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Modeling and Simulation (M&S) Assessment of Mechanical Response of Open-Cell Porous Media

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The present work is devoted to V&V of the elastic and plastic behavior of porous materials obtained from micromechanical modeling. Nonlinear numerical analyses were conducted using the finite element method (FEM), with the nano-porous gold media being the three-dimensional model system. The effective elastic and plastic response of the model structures, encompassing a wide range of porosity and pore geometry, were simulated using ANSYS. Attention is directed to the uniaxial stress-strain response as a function of the porous microstructure. The model geometries were generated based on interconnected and non-overlapping pore topologies arranged in an orderly manner. The sensitivity of the numerical result to the pore morphology was examined by comparing the normalized effective modulus of elasticity for all cases at the same porosity. Model verification with theoretical solutions was considered for open-cell foams. As expected, the introduction of porosity was found to reduce the elastic modulus of the media. In addition, stress distribution in the porous microstructure was significantly influenced by the pore morphology. The approach can be readily generalized to study a wide variety of porous solids from nano-structure materials to geological structures.

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