On power scaling laws dictating the mechanics of porous materials

Ameya Rege*†[1]

[1]University of Twente – Netherlands

Abstract

The mechanical, thermal, and acoustic properties of porous materials exhibit a power law relationship with their density or solid fraction. Thus, it is generally assumed that density is the critical parameter dictating the properties in the case of open-porous cellular materials. The Gibson and Ashby open-cell foam model derives a quadratic relation between the Young modulus and density for the case of such open-porous cellular materials (1). This relationship is validated against several foam-like materials. However, many novel materials such as aerogels or porous graphene demonstrate scaling exponents around 3.0 or 3.5. To design such materials for tailired applications, it becomes imperative to understand the origins of this unusually high scaling exponents. Thus, the effect of pore-size distributions, pore-wall morphology and the network connectivity of the solid material through the porous space is computationally investigated. The results demonstrate that the unusually high scaling exponents emerge from the network connectivity of the material (2). This aspect will be further explored.

References

(1) Gibson, L.J. and Ashby, M.F., 1982. The mechanics of three-dimensional cellular materials. *Proceedings of the Royal Society of London. A. Mathematical and Physical Sciences*, *382*(1782), pp.43-59.
(2) Aney, S., Pandit, P., Ratke, L., Milow, B. and Rege, A., 2023. On the origin of power-scaling exponents in silica aerogels. *Journal of Sol-Gel Science and Technology*, pp.1-8.

*Speaker
†Corresponding author: ameya.rege@utwente.nl