Numerical study of the hyperviscoelastic response of polymer foams under compression

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Abstract

We study numerically the compression up to large deformation (typically 50%) of a commercial closed-cell polymer foam with 90% porosity when the polymer exhibits hyperviscoelasticity.
The polymer's viscoelasticity has been largely overlooked in related existing studies in the literature, highlighting the novelty of the current work. This effect is important when considering the influence of the compressive strain rate, or when studying more complex loading histories taking place over long time periods such as the succession of compression, stress relaxation and creep tests for instance. The predicted viscoelastic response of the foam is compared to experimental data.

In the literature, microstructures are usually either derived from SEM or tomography images, or generated as perdiodic lattices in order to reach high porosity values such as 90%. In the current study, random microstructures with 90% porosity are generated with Voronoï techniques, such as M-Voronoï (1). This enables to get microstructures closer to the real ones than periodic arrangements of pores on the one hand, while not depending on real images and therefore having some control on microstructural parameters such as porosity and pores spatial and size distributions on the other hand. The influence of the microstructure on the mechanical response at the macroscale is studied and discussed.
(1) Z. Hooshmand-Ahoor, H. Luo, K. Danas, M-Voronoi and other random open and closed-cell elasto-plastic cellular materials: Geometry generation and numerical study at small and large strains, International Journal of Solids and Structures, Vol 290, 2024, 112680, ISSN 0020-7683.

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