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ABSTRACT:

3D Finite Element Study of Hyperelastic Foam Behavior

T. Merlette & J. Diani
Laboratoire de Mécanique des Solides, UMR 7649 CNRS, Ecole Polytechnique, Palaiseau, France

The mechanical behavior of isotropic hyperelastic foams is investigated numerically using 3D finite element simulations under finite-strain uniaxial compression and tension, as well as infinitesimal-strain shear and hydrostatic loading conditions.

Foam microstructures with porosities ranging from 77% to 95% were generated. Two types of microstructures were considered: (i) classic Voronoi closed- and open-cell foams, characterized by flat walls of uniform thickness, and (ii) mechanical Voronoi (M-Voronoi) microstructures, featuring curved walls with spatial variations in wall thickness.

Infinitesimal-strain characterizations of the shear and bulk moduli revealed that the shear modulus is accurately predicted by the Differential Hollow Sphere Assemblage (DHSA) model, originally developed for spherical voids. However, the same model was found to overestimate the bulk modulus. A phenomenological correction is therefore proposed to allow for faster and more accurate estimation of this quantity.

Finite-strain uniaxial tension (up to 200%) and severe uniaxial compression (up to 95% nominal strain) were simulated using the ***Abaqus/Explicit*** solver. Parametric studies on both the microstructural morphology and the mechanical behavior of the polymer matrix provide new insights into the mechanical response of the foams.

Finally, the effect of internal gas pressure within closed cells was assessed numerically and compared with experimental data, confirming the validity of the analytical model proposed by Gibson and Ashby (1997).