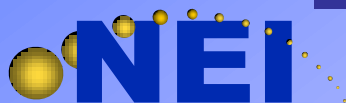


Novel Self-Healing Nanocomposite Coatings

DOD Corrosion Conference 2011

August 2, 2011



NEI Corporation

Dr. Robert A. Iezzi

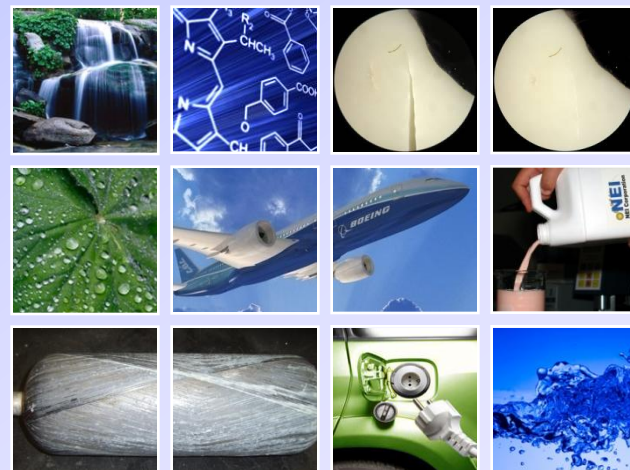
Vice President, Coating Technologies

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www.neicorporation.com

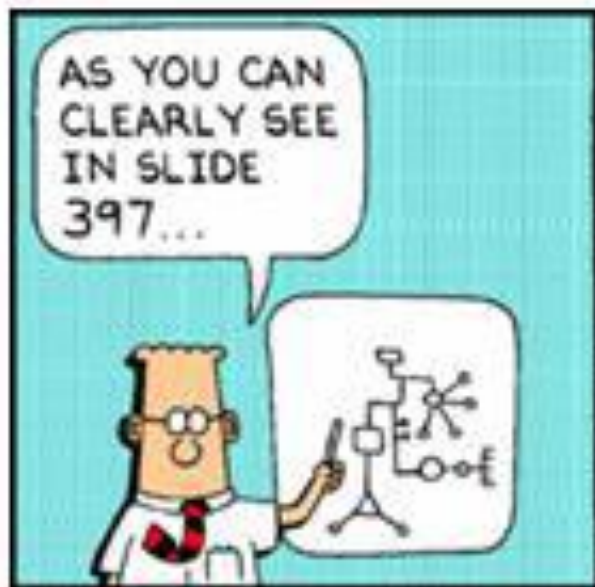
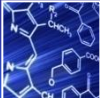
NEI Proprietary Information





Outline

- **Brief Overview of NEI Corporation**
- **NEI Self-Healing Technical Platform**
 - **What Do I Mean by Self-Healing?**
 - **Why is Self-Healing Important?**
 - **Self-Healing Technical Approach**
 - **Self-Healing Results**
 - **Benefits of Self-Healing Coatings**
- **Summary**

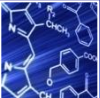


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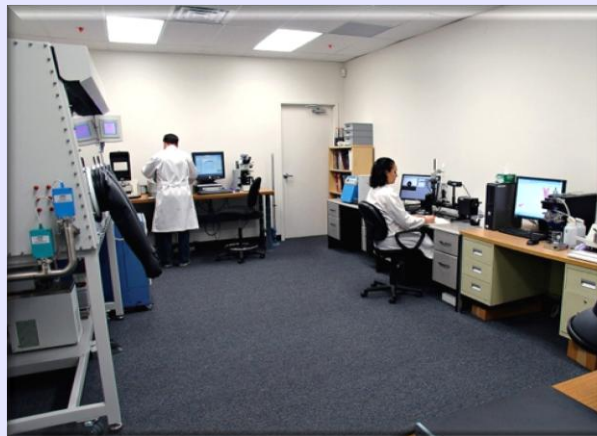
NEI Corporation Overview



Key Highlights

13 Years Using Nanotechnology to Create Novel Products

- 15,000 ft² in two locations in NJ
- 45,000 ft² factory in India for Battery market
- Spun-out American Nanomyte for Self-Healing Coatings
- >20 patents (approved and pending)





NEI Core Competencies

- **Nanotechnology Specialists**
 - Bridge gap between science and applications
- **Primary Sectors**
 - Industrial
 - Energy
 - Environmental
 - Contract Research



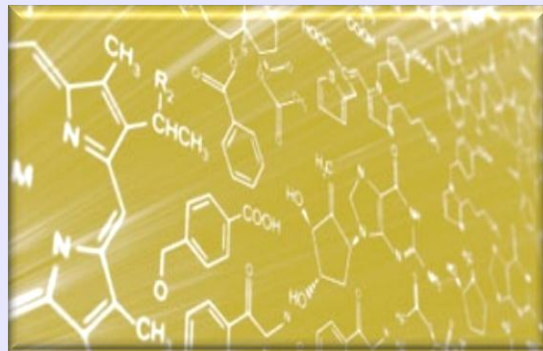


From Research to Products

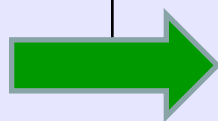
**Institutional
Contract R&D**



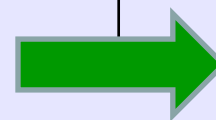
**Materials
Development**



Products

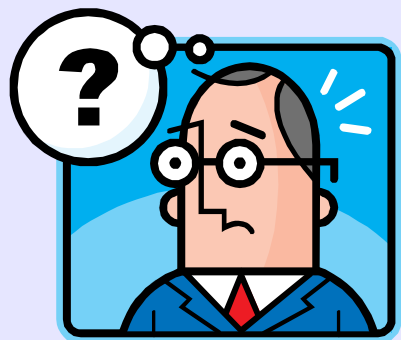


**Outside-In
Focus**





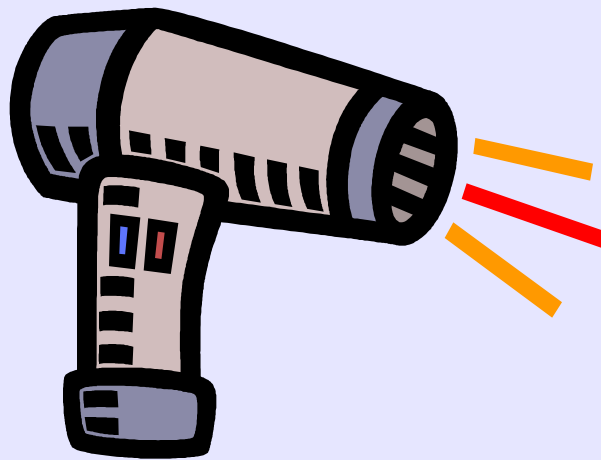
What Do I Mean by Self-Healing?





What Do I Mean by Self-Healing?

**Repair a scratch or small damaged
area in a polymer coating by the
application of a small amount of heat**



**30 – 60°C
Few seconds**



Why is Self-Healing Important?





Why is Self-Healing Important?

- **Two important functions of polymer coatings**
 - **Aesthetics**
 - **Protection**
 - **Protects the substrate from moisture, mechanical, and chemical damage**





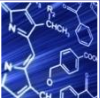
Why is Self-Healing Important?



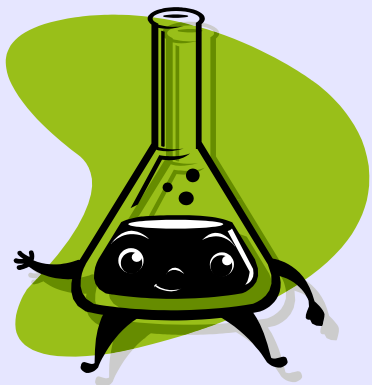
- **Routine wear and tear**
 - Surface scratches in coating generated
 - Micro-cracks develop
 - Lead to macroscopic damage

Coating loses its aesthetic & protective functionality

Shortens service life



Self-Healing Technical Approach

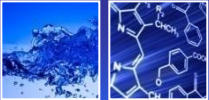




Self-Healing Technical Approach

- **Polymer-based, nanocomposite formulation**
- **Novel, proprietary morphology**
 - **Drives self-healing phenomenon by application of warm air (e.g., simple hair dryer) for a few seconds**





Self-Healing Results





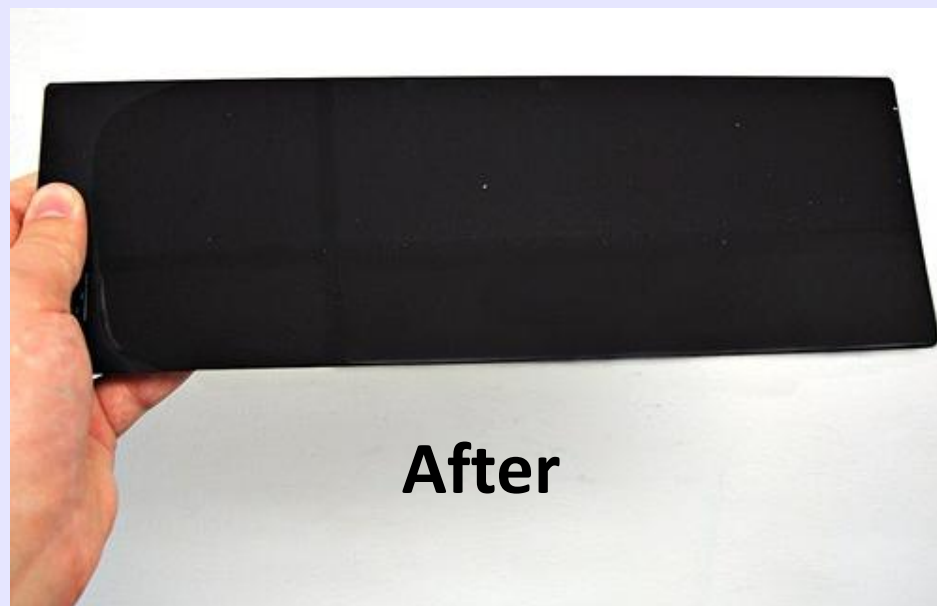
Self-Healing Results

Clear PU-based nanocomposite coating on a black steel panel with significant surface damage

Fine Scratches Deep Scratches



Before



After

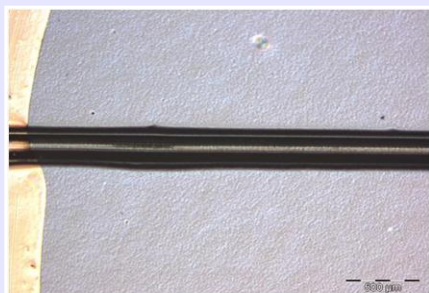
Thermal healing treatment
(~60°C for less than 5 seconds)



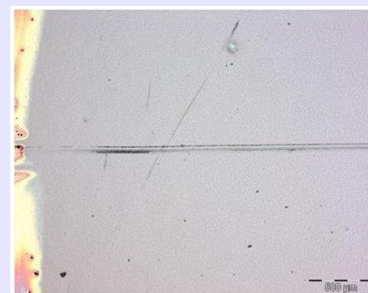
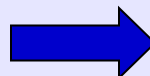
Self-Healing Results

Healing of Shallow, but Wide Scratch

PU/Nanocomposite Coating

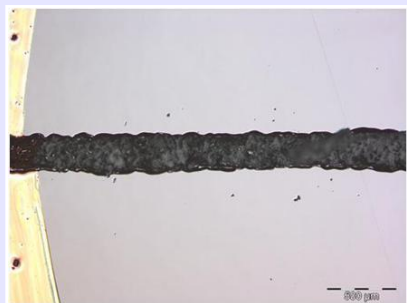


Before Healing

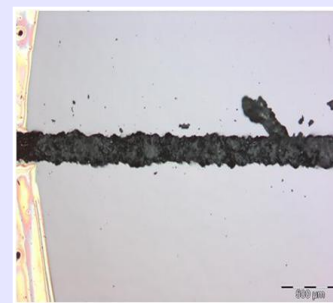


After Healing

PU Control



Before Healing



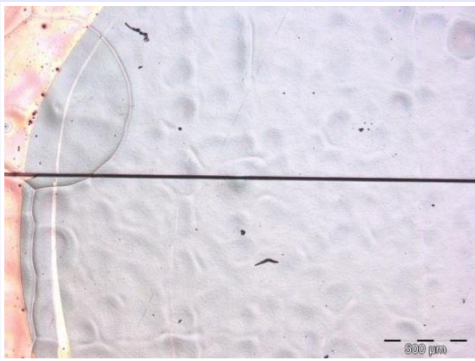
After Healing



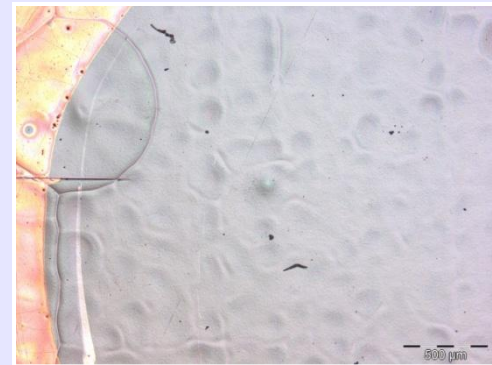
Self-Healing Results

Healing of Deep, but Narrow Scratch (Razor Blade Cut)

PU/Nanocomposite Coating

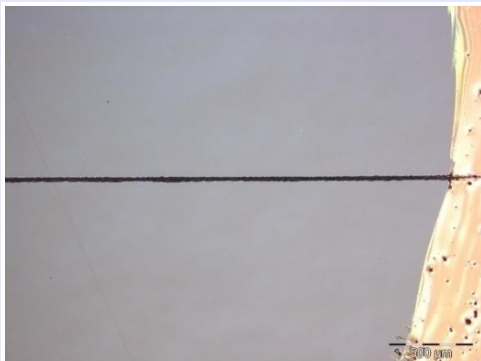


Before Healing



After Healing

PU Control



Before Healing

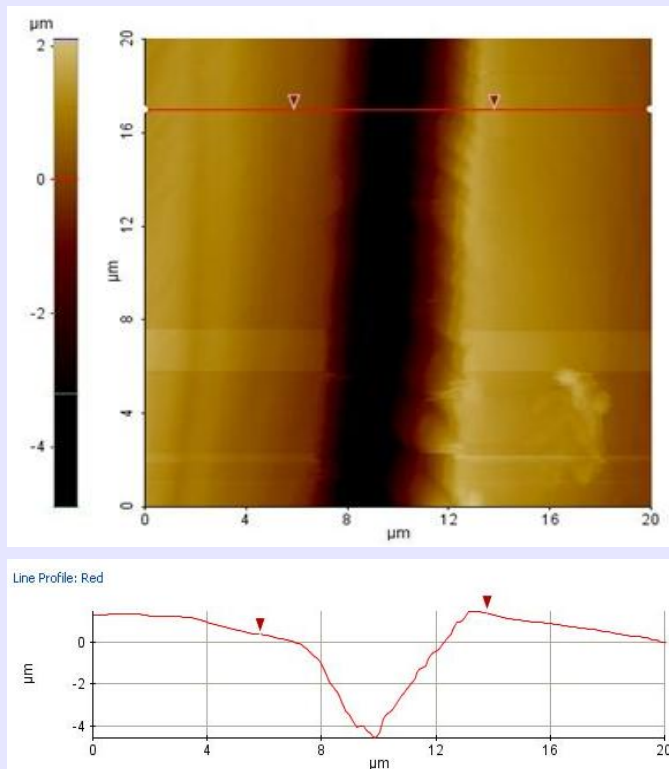


After Healing

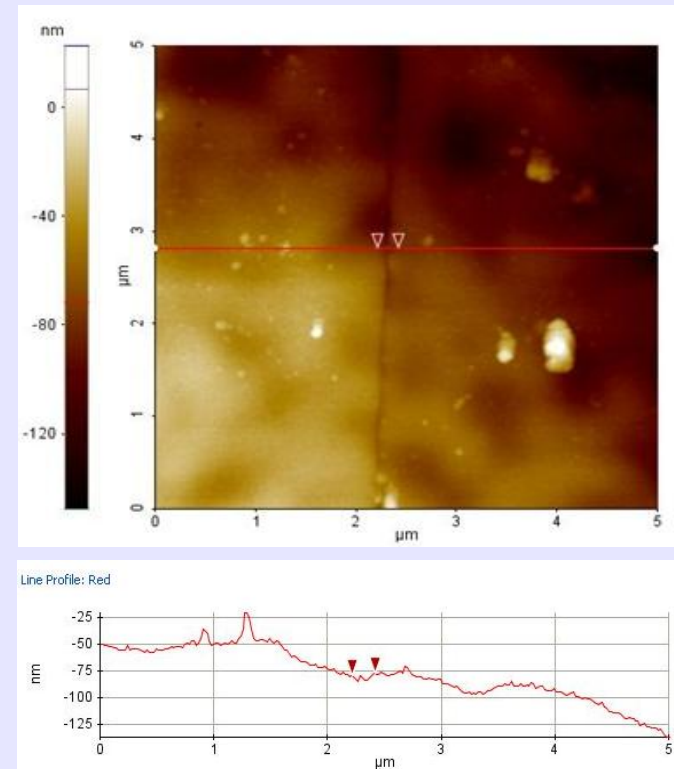


Self-Healing Results

AFM - Original Crack - $\sim 5\ \mu\text{m}$ wide x $\sim 6\ \mu\text{m}$ deep



Before Healing



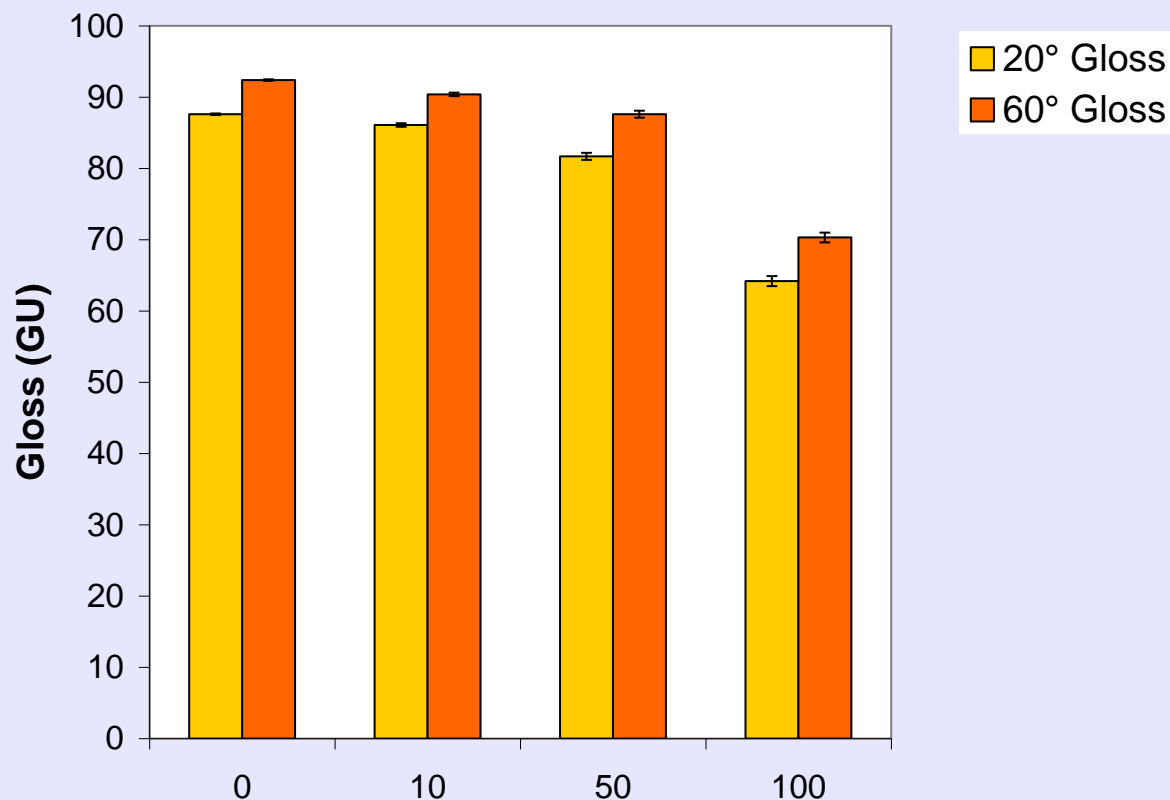
After Healing

PU/Nanocomposite Coating

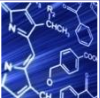


Polyurethane Self-Healing Coating on Steel

Gloss Retention - After Healing 10 Seconds at 70°C

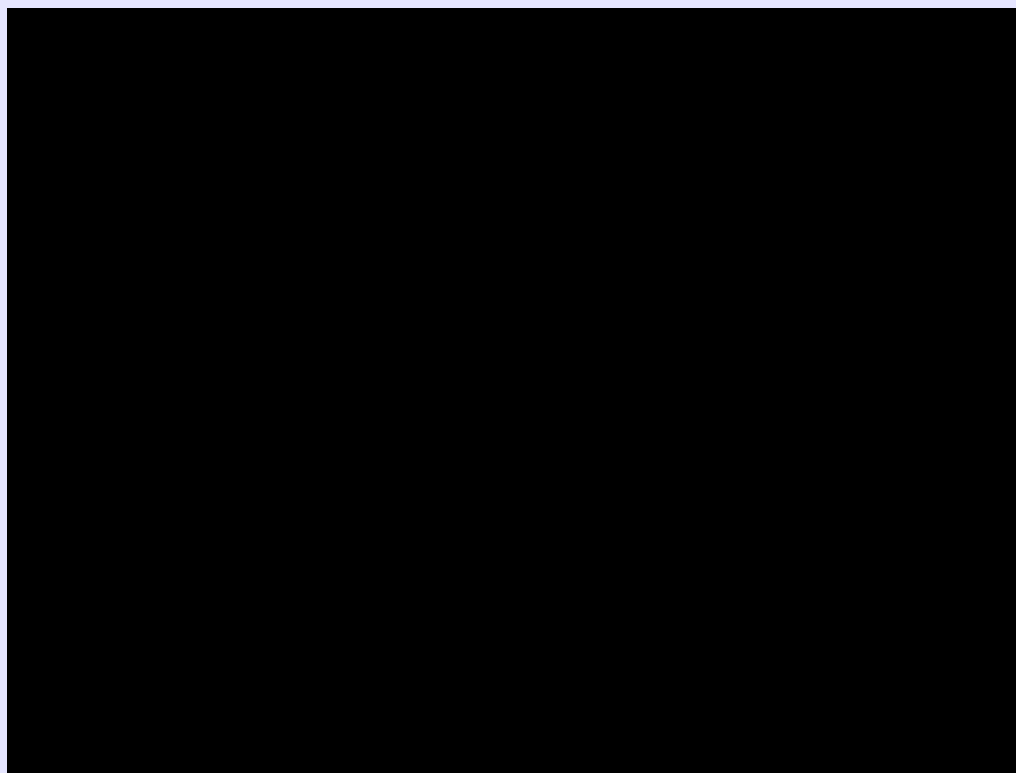


Double Rubs (#0000 Steel Wool Under 500g Load)



Self-Healing Results

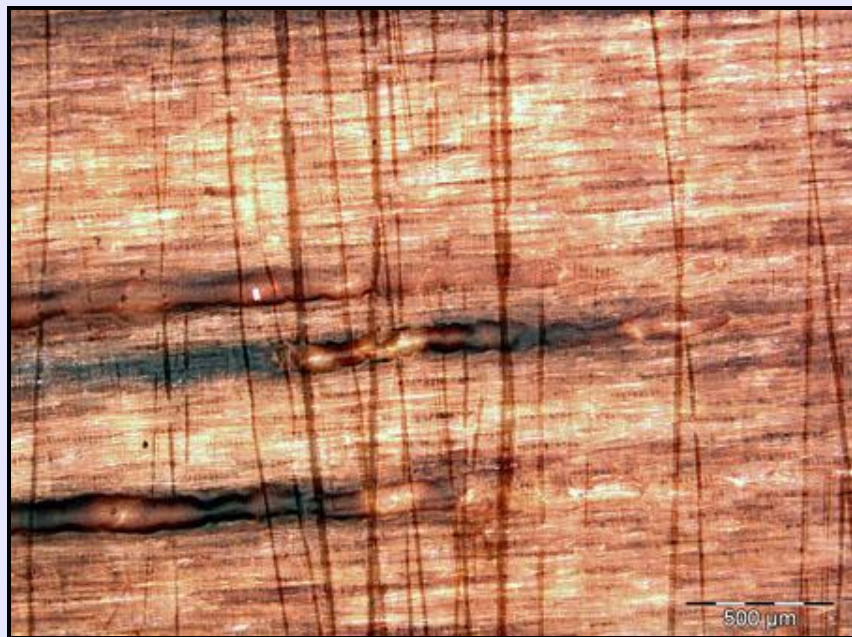
Demonstration Video





Self-Healing Results

Wood Panels: PU/Nanocomposite Coating (50X)



Before Healing

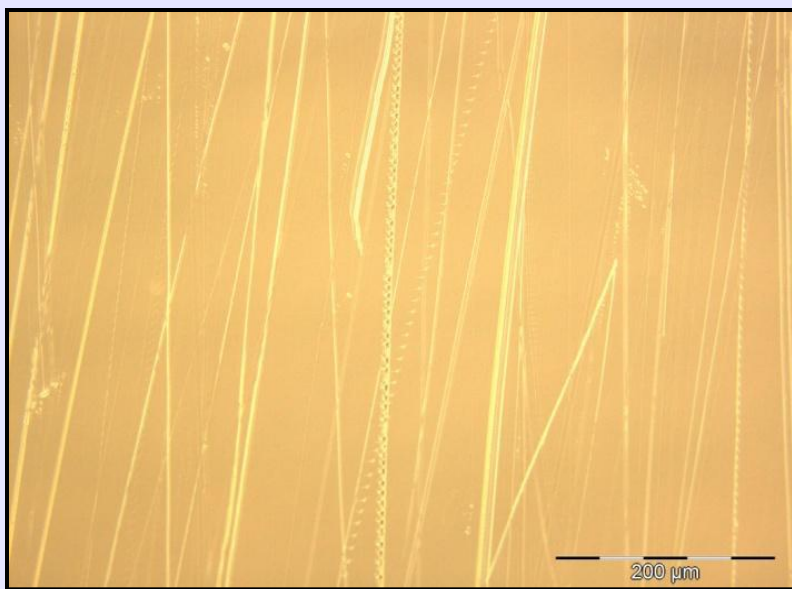


After Healing

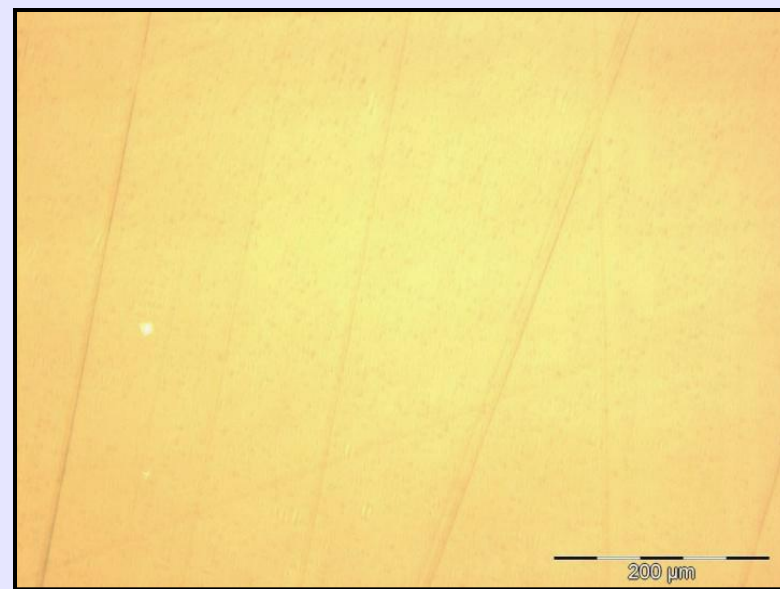


Self-Healing Results

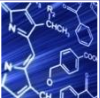
Polyurethane Self-Healing Coating on PET Substrate (200 X)



Before Healing

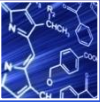


After Healing



Self-Healing Results

- **Repairs minor surface scratches & deep scratches**
- **Can be healed multiple times**



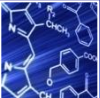
Benefits of Self-Healing Coating





Benefits of Self-Healing Coating

- **Increases service life of substrates**
 - Preserves the coating's aesthetics & protective functions
- **Reduces life cycle costs**
 - Less frequent repainting or replacing damaged items



Benefits of Self-Healing Coating

- **Reduces the raw materials and energy used to produce the coating materials used for repainting**
- **Reduces the labor and materials needed to apply the repair paint**



Benefits of Self-Healing Coating

- **Minimizes the environmental costs and societal impact of repainting**
 - **Waste disposal**
 - **VOC emissions**

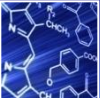




Benefits of Self-Healing Coating

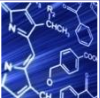


- **Self-healing technology is applicable to:**
 - **Various military uses**
 - **Marine structures & ships**
 - **Automotive clear coats**
 - **High value architectural coatings**
 - **Metal, wood, plastic & film substrates**



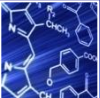
Summary





Summary

- **A novel self-healing coating technology platform**
- **Increases service life & reduces life cycle costs of various substrates**
- **Can heal minor surface scratches & deep scratches**



Summary

- **Based on proprietary polymer-nanocomposite morphology**
- **Self-healing phenomenon achieved by application of minimal amount of heat**
- **Can be healed multiple times**



Summary

- **Full potential yet to be realized**
- **In early stages of development**
- **Future developments**
 - **Waterborne**
 - **UV-Cure**
 - **Lower Self-heal Temperatures → RT**
 - **Other substrates (plastics, films...)**

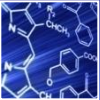


Acknowledgments

NEI Scientists:

- Runqing Ou
- Ken Eberts





Questions

