REAL TO VIRTUAL—CREATING MULTIFUNCTIONAL MATERIALS

M.D. Sarzynski [1], O.O. Ochoa [1*], K. Lafdi [2] and D.M. Nave [3]

1. Mechanical Engineering
   Texas A&M University
   MS 3123-TAMU
   College Station, TX
   77843-3123 USA
   oochoa@tamu.edu
2. Mechanical Engineering
   University of Dayton
   300 College Park
   Dayton, OH
   45469-0168 USA
3. Pittsburgh Supercomputing Center
   Carnegie Mellon University
   4400 Fifth Avenue
   Pittsburgh, PA
   15213 USA

Carbon and graphite foams comprise a relatively new material system with applications in military, industrial and commercial fields such as thermal management, EMI shielding, filtration, electrodes, crash absorption panels and orthopedic devices. Created from a mesophase pitch precursor, carbon foams are composed of a three-dimensional network of ligaments thus accounting for the high specific strength and stiffness values. In addition to unique mechanical characteristics, carbon foams show great promise in thermal management applications that require low coefficient of thermal expansion and/or high conductivity values. By transforming the carbon foam into a multi-functional material system, their use may be greatly expanded into emerging technologies.

In an effort to create and characterize multi-functional carbon foams, computational models that capture the details of its microstructure are essential to understand and predict its constitutive behavior. The current focus is in obtaining micro-CT x-ray images and translating them into an accurate and representative geometrical model of the microstructure of the carbon foam at multiple scales. In this paper we will illustrate this approach for a single as well as several interconnected ligaments. In addition, work is in progress to create models with multiple pores or cells.

Beyond the geometrical representation of the carbon foam microstructure, the anisotropy of the carbon foam ligaments is also addressed. Since polarized light microscopy images show orientation in the graphene layers in a single ligament, this pattern is then built into the ligament model. Subsequent parametric studies enable the assessment of orientation impact on material and physical properties. In a similar fashion, coatings and infiltrations in these simulations will help select optimum processing materials to tailor multifunctional response to coupled fields such as mechanical, thermal and electrical.

Key words: micro-CT, FEA, foam