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Mechanical scaling behavior of nanoporous gold based on 3D structural analysis and indentation-based testing

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The strength of nanoporous gold (npg) has been shown to be strongly dependent on the length-scale of the gold ligaments, an observation consistent with countless micromechanical experiments that show the typical trend of “smaller is stronger”. Such size-dependent strength can be exploited in npg through targeted annealing in order to tailor the structures for specific applications. However, this approach to structural optimization requires adequate scaling laws for the prediction of strength as a function of structural length-scale, an approach reliant on the assumption of self-similarity of the coarsened structure. Here we present evidence from high resolution 3D structural characterization that the condition of self similarity may be sufficiently met for the prediction of mechanical response. By identifying representative volumes, a rich set of structural parameters is achieved, though many parameters may be superfluous for understanding the scaling behavior in mechanical response. Through nanoindentation and microcompression testing of such respresentative volumes, a correlation of salient structural parameters to the mechanical properties is achieved, and discussed in terms of the limits of the Ashby-Gibson laws and the potential for optimizing strength and stiffness of nanoporous metals.