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Scaling relations for select effective engineering properties of highly-porous materials

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We discuss scaling relations for select effective engineering properties - Young's modulus, compressive strength, and thermal conductivity - of highly-porous materials with emphasis on closed-cell microstructures [1-3]. These scaling relations were obtained by analysis of unit cell-based microstructural models based on the arrangement of thin spherical shells or spheres. In the highly-porous regime, the obtained scaling relations of power-law type - with effective material properties proportional to the n-th power of the volume fraction of the solid material phase - seem to represent the experimentally observed behavior better than classical homogenization schemes from continuum micromechanics (Mori-Tanaka scheme, differential scheme, etc.). The obtained scaling relations are compared to test data on aluminum foam, polymeric foam, and porous ceramics.

[1] Ch. Pichler, R. Lackner. Sesqui-power scaling of elasticity of closed-cell foams. Material Letters 2012;73:212-215.

[2] Ch. Pichler, R. Lackner. Sesqui-power scaling of plateau strength of closed-cell foams. Materials Science and Engineering A 2013;580:313-321.

[3] Ch. Pichler, R. Traxl, R. Lackner. Power-law scaling of thermal conductivity of highly-porous ceramics. Journal of the European Ceramic Society 2015;35:1933-1941.

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