Advanced 3D Reconstruction of Ceramic Foamy Materials

C. Stiapis[1,2], E. D. Skouras[1,3], V. N. Burganos[1*]

[1]Institute of Chemical Engineering Sciences (ICEHT), Foundation for Research and Technology, Hellas (FORTH), Patras, Greece

[2] Department of Chemical Engineering, University of Patras, Patras, Greece

[3]Department of Mechanical Engineering , TEI of Western Greece, Patras, Greece

*(*vbur@iceht.forth.gr*)

ABSTRACT

Ceramic foams represent structural materials with high porosity and widely varying specific surface area. They are composed of relatively large pores interlinked with filaments. The transport and mechanical properties of ceramic foamy materials that are used in a range of industrial applications, e.g., for thermal insulation due to their decreased thermal conductivity[1], in filtering for hot gas cleaning[2], and in bioreactors[3], are heavily influenced by their micro-structural features. A key element in the design of such modern high-performance materials is the quantification of the effect of the pore structure and the pore geometry on their macroscopic transport properties. Computer-aided techniques have been increasingly important and practical in this direction, thanks to significant increase of computing power, rendering the generation of highly accurate digital 3D representations of such materials feasible. In the present work, algorithms for the digital reconstructions of foamy materials from SEM images have been developed. Their utilization allowed the numerical evaluation of effective transport properties of the foams with increased accuracy, simultaneously avoiding extensive laboratory experimentation. Quantitative analysis on the SEM images provided crucial information for geometrical properties such as cell size distributions, struts shape, and orientation distributions for different features. The 3D model offered a detailed representation of the internal structure, as well as the spatial associations of the foamy material under consideration. This study suggested a technique for the full 3D reconstruction of foamy materials structures that can be used for the reliable prediction of the transport properties for different pore sizes and filament types. A satisfactory agreement was observed for the Darcian permeability and Forchheimer coefficient values between the model predictions and data obtained from the literature.

References

[1] Acchar, W. Ramalho EG, Souza FBM , Torquato WL, Rodrigues VP, Innocentini MDM. (2008). *J. Mater. Sci.* 43**:** 6556-6561

[2] Eggerstedt PM, Zievers J , Zievers E. (1993). *Chem. Eng. Prog.* 89**:** 62-68.

[3] Gibson LJ, Ashby MF. (1999). *Cellular solids: structure and properties* (Cambridge university press).