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Advanced Characterization and Modification of Nanoporous Metals

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Extended Abstract

The results of a number of recent investigations into nanoporous metals will be summarized, and some general principles elucidated. The most common nanoporous metal, "nanoporous gold" (NPG) is actually several variants, made from Ag-Au precursors with low (5 at.%), or high (up to 30 at.%) Au, with or without small additions of elements such as Pt.

NPG is usually synthesized by dealloying – the selective electrolytic dissolution of more reactive element(s), in this case Ag, from a solid solution. The operative mass transport process is diffusion of Au (and Pt, where present) at the solid-electrolyte interface, allowing the continual emergence of Ag.

One would like to use NPG for various applications, such as membranes, catalysts, sensors, and so on. One drawback of ordinary NPG for such purposes is the continued mobility of Au at the surface, which leads to coarsening of the structure, especially at elevated temperatures. The addition of small amounts of Pt [1] hinders such coarsening, even at low Au contents [2] and also has obvious relevance to catalysis.

Atom Probe Tomography (APT) has proved very successful for the nanoscale analysis of NPG [2-4]. The essential step was to learn how to electroplate Cu into the pores, achieving complete filling, at least locally. This strengthened the material against the otherwise inevitable fractures that would occur during the APT analysis.

Heating of NPG, in air or inert environments, causes surface segregation that can be beneficial, especially for catalysis [4,5]. Much remains to be learned about the operative mass transport processes.

Adsorption on to the ligament surfaces in NPG can alter the electrical resistance of the metal itself, leading to potential applications in gas sensing [6].

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