CHARACTERIZATION OF COMPOSITE MATERIALS FROM TEMPORAL THERMAL RESPONSE

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Abstract

There is an increasing interest in the characterization of complex structures with thermographic techniques. Typical of these structures are multilayered systems and fiber reinforced composites where structural thermal response is a function of the combined responses of the constituents. In this work, techniques are presented for measuring the early thermal response. For multilayered structures, the response is reduced to the thermal properties of the constituents. For fiber reinforced composites, the short term response enables detection of the fibers.

A measurement system was developed consisting of an infrared detector focused on a single point on the structure. An input heat flux was provided by either an Argon laser or a flash lamp depending on the configuration. To measure the spatial variations in the thermal response, specimens were mounted on a translation stage.

Initial measurements with the system were performed on multilayered structures. An analytical solution was developed for the thermal response of a two or three layer system, given the thermal properties of the layers. This solution was combined with a nonlinear estimation routine to enable the determination of the properties of the constituents from the thermal properties of the structure. This technique was applied to the characterization of a thermally thin layer on a thermally thick layer. It was also applied to the characterization of a center layer of a three layer structure.

Subsequent measurements were performed on a ceramic composite (reaction bonded silicon nitride reinforced with SiC fibers). images of the spatial variations in the thermal response were obtained by translation of the composite. To give insights in the significance of the data, a two dimensional analytical solution was developed for the thermal response of a fiber embedded in a matrix material. Predicted responses of the structure were compared with the measured responses.