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**10<sup>th</sup> International Conference on Diffusion in Solids and Liquids DSL-2014,**  
Thermographic and tomographic methods for three-dimensional characterization of  
thermal diffusion in silica/phenolic composites

**INVITED TALK**

**Thermographic and tomographic methods for three-dimensional characterization of  
thermal diffusion in silica/phenolic composites**

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Aeronautical and space vehicles include many parts made of composite materials. The thermal design of these materials is critical versus their application. Indeed, the presence of very high thermal gradients during use may cause many technological problems such as resistance to thermal shocks or ablation. Furthermore, certain manufacturing processes call upon very high thermal gradients. Hence, the knowledge and control of the evolution of thermal properties during manufacturing and use is essential.

In this work the development of a dual approach for thermal characterization of composite materials is presented. The first method makes use of standard and specific experimental methods, while the second is based on upscaling tools. In the second, 2D microscopic and 3D tomographic images are used in a two-step upscaling process using the Volume Averaging Method with closure: microscopic scale to mesoscopic scale to macroscopic scale. The procedure starts from the knowledge of the properties of the elementary constituents (matrix and fibers) and their spatial arrangement. The method can also be applied to virtually generated images of composite materials and can therefore contribute to the creation of a “design tool” that can allow the prediction of the influence of the architecture of the fiber reinforcement on certain properties of the composites namely the heat conductivity tensor. The two approaches are applied to two silica/phenolic composites with different spatial organizations. These composites are often used in thermal protection systems for atmospheric re-entry. Numerical results are

compared to experimental ones in terms of transverse and longitudinal thermal conductivities of the composites, and are found to be in good agreement. A discussion is made on the different possible sources of uncertainty for both methods.