Multilayer coatings based on aluminum nitride coatings for receivers in concentrated solar power technology

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Jury :

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- M. Yves WOUTERS, Professeur, Université de Grenoble Alpes, Examinateur
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Abstract: There is an increasing interest for concentrated solar power (CSP) systems which can work at temperatures higher than 1000 °C to optimize efficiency. One of the challenges is to design the receiver that will be heated at high temperature in air. Compared to coatings in gas turbine engine, the coating(s)/substrate system must have a high thermal conductivity to ensure a good heat transfer to the fluid. Aluminum nitride (AlN) coating, deposited by chemical vapor deposition at 1100-1200 °C at a growth rate of 10-50 µm·h-1, is selected for its high thermal conductivity, low thermal expansion coefficient, high temperature stability and its ability to develop stable alumina scales above 1000 °C. Molybdenum-based alloys are selected as substrate materials for their excellent thermal and mechanical properties. The alumina-forming iron-based alloys are also chosen as model substrates to reduce the influencing parameters in real-life receivers and to study the potential of these coatings. Accelerated cyclic oxidation tests and emissivity measurements allow the evaluation of AlN coatings as materials for high temperature CSP receivers. The multilayered systems exhibit low degradation after hundreds of thermal cycles at 800 °C in air and can support higher temperatures (1100 °C) for 100 to 500 h depending on the coating thickness. Nevertheless, the fast cyclic oxidation in solar furnace leads to cracks through the coatings. An analytical model is developed to study the stress evolution within the coating(s)/substrate system. Calculated results are in good agreement with experimental data. The measurements of the optical properties reveal a decrease of absorptivity after oxidation for AlN coatings, but a significant increase of absorptivity when SiC coating is added as a top layer.