

Quantitative Porosity Evaluation in CFRP Through Thermal Diffusion Time Measurements

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Porosity in carbon fiber reinforced polymers (CFRP) degrades the engineering performance, especially the interlaminar shear strength. In this work the porosity content of CFRP was successfully determined by thermal diffusion time measurements based on pulsed thermography experiments. The thermal diffusion time is defined as $t_{(d)} = L(\varphi)^2 / \alpha(\varphi)$ where L is the sample thickness and α represents the thermal diffusivity. Both parameters depend on the porosity content φ . The sample thickness – porosity relation is explained using a geometrical model for a 1D volume expansion. The effective thermal diffusivity is modeled by using an effective medium theory (EMT), particularly the Maxwell-Garnett Approximation (MGA). For the accurate prediction of the effective thermal diffusivity of porous CFRP, more information about the microstructure is required, because it not only depends on the volume fraction and the material parameters of each phase. Therefore the pore shapes and their distribution are of significant importance. Oblate shaped pores will lead to a decreased thermal diffusivity. In this work the microstructural information is derived from cone-beam X-ray computed tomography (CT) measurements. The effective thermal diffusion time was determined for 116 CFRP test specimens with different porosity contents and different number of plies. The correlation between the effective diffusion time models and the experimental results allows a quantitative evaluation of porosity with pulsed thermography. CT measurements were used to validate the results. The accuracy of porosity evaluation based on thermal diffusion time measurements is comparable to ultrasonic testing.