Design, plasma deposition and optical performance of absorbers based on W/W-SiCH/TaO_xN_y multinanolayers for Concentrated Solar Power

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Improving the performance of concentrated solar power technologies (CSP) requires the development of optically efficient and thermally stable absorbing materials. To achieve this, our objective is to develop spectrally selective coatings using plasma technology, i.e., absorbing in the visible and near infrared solar range and with low infrared emissivity. These coatings must also be resistant to high temperatures in air and high thermomechanical stresses. Suitable solutions include ceramic-metal composites (cermets) based on tungsten and SiCH materials. Anti-reflective materials such as TaO_xN_y can be deposited on these cermets to ensure maximum solar transmission to the absorbing part and potentially high temperature protection under oxidizing atmosphere.

First, the thermo-optical properties of cermets consisting in tungsten inclusions embedded in SiCH matrix were simulated and optimized by optical modelling, using optical indices measured by ellipsometry on W and SiCH coatings previously developed at PROMES-CNRS. This study revealed that W-SiCH composites exhibit high efficiency in converting concentrated solar flux into heat under CSP working conditions. Then, W-SiCH materials were synthesized by radio frequency reactive PVD magnetron sputtering with ECR microwave assistance, and characterized by SEM, EDS, RBS, spectroscopic ellipsometry and spectrophotometry. In addition, TaO_xN_y deposited by the same method (without microwave assistance) have shown an antireflective potential for W-SiCH absorbing layers due to their suitable optical properties (n ~ 2 at 2 eV).

Finally, the thermo-optical performance of W/W-SiC:H/TaON multinanolayer solar selective absorber coatings was simulated based on the experimental optical indices of these materials. As an example, $\alpha_s = 0.69$ and $\varepsilon(500°C) = 0.027$ could be obtained with $TaO_{2,40}N_{0,69}$ and W-SiCH annealed at 500 °C, showing good potential for CSP applications.