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Design and high-temperature durability tests of solar-selective coatings based on aluminium titanium oxynitrides AlyTi1-y(OxN1-x)

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Aluminium titanium oxynitrides were studied as candidate materials for high temperature absorbers in solar-selective coatings (SSC) due to their excellent stability and their tuneable optical behaviour. A set of individual $Al_yTi_{1-y}(O_xN_{1-x})$ layers with different oxygen content was prepared by cathodic vacuum arc (CVA) deposition. A comprehensive analysis of the sample microstructure and morphology allowed an accurate modelling of the optical constants in the whole wavelength range of solar interest (190 nm - 25 µm). The optical properties of these films can be controlled from metallic to dielectric character by adjusting the oxygen content. Complete multilayer SSC, including a TiN layer as IR reflector, were designed by applying optical simulations, obtaining excellent optical selective properties (α = 94.0% and ε_{RT} = 4.8%). The design concepts were validated by an excellent agreement between simulated and experimental stacking order, composition and optical properties. The durability of two multilayers was studied under conditions simulating realistic operation of central receiver power plants. Both SSC stacks were stable in single stage tests of 12 h at 650°C in air. During cyclic tests, the coarser microstructure of multilayer 1, was found to be more resistant against oxidation than multilayer 2 constituted of four oxynitride layers with a graded oxygen content. Multilayer 1 fulfilled the performance criterion of PC ≤ 5% for 300 symmetric, 3 h long cycles at 600°C in air confirming that the designed SSCs are exciting candidate material for concentrated solar power applications at high temperature. Financial support by the EU, grant No. 645725, project FRIENDS[2], is gratefully acknowledged.

Keywords
Solar-selective coatings
CSP
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