indicate a cost-effective coating for high performance applications w/ potential to replace SS bars
- Independent evaluation results forthcoming from TAMU
- Interest from several DOTs to evaluate A1055 (Epoxy over CGR) system