Effect of the Scattering of the Light on the Thermal Radiative Properties of a Nearly Black Body Coating

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Black body coatings can be elaborated by depositing a rough layer of $Pr_2NiO_{4+\delta}$, onto a ceramic substrate [1]. Two complementary effects can be underlined when one investigates the physical basis explaining such a remarkable behaviour. The first one lies in the oxygen excess ($+\delta$), creating polaronic carriers that are responsible for the intrinsic absorption mechanism in the infrared range [2]. It makes the deposit opaque when the thickness is more than 2.5 µm. The second one involves the roughness of the layer that is due to the chemical deposition process [1]. To get a more quantitative evaluation of this second effect, we carried out a Monte Carlo Ray Tracing program acting in a virtual reconstruction of the layer. Our aim was to reproduce the normal spectral emittance of the layer, for which experimental measurement has been done at T = 1000 K [1].

To reconstruct the surface, we have investigated the layer by using both a Scanning Electron Microscope and a mechanical profilometer. We have observed nearly spherical scatterers characterized by a typical mean size of 20 microns, each being spaced by a mean gap of around 10 microns. Based on this observation, we have reconstructed a rough layer. Interaction of the light with the deposit is treated with the formalism of the geometrical optic. Then we calculated the normal hemispherical spectral reflectance of the layer that gives, according to the Kirchhoff laws, the normal spectral emittance. To validate the simulation, 10^6 rays are used. In this work, we will discuss the validity of the model by comparing the two kinds of results obtained.

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