Corrosion Mitigation and Control at NASA Kennedy Space Center

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Introduction

The launch environment at KSC is extremely corrosive:

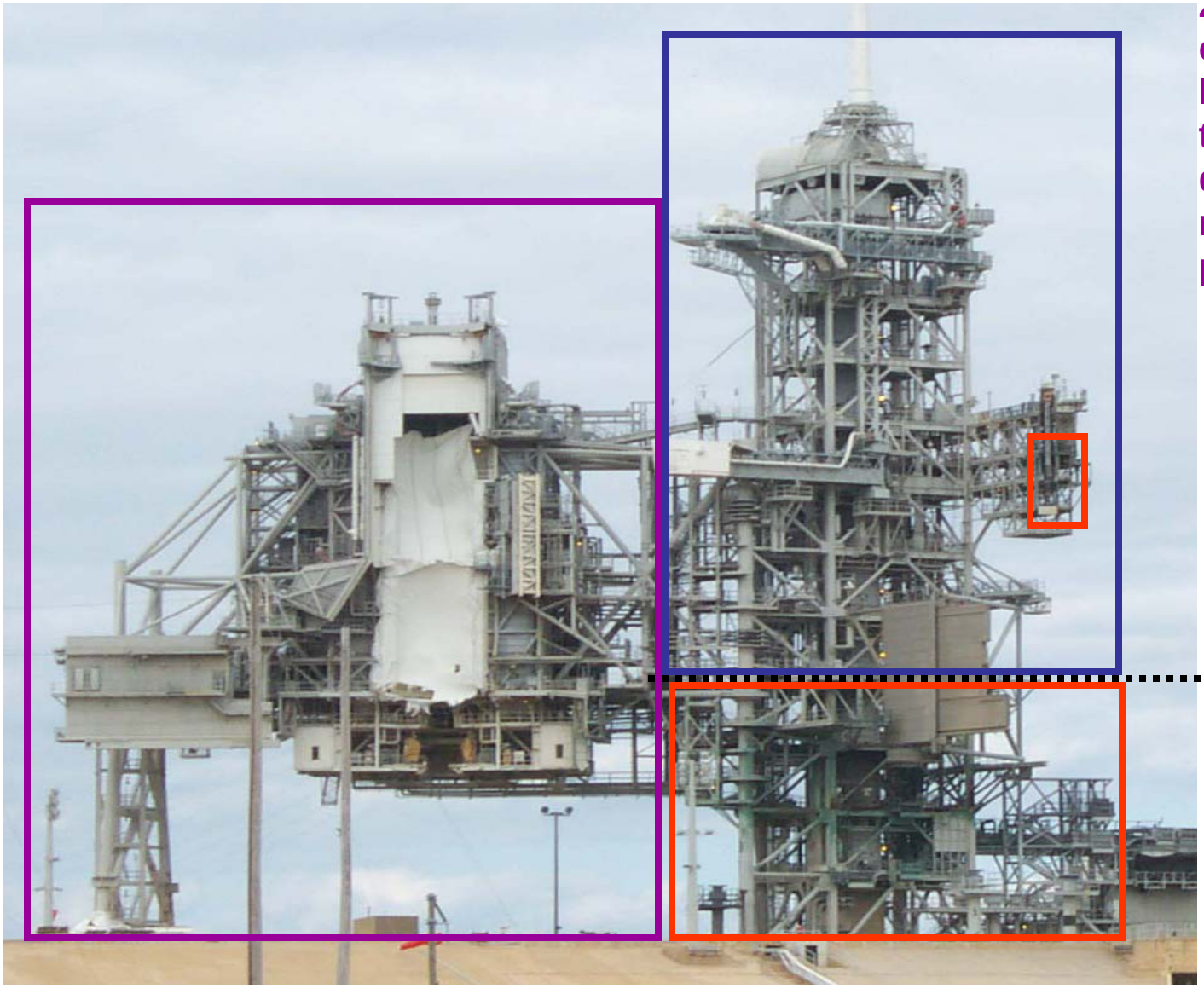
- **Ocean salt spray**
- **Heat**
- **Humidity**
- **Sunlight**
- **Solid Rocket exhaust**

Launch Complex 39A & 39B


In 1981 the Space Shuttle introduced acidic deposition conditions
SRB Exhaust
USA

Launch Complex After Launch

Launch Complex 39 Zones of Exposure



Zone 3: Surfaces, other than those located in Zones 1 or 2, that receive acid deposition from solid rocket booster exhaust products

Zone 2: Surfaces that receive elevated temperatures and acid deposition from solid rocket booster exhaust with no exhaust impingement.

FSS 115” Level

Zone 1: Surfaces that receive direct rocket engine exhaust impingement.

Corrosion Mitigation of Launch Structures

- Cost of launch scrub is about $1 million
- Yearly launch complex maintenance is about ???
- Major launch complex refurbishment cost about ???

Corrosion Control and Mitigation

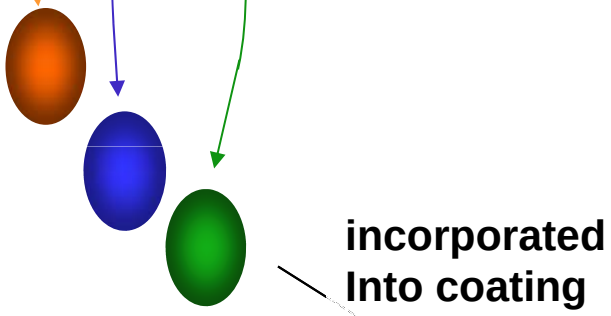
- **NASA STD-5008: Protective Coating of Carbon Steel, Stainless Steel, and Aluminum on Launch Structures, Facilities, and Ground Support Equipment**
  - **Establishes practices, methods, and procedures for the protective coating of GSE and related NASA facilities.**
  - **Contains the Qualified Products List**
- **Coating Development**

NASA STD-5008 QPL Qualification Process

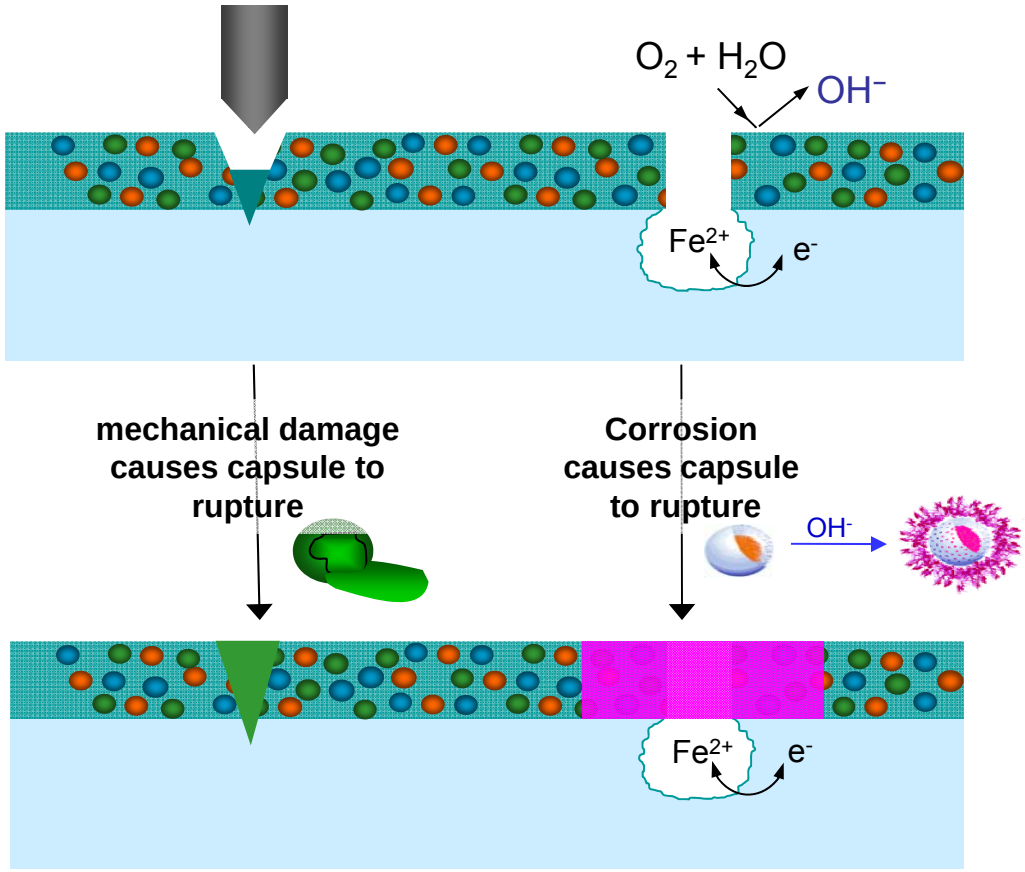
- **Atmospheric testing at the Corrosion Technology Atmospheric Test Facility**

Smart Coating Development Concept

1. Corrosion indicators
2. Corrosion inhibitors
3. Healing agents

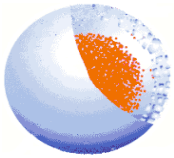


incorporated
Into coating



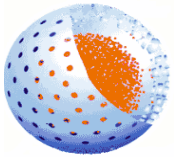
Ruptured Microcapsule:
- **indicates corrosion**
- **protects metal from corrosion**
- **repairs damaged area**

pH Sensitive Microcapsules



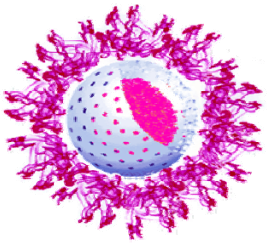
Microcapsule containing pH indicator (inhibitor, self healing agents)

OH^-

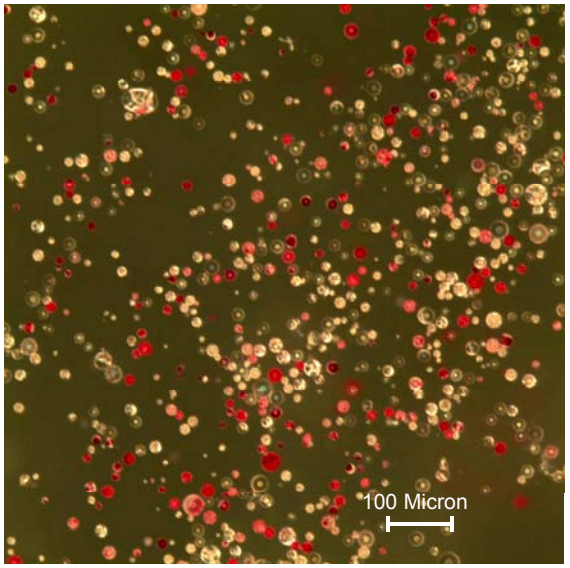


The shell of the microcapsule breaks down under basic pH conditions through the ester hydrolysis reaction

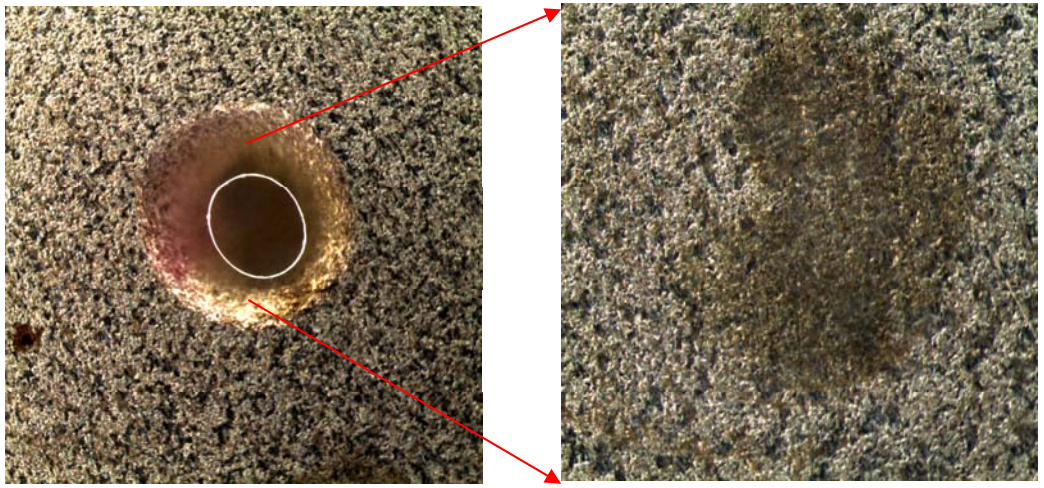
OH^-



pH indicator changes color and is released from the microcapsule under basic conditions



Color change due to Microcapsules in solution responding to basic pH conditions



Microcapsules in solution indicating presence of localized corrosion on carbon steel substrate

Conclusions

- **Corrosion Control and Mitigation for NASA Kennedy Space Center**
  - **NASA STD-5008 procedures**
  - **Atmospheric Coating Testing**
  - **Coating Development**
- **Taking advantage of new and improved technologies could dramatically reduce expensive corrosion related repairs and possible catastrophic failures.**

Acknowledgements

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