Low-Cost Self-Cleaning Reflector Coatings for CSP Collectors

Oak Ridge National Laboratory

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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%

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:

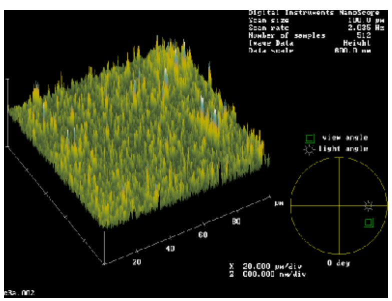
- 1 - Fabrication optically transparent, water repellent coatings meeting metrics contact angle = 165^0-755^0, rolling angle = 0.5^0-5.0^0
- 2 - No loss in optical transmission due to coatings over 250 nm - 2.5 µm, pass specularity metric, survive optical tape pull test

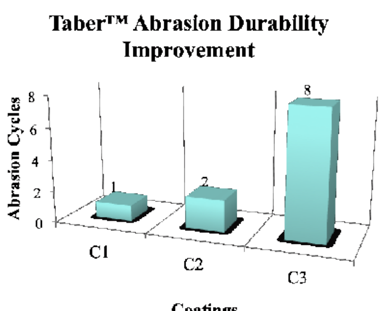
APPROACH

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





- Coatings with thermodynamically miscible components demonstrate excellent dispersion properties
- Significant increase in the abrasion resistance of the coatings. Durability has increased 8 times compared to our initial studies prior to the Sunshot project and 4 times compared to our results in the previous quarter
- Synthesis of scalable monodispersed colloidal silica (40nm)

NEXT MILESTONES

Milestone 2: Accomplished – May 15, 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/film substrates
- Coatings on at least 10 glass/film substrates will be tested and will survive a standard optical tape pull test

Milestone 3: Accomplished Sept. 30, 2013

- <10% reduction in superhydrophobicity after 25 Taber rub tests
- <1% loss in transmission after environmental exposures
- Less transmission degradation due to blown sand and dust than uncoated mirrors

Technical Risks:

- Cannot meet required coating durability and optical clarity
- Risk mitigated by extensive testing and optimization of several superhydrophobic coating components and systems, explore several paths to arrive at acceptable coatings