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On the self-similarity of structural evolution of nanoporous gold

Sunday, November 27, 2022 2:00 PM (45 minutes)

This talk addresses the validity of the commonly assumed self-similarity of the structural evolution of nanoporous gold. To this extent, a quantitative study of the salient structural parameters identified from so-called 'representative volumes' of the bicontinuous nanoporous gold (NPG) network has been carried out and is based on a variety of characterization approaches. 3D-focused ion beam tomography applied to as-dealloyed and isothermally annealed NPG samples provide direct assessment of topological characteristics, while TEM identifies the evolution of defect distributions. After identifying sufficiently large representative volumes, we show that the ligament width distributions coarsen in a sufficiently self-similar, time-invariant manner, while the scaled connectivity density shows a self-similar ligament network topology. Using these critical parameters, namely mean ligament diameter and connectivity density, the Gibson–Ashby scaling laws for the mechanical response of cellular materials are revisited. The inappropriateness of directly applying the Gibson–Ashby model to NPG is demonstrated by comparing finite element method compression simulations of both the NPG reconstruction and that of the Gibson–Ashby solid model; rather than the solid volume fraction, we show that an effective load-bearing ring structure governs elastic behaviour. On the other hand, TEM investigations show a breakdown in self similarity of internal microstructure of the ligaments themselves, and may explain some of the variations in the mechanical behavior in the plastic regime. The consequences of the results will be placed the context of tailoring nanoporous metals for targeted applications.

Category

Solid State (Theory)

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