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Pulse thermography to assess thermal diffusivity in semitransparent materials.

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Abstracts
Pulse thermography and Laser Flash equipments are utilized in a complimentary way to measure thermal diffusivity of semitransparent materials. The best way to measure such a parameter is discussed when the heating source is not completely absorbed in a very thin layer of the front surface of the sample, but propagates through it and is eventually absorbed strongly on the back surface. This case appears when semitransparent materials are tested and their surfaces are blackened to increse the light absorption on the front side and the emissivity on the back.

Introduction

Pulse thermography is utilized in a complimentary way with laser flash technique to measure thermal diffusivity of semitransparent materials. The best way to measure such a parameter is discussed when the heating source is not completely absorbed in a very thin layer of the front surface of the sample, but propagates through it and is eventually absorbed strongly on the back surface. This case appears when semitransparent materials are tested and their surfaces are blackened to increse the light absorption on the front side and the emissivity on the back. Typical case is that of Thermal Barrier Coatings (TBCs) that are applied to protect components of gas turbines from high temperature combustion gases[1]. On the other hand the main component of TBCs, i.e. ZrO_2 is semitransparent to near IR radiation. This is the wavelenght range where the laser heating source of the laser flash [2] equipment emits. Moreover, the characterization of TBCs at high temperatures is particularly interesting as the typical working temperature of gas-turbine is >1000 °C [3]. At these temperatures the radiative heat transfer becomes more and more relevant. The effect of blackening surfaces by a thin layer of graphite is considered [4]. 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 [5]. Successively, the possibility of radiative exchange between the two blackened sides of the sample [6] (see Fig. 1), 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

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facing the detector as shown in Fig. 2. Measurements on semitransparent sapphire are carried out with one or both sides blackened with carbon paint.

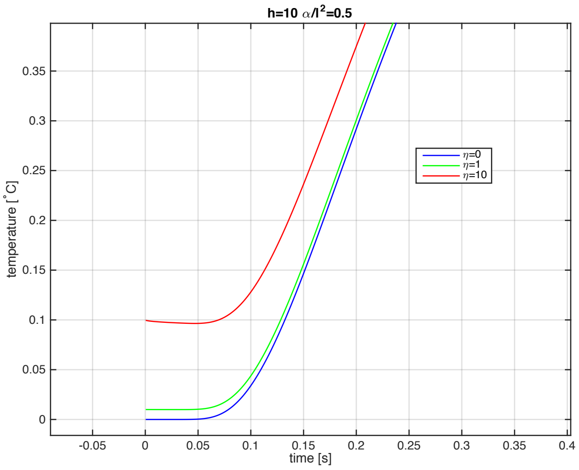

Fig. 1. The Mehling model describes the jump of the temperature signal of the laser flash experiment immediately after the shot by a radiative exchange between the two blackened sides of the sample

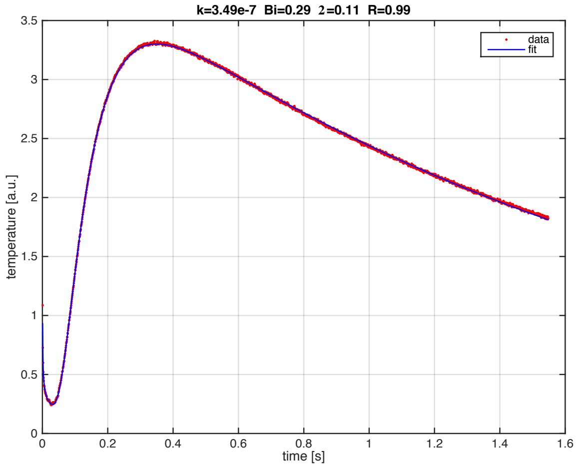

Fig. 2. The large increase of temperature on the side facing the detector can be explained by a semitransparency of the material to the laser shot that simultaneously heat the side facing the laser and the back side as well.

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