High-Performance Nanostructured Coating
University of California, San Diego
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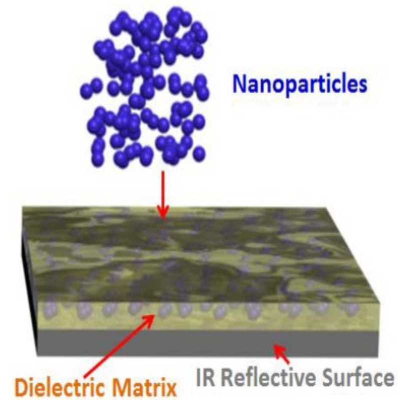
PROJECT OBJECTIVES

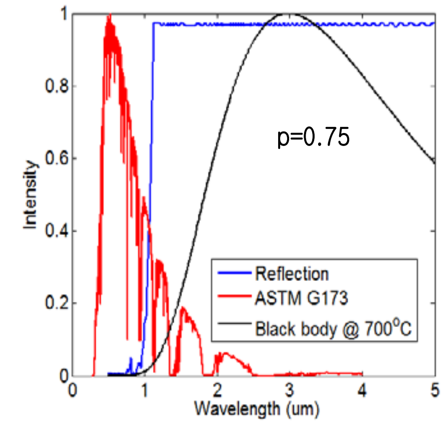
<u>Goal</u>: Develop high performance spectrally selective coating materials with high solar absorptivity, low infra-red emissivity, and excellent high temperature (>750 °C) durability in air. Such a coating material will enable high temperature and high efficiency operation of future concentrating solar power systems, such as solar towers.

<u>Innovation</u>: A model-based design utilizing a nanoparticle in dielectric matrix approach is used to achieve high optical performance. New refractory materials are used to either make or coat the nanoparticles for excellent high temperature durability.

<u>Milestones</u>: 1. Evaluation of a variety of refractory materials and down-selection of promising materials based on borides and oxides that outperform Pyromark ®.
2. Control of nanoparticle size and particle concentration in SSC matrix.
3. Development of Si-Boride conformal coating for oxidation resistance
4. Completion of spectral optical measurements from 400 nm to 2 μm; near-completion of high temperature measurement (750 °C) setup

APPROACH

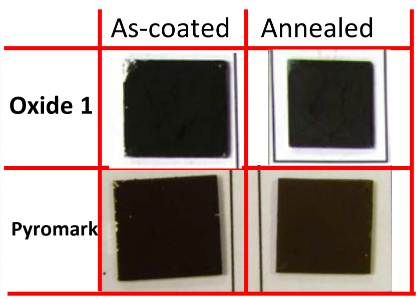




We are using refractory nanoparticle (semiconductor or metallic) in dielectric matrix (left) to achieve high solar absorptivity and low infra-red emissivity (right). The design is guided by effective-medium theory based model. Nanoparticles are fabricated using a highly scalable proprietary process.

KEY RESULTS AND OUTCOMES

ID	Material	FOM (C=1000)
3_2	Oxide 1 + resin	0.8806
2_2	Oxide 1	0.8723
	Pyromark® 2500	0.8674
6_2	Oxide 2	0.8486
8_2	Oxide 2 + resin	0.8475
10_1	Ni	0.8456



- Oxide 1 shows higher figure of merit compared to Pyromark under identical measurement conditions,
- After annealing in air at 750 °C for two days, oxide 1 still remains black while Pyromark turns brown.
- EDAX results show Pyromark get oxidized.

NEXT MILESTONES

- Scale-up and fabrication of shell protected NPs for optical tests (07/31)
- Production of nanoscale black oxide particles (06/30). Risk: composition may vary after nanoparticle fabrication. Solution: investigate alternative NP production methods.
- Systematic optimization of the coating process to improve optical properties to further improve optical performance with FOM > 90% (07/31).
- Durability test of boride-coated NPs and black oxide NPs, under 750 and 850 °C in air, for different durations (1 hr, and until the materials fail). Risk: black oxide may get oxidized under accelerated testing condition (850 °C). Solution: testing at lower T, and protection shell.
- High temperature (750 °C) optical measurements.