Thermal Characterization of Complex Composite Structure using Scanning Thermal Microscopy

I.De[1], J-L. Battaglia[1], A. Saci[1], G.L. Vignoles[2]

[1] *I2M Laboratory, University of Bordeaux, UMR 5295, 351 Cours de la Liberation,33405 Talence Cedex, France*
[2] *LCTS Laboratory, University of Bordeaux, UMR 5801, 3 Allée de la Boétie, 33600 Pessac, France.*

Laminar pyrocarbon, used in high-temperature aerospace applications, is quite unavailable in bulk form: it is only prepared via a gas-phase route as a matrix in composite materials. It has, depending on its processing parameters, a very versatile nanostructure [1] and, consequently, broadly varying mechanical and thermal properties [2]. Hence, it is important to know the properties of these matrices at the micrometer scale in order to improve and control the composite behavior in a macroscopic scale. The thermal behavior of these non-homogeneous composites can be better understood through characterization that will provide the thermal resistance at the interfaces between constituents. This will also allow mastering the thermal properties of the composite by providing material properties via thermal resistance. In order to achieve this thermal characterization in a microscopic scale, we have implemented a scanning thermal microscopy experiment using the 3ω mode technique. The experiments have been performed at room temperature using a two-point probe having a Pd strip deposited on a Si_3N_4 AFM tip. Sweeping the composite surface with the probe leads to measure the topography as well as the amplitude and phase of the 3ω signal, containing all the useful thermal information about the material at the micro-scale. The experimental results have also been accounted for by comparing with finite element analyses. The obtained results will allow us to identify the thermal boundary resistance at the interface between the glass fiber and its pyrocarbon coating, as well as the thermal diffusivity of these constituents.

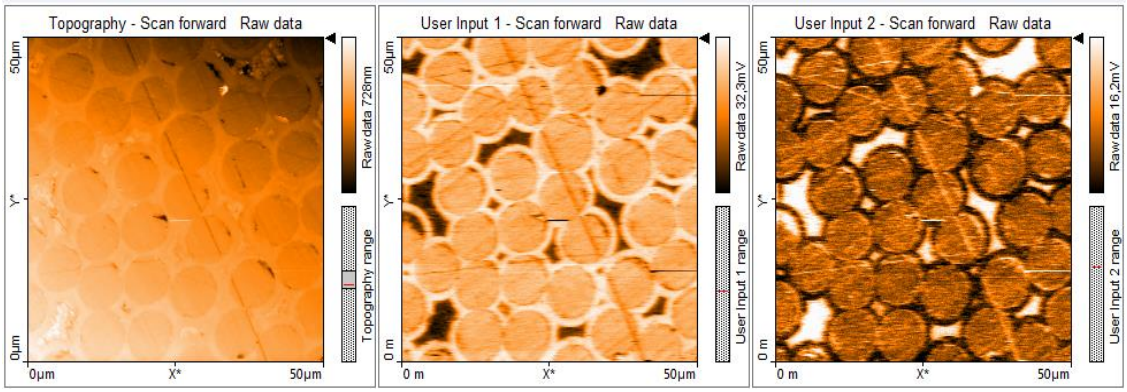

Figure 1. The topography, amplitude and phase obtained by experimental SThM at 1125.547Hz when sweeping the surface of a composite made of glass fibers (quasi-circular section) with their pyrocarbon sheath (in white for the amplitude image and in black for the phase image)

1. G. L. Vignoles, R. Pailler, F. Teyssandier, *The Control of Interphases in Carbon and Ceramic Matrix Composites*, Ceramics Engineering and Science Proceedings (2013) vol. **33**(8), pp. 11-23.
2. G. L. Vignoles, P. Weisbecker, J.-M. Leyssale, S. Jouannigot, G. Chollon, *Carbones Pyrolytiques ou Pyrocarbones – des Matériaux Multi-Echelles et Multi-Performances*, Techniques de l'Ingénieur, ref. NM3150, Date de mise en ligne: Avril 2015.