

LASER FLASH TECHNIQUE: A CRITICAL ANALYSIS OF TESTING PARAMETERS AND MODELS FOR FITTING EXPERIMENTAL DATA

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Laser Flash is considered the standard technique for measuring the thermal diffusivity of solids. To avoid any permanent damage of the sample when a LF measurement is carried out on brittle materials, characterized by very low values of thermal diffusivity, thermal effusivity, and toughness, as the case of freestanding APS TBC samples, the energy density deposited onto the sample surface should be minimized. The damaging effect of the energy deposited on the surface of free standing TBC samples during LF measurements has been experimentally investigated. The damage has been evaluated experimentally and analyzed by suitable heat conduction modeling and some suggestions are provided [1]. ZrO₂ is semitransparent to near IR radiation. This is the typical wavelength range of the laser heating source of the laser flash equipment. Moreover, the characterization of TBCs at high temperatures is particularly interesting as the typical working temperature of gas-turbine is >1000 °C [2]. At these temperatures the radiative heat transfer through the TBC becomes more and more relevant. The effect of blackening surfaces by a thin layer of graphite is considered [3]. Experiments are carried out at ambient temperature by means of a thermographic camera, at higher temperature in vacuum until 1200 °C and in argon atmosphere until 1000 °C. Data are analysed taking into account the heat exchange with the environment [4]. Successively, the possibility of radiative exchange between the two blackened sides of the sample [5] is taken into account. Finally, the possibility of simultaneous heating of the two sides of the sample, due to the semitransparency of the material is considered. This last model explains the anomalous immediate heating of the side facing the detector as shown in Fig. 1 Laser Flash is a very reliable technique for measuring thermal diffusivity of single layer samples but, especially for coatings, measuring their thermal diffusivity directly on a component they are deposited onto is a need. To satisfy this request in-reflection configuration photothermal techniques have been developed and successfully applied [6]. Furthermore, when the thickness of the substrate is not too thick, also the LF technique can be used on two-layer samples as some algorithms for estimating thermal diffusivity of a single material in a two layer sample have been developed since many years [7,8]. In particular all these models require to know the density, the specific heat and the thermal conductivity of the second layer. The effects of the uncertainty in the evaluation/estimation of the thermophysical parameters of the second layer will be discussed theoretically and compared with some experiments designed to highlight the most critical issues in this type of measurement.

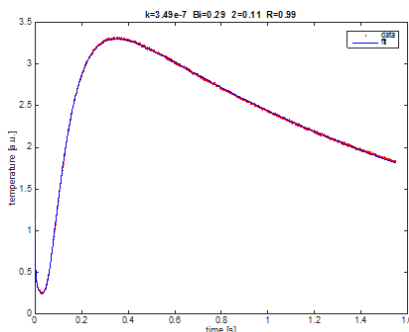


Figure 1 – laser flash experimental data with radiation heating also the rear face.

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