Complex Oxidation Behavior of Ti-6Al-4V Revealed by Infrared Emissivity Measurements

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Emissivity measurements are a useful tool to investigate temperature-dependent surface properties of materials, including the study of oxidation kinetics. Optical methods for these investigations allow for non-destructive in situ characterization of the oxide layer growth, which is more advantageous than the more traditional weight-based methods. In this work, emissivity measurements have been used to determine the effect of nitridation on the oxidation of the standard aeronautical alloy Ti-6Al-4V. Nitridation of this alloy creates a protective TiN-Ti_2N layer, which has been suggested to be effective as an anti-corrosion coating by several authors.

The oxidation kinetics of Ti-6Al-4V samples has been investigated using infrared emissivity measurements from 500 to 800 °C. The typical oscillatory behavior of the spectral emissivity is observed, which is induced by interferential patterns changing with the oxide growth. It is possible to fit these results to obtain time-dependent kinetic exponents, which reveal the complexity of this oxidation process, with substantial variations with temperature and time. The thermodynamics of these oxidations is similar to that of the non-nitrided material, but different from that corresponding to TiN oxidation. Instead, the protective nature of this treatment is attributed to the Ti_2N layer.

These measurements can be complemented by microstructural characterization, which sheds light on the mechanisms behind these behaviors. The microstructural characterization reveals a reduction in the amount of oxygen dissolved in the bulk and a multi-layered Al_2O_3-TiO_2 oxide at high temperatures.