SMALL SCALE MECHANICAL TESTING OF NANOPOROUS TUNGSTEN TAILORED BY REVERSE PHASE DISSOLUTION

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Nanoporous metals possess a number of positive attributes such as light weight, large surface area, excellent thermal properties, and energy absorption capability, making them a good candidate as future radiation shielding materials [1]. Tungsten seems to be ideally suited as the base material for such a foam, as it is commonly used in nuclear facilities, medical diagnosis systems and a number of other circumstances in order to protect personnel and sensitive equipment from radiation [2]. Therefore, it is of great value and interest to tailor such novel nanoporous tungsten, in order to combine the beneficial properties of tungsten with the positive attributes of nanoporous foams. In this work, nanoporous tungsten foams with relative densities ranging from 20 to 50 % were created on a bulk scale through a unique route involving severe plastic deformation of a coarse-grained tungsten-copper composite, followed by the selective dissolution of the nobler copper phase. Scanning electron microscopy and high-resolution transmission electron microscopy were utilized for characterizing the microstructural evolution and analyzing the way the etching solutions affect the resulting nanoporous structures. The mechanical properties, which are an important consideration in fusion reactor applications, were investigated by employing nanoindentation and other small-scale testing techniques in situ in the SEM. Based on this, the elemental plasticity mechanisms governing the mechanical behavior were elucidated. This work for the first time provides an innovative and adaptive approach to create bulk nanoporous tungsten. The developed reverse phase dissolution method is generally applicable and can be transferred to other refractory metal materials in the future. The promising mechanical results of nanoporous tungsten will serve as foundation for forthcoming related scientific studies and engineering applications.

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