UMEÅ UNIVERSITET

HEATING A SUSTAINABLE FUTURE

Optical coatings for solar collectors

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Akademisk avhandling

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Abstract
The green transition is the great undertaking of our time, and it will require significant ingenuity and change in all areas of society. Most urgently, perhaps, regarding energy, where the demand for transport, electricity and heat must be met by renewables instead of fossil fuels. Solar thermal is one alternative with the potential to contribute substantially to sustainable heat production. To realize this potential, the availability of competitive, sustainable and cost effective optical coatings for solar collectors is a prerequisite. The coatings used today are primarily produced with expensive vacuum-based deposition techniques, transferring a hampering cost to the collectors, which impede the deployment of solar thermal as an energy source. Herein, we show that by leveraging scalable deposition techniques, with elaborate material choices and innovative nanoscale designs, it is possible to produce sustainable coatings that are highly competitive with regards to cost and performance.

Using a scalable aerosol-based deposition technique, an antireflective mesoporous silica coating, commonly implemented in advanced solar technologies, is produced with an ordered hexagonal pore structure. The attention to optical thickness and pore structure facilitates a superior performance and an increased durability, making it especially suitable for arid climates. Moreover, we present several methods to achieve solar selectivity for the receiver. We leverage the large potential window of a deep eutectic solvent to facilitate electrodeposition of a texture-based cobalt-chromium coating, making an otherwise unsustainable technique viable today. High selectivity is also achieved by manipulating interference effects in coatings produced through precise control of thermal annealing of steel and ultrasonic spray coating of carbon nanotube composites. Such optical effects are only achieved for selective coatings deposited with more advanced and expensive techniques.

Science is an iterative process of small incremental advances, often seemingly insignificant in the moment, which over time accumulate to surprisingly quick change. Here we present examples of sustainable, scalable, durable and cost competitive antireflective and solar selective coatings, thereby hopefully contributing to an accelerated implementation of solar thermal technologies.

Keywords
Solar thermal collectors, optical coatings, solar selective coatings, antireflective coatings

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