High-Temperature Spectrally-Selective Absorber Coatings & Integrated Thermoelectric Materials for Efficient Concentrated Solar Power Energy Conversion

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Desired cost-effectiveness of concentrated solar power (CSP) platforms is enabled through higher temperature operation, maximizing electric power output from solar thermal energy conversion. One significant technology for reliable high-temperature operation has been the implementation of high temperature durable spectrally-selective solar absorber coatings – they can absorb ultraviolet, visible, and near-infrared solar irradiation while limiting spontaneous thermal radiation from emittance at higher wavelengths. Additionally, the inclusion of thermoelectric devices, incorporating materials that generate an electric potential given an input temperature gradient, have also been recognized as a sustainable energy-harvesting platform capable of reducing waste heat among power plants' thermal processes. For this project, metal-oxide solar absorber coatings have been investigated for high temperature CSP energy conversion, and it aims to develop low-cost thermoelectric devices through additive manufacturing technologies.

The Energy & Environmental Materials Laboratory at The University of Nevada, Las Vegas (UNLV) is currently investigating variant metal-oxide materials that can be utilized to efficiently absorb solar thermal energy leading to enhanced CSP system efficiency. In addition, thermoelectric devices have been developed aiming to harvest low-grade thermal energy generated from solar facilities. Succeeding metrological analyses methods including SEM, STeM, TEM, XRD, and profilometry, our development of metal-oxide solar absorber coatings are characterized through spectroscopic measurements (FTIR & scan monochromatic) on an optical testbench to identify spectral absorptive response.

The primary research goal of this project will seek to improve energy-efficient technologies by boosting high-temperature thermocycles, limiting water use, and reducing environmental impacts for power generation at solar sites. This research effort contributes to various multi-phase objectives of the Solar Energy-Water-Environmental Nexus project in Nevada.

This material is based upon work supported by the National Science Foundation under Grant No. IIA-1301726. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.