Thermal Diffusivity Measurements on Porous Carbon Fiber Reinforced Polymer Tubes

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Porosity in carbon fiber reinforced polymers (CFRP) degrades the mechanical resilience especially the interlaminar shear strength of structural components. Hence, a porosity level lower than 2.5% has to be ensured in a majority of the cases.

Former studies have shown the capability of Active Thermography for the determination of porosity in CFRP [1]. Especially, thermal diffusivity imaging shows a great potential for the detection of material inhomogeneities like porosity. For a model-based prediction of the porosity the quantitative evaluation of the effective thermal diffusivity is crucial [2]. To determine the thermal diffusivity common evaluation methods like the Thermographic Signal Reconstruction (TSR) or methods related to the Parker’s approach are suitable for flat geometric bodies. New fabrication techniques just as braided fibers with infiltrated resin (RTM) allow the integral construction of complex geometric shapes. Such curved geometries lead to multidimensional heat flux, wherefore the above mentioned one-dimensional evaluation methods give systematic deviations of the thermal diffusivity.

In this work, we show the limitations of one-dimensional evaluation methods related to the radius and present an adapted approach for the quantitative evaluation of the thermal diffusivity. For this purpose finite element (FE) simulations were carried out to develop and verify the adapted evaluation methods. Furthermore effects of an inhomogeneous excitation and the anisotropic heat conduction of CFRP were taken into account in the FE simulations.

The results of the simulations and the adapted evaluation methods were tested with pulsed thermography measurements carried out on cylindrical shaped porous tubes made of CFRP (fig. 1).

Figure 1. Location of the pores (colored dots) of a porous CFRP tube obtained by x-ray computed tomography measurements (left) and the evaluated thermal diffusivity as pseudo color image (right)

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