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TiAlN Selective Absorber for High Temperature Concentrated Solar Power (CSP) Applications

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CSP (Concentrated Solar Power) parabolic-trough and Linear Fresnel Reflector absorbers, convert sunlight into heat for producing electrical energy, reaching temperatures of about 250-450°C. At this working temperature thermal losses are mainly radiative. Thus, the absorber must be coated with spectrally selective films, with good solar absorbance properties and low thermal emittance in the infrared range (beyond 2450nm). Furthermore, the absorber will be directly exposed to severe conditions in air and must have a good thermal stability and oxidation resistance at high temperature for several years (at least 20 years)
The presented selective coating is made of 4 thin layers deposited on a stainless steel substrate. The bottom layer consists in a TiAl based layer and plays the role of an IR reflector. The next two layers constitute a tandem absorber made from $Ti_xAl_yN_z$. And the last thin layer is a SiNCH anti-reflective layer enhancing solar absorption.
Optical index of each layer has been measured by ellipsometry. Multilayer compositions and thicknesses are then optimized using optical simulations.
IR reflector and absorbing layers are deposited by magnetron sputtering of TiAl target with argon and nitrogen. Antireflective coating is produced by PECVD from TMS (Tetramethylsilane) precursor and nitrogen.
Samples were annealed at constant temperature above 500°C in air for 120 hours. Annealing has been followed by AFM measurement and optical characterizations. No significant changes of surface topography and optical properties have been observed. Good results have already been reached with solar absorption of 94%, a 550°C-emissivity of 23% in the IR domain and a promising thermal stability in air. The authors will present both modeling of the absorptive layers stack and process deposition. Preliminary results will presented as well.

Keywords
Solar thermal energy
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magnetron sputtering
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