Low-Cost Self-Cleaning Coatings for CSP Collectors

Oak Ridge National Laboratory
CSP 25745: 1-15-2013: Dr. S. R. Hunter:

PROJECT OBJECTIVES

Goal:

- Operations and Maintenance costs are a significant barrier to achieving CSP electricity generation costs of $0.06/kWh
- The development and implementation of low-cost, durable self-cleaning nanostructured collector surface coatings will significantly enhance the reliability and efficiency of CSP collectors up to 20%, while reducing collector cleaning and maintenance costs up to 90%
- No other known mirror self cleaning technique can achieve these goals

Innovation:

- Low cost hydrophobized nanosilica in conventional clear coat binders, along with simple industry standard spray paint application techniques, will allow very low cost, large scale deployment of self cleaning coatings

Milestones:

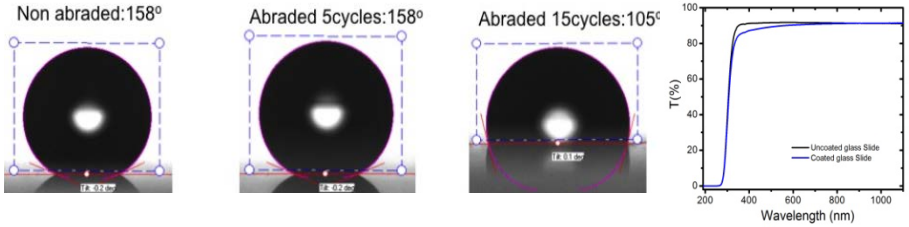
- Development of low cost superhydrophobic silica powders

APPROACH

Three main tasks will be accomplished during this project.

- Development and optimization of the self-cleaning coating system
  - Optimization of nanosilica particle size
  - Low cost fluorosilanation techniques
  - Optically clear, UV resistant polymer binding agents
- Characterization, optimization and durability testing of the optimized coating system
  - Surface characterization using AFM, SEM and optical profilometry
  - Hydrophobicity measurements
  - Taber abrasion surface durability tests
  - Optical reflectance and scattering measurements
- Demonstration, partnering and field testing of the coating system
  - Establish a manufacturing and demonstration partner
  - Field test coated mirrors and test structures
  - Perform cost benefit analyses of anti-soiling mirror coatings

KEY RESULTS AND OUTCOMES



- Superhydrophobic coating maintains hydrophobicity and optical transparency after several Taber rub cycles which simulate washing cycles in real-world CSP collector and heliostat mirrors
- First demonstration of large commercial scale application of transparent superhydrophobic coatings to glass substrates
- Use of low cost coating fabrication and application techniques are essential requirements in minimizing CSP mirror M&O costs

NEXT MILESTONES

Milestone 1: Accomplished - March 31, 2013

- Fabrication of optically transparent low-cost water repellent coatings with super-hydrophobic properties defined as those with measured water contact angles (CA) in the range 165°-175° and water rolling angles (RA) in the range 0.5°-5°

Milestone 2: Accomplished - March 31, 2013

- Coatings will possess an initial optical transmission identical to that of uncoated glass/film substrates over the solar spectrum (250 nm – 2.5 μm)
- The specularity of the reflected radiation will be reduced by ≤ 1% as compared to uncoated glass/filmsubstrates
- Coatings on at least 10 glass/film substrates will be tested and will survive a standard optical tape pull test

Technical Risks:

- Cannot meet required coating durability and optical clarity
- Risk mitigated by extensive testing and optimization of several superhydrophobic coating components and systems