Scalable Plasmonic Solar Selective Coatings by Spray Deposition

Project description

Solar thermal is a cost-effective route to sustainable heat, but collector performance depends critically on the solar selective coating (SSC) of the receiver. An ideal SSC (Figure 1) absorbs the entire solar spectrum while suppressing thermal radiation losses via high infrared reflectance. The best SSCs are plasmonic metal–dielectric cermets made by physical vapor deposition which makes them expensive, energy intensive and hard to scale. Solution-based alternatives can potentially increase sustainability while reducing cost.

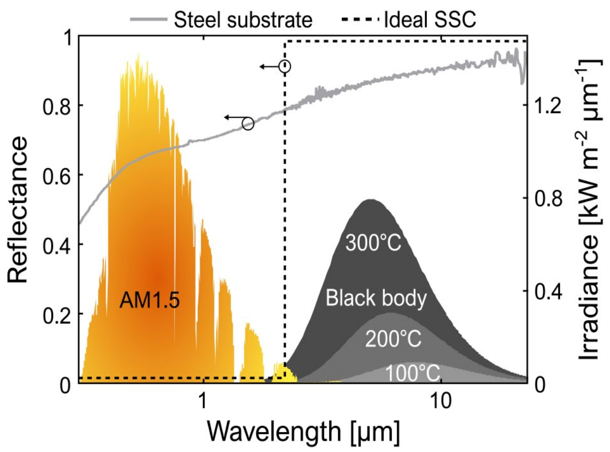

Figure 1. Reflectance spectra of a stainless steel substrate and an ideal SSC, alongside the AM1.5 direct solar spectrum and blackbody emission spectra at 100–300°C.

The project aims to achieve spray-deposited metal–dielectric composite coatings analogous to the cermet SSCs dominating the commercial market, where dielectrics such as Al_2O_3 or TiO_2 and plasmonic nanoparticles based on Al, Ag, or W, are combined in multilayers coatings of graded concentration. This project builds on recent work where we utilize spray-coating to produce thin uniform silica composite films on thermally induced antireflective oxide coatings. Using the group's new Sono-Tec dual-feed ultrasonic spray system a particle dispersion can be co-deposited with the dielectric sol without premixing. The work spans: (1) a literature study to guide the material selection; (2) development and deposition of dielectric sol; (3) development of nanoparticle ink formulation; (4) dual-feed co-deposition of metal nanoparticles/dielectric composite; (5) structural and optical characterization. The student will gain experience in sol-gel chemistry, spray coating, nanoparticle dispersion science, optical simulation, and advanced characterization. No prior experience with solar coatings is needed. The project addresses, *SDG 7, Green materials for efficient technology and infrastructure to harvest, transport, store, and convert energy, in the WISE-matrix.*

Research group/environment

The project is hosted by the Nano for Energy group which focus on nanomaterials based on carbon, transition metal oxides, noble metals and hybrid materials of these. We focus on investigating and exploiting the electronic, structural and chemical properties of these materials for renewable energy applications.

To be conducted at: Department of Physics, Nano for Energy Group

Level: A (Master, 30/45/60 hp/ECTS depending on program)

Examiner: Thomas Wågberg

Supervisor: Erik Zäll

Contact person: Thomas Wågberg (thomas.wagberg@umu.se)