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Solar selective absorber coatings based on double AlSiOx:W cermet layers

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It is reported the design, deposition and performance of a multilayer coating for selective absorption of solar radiation. The optical stacks consist of four layers, a metallic tungsten (W) layer as back reflector, a double $AlSiO_x$:W cermet layers and a $AlSiO_x$ layer, as antireflection (AR) layer. The spectral optical constants of a set of the single layers were calculated from the reflectance and transmittance measurements and used to design the optical stack. The coatings were deposited on stainless steel substrates by magnetron sputtering.The X-Ray diffractograms of $AlSiO_x$:W layers show a broad peak around 2θ=40º, which could be assigned to (110) planes of bcc W lattice. The intensity of the broad peak increased with tungsten volume fraction (f), but the FWHM of about 7º, indicates that both, W and $AlSiO_x$, are amorphous. The Chemical analysis was performed using X-ray photoelectron spectroscopy (XPS) and the results show that in the high metal volume fraction $AlSiO_x$:W cermet layer, about one third of W atoms are in the W^0 oxidation state, another third in the W^{x+} oxidation state and the last third in the W^{4+}, W^{5+} and W^{6+} oxidation states. The Al 2p core level spectra show that Al atoms are mainly present in oxide state, but also show that some Al atoms are present in the metallic state. Moreover, the peaks corresponding to metallic Al are shifted towards higher binding energy, suggesting that Al atoms are coordinated with Si atoms, which agrees with what is seen in Si 2p core level spectra. The coatings exhibit a solar absorptance of 94%-96% and an emissivity of 10%-14% (at 400 ºC). The coatings also exhibit good thermal stability, with small changes in the optical properties of the coating during heat-treatments at 400 ºC in air and at 580 ºC in vacuum.

Keywords
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