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NANOCOMPOSITE CERMET COATINGS FOR CSP TECHNOLOGIES DEPOSITED BY RF REACTIVE PVD ASSISTED WITH MICROWAVE ECR SOURCES

NANO / Nanomaterials ans nanostructured thin films

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Abstract content

Improving the performance of Concentrated Solar Power technologies requires the development of optically efficient and thermally stable absorber materials. To achieve this, our objective is to develop spectrally selective coatings using plasma technology, i.e. absorbent in the visible and near infrared and lowly emissive in the infrared. These coatings must also be resistant to high temperatures in air and high thermomechanical stress. Among suitable solutions are ceramic-metal composites (cermets) based on Tungsten and SiCH materials. Compared to more classical multilayer selective solar, allow the diffusion of oxygen in the coating to be limited by eliminating grain joints and improving mechanical properties (e.g. crack blocking, resistance to deformation).

First of all, thermo-optical properties of cermets including various metals, embedded in a SiCH reference matrix from our laboratory, were simulated and optimized with a homemade optical modelling tool. This study revealed that metal-SiCH composites presented a high thermo-optical efficiency to convert concentrated solar flux into heat for real CSP operating conditions. W-SiCH was found to be well adapted for such applications. W containing SiCH materials were then synthesized on silicon and steel substrates by two direct plasma methods: reactive radiofrequency (RF) magnetron sputtering PVD, with and without the assistance of microwave ECR sources.

Study of the reactive PVD processes to control the formation of cermet layers was carried out by Optical Emission Spectroscopy (OES) coupled with films characterizations. OES showed an attended increase in electron concentration and a decrease in the mean electron temperature. Addition of ECR sources to reactive RF PVD allows for plasma parameters to be modified and favors the production of powders. The crossing of various material characterizations (XPS/AFM/KFM/EDS/RBS) reveal that nanograins containing tungsten were enclosed into the material coating deposited on steel substrates. Thermo-optical characterizations of these cermets show that they are optically selective, and that their insertion in multilayers containing tungsten IR-reflective sublayer and silicon carbide antireflective top layer could lead to good optical performance as solar absorbers.