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P2.193 Synthesis densification and mechanical properties of nanometric tungsten for fusion applications

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Recent works have shown that low grain sizes are favorable to improve ductility and machinability of tungsten, as well as the resistance to ablation and spallation, which are key properties for the use of this material in thermonuclear fusion environment [Reiser et al. Int. Journal of Refractory Metals and Hard Materials, 64 (2017) 261]. However, current production routes are not suitable for the fabrication of bulk nanostructured tungsten samples. We propose here a new methodology based on powder metallurgy. Powder synthesis is performed using the Self-propagating High-temperature Synthesis (SHS) process. SHS is based upon the reduction of tungsten trioxide with magnesium in excess, and using sodium chloride as a reaction moderator. Resulting powders show platelet-like grains as the main feature, below 1µm in their largest dimension and around 60nm in thickness. Densification is then performed using Spark Plasma Sintering (SPS) at temperatures of up to 2000℃, even though the densification seems to be complete below 1600℃. Relative densities of 99.99% have been obtained. While Scanning Electron Microscopy (SEM) reveals an apparent grain size in the micrometer range, Electron Back Scattered Diffraction (EBSD), which is sensitive to the grain crystallographic orientation, clearly indicates that these micrometric grains are in fact nanostructured (see figure). A global preferential crystallographic orientation is observed, although the surface analyzed is only 60x60 µm2. Simultaneously, this nanostructure induces an increase in hardness to a value of 428 HV, much higher than microcrystalline tungsten (~327 HV). These first results confirms that the process presented in this paper go in the right direction e.g. bulk nanostructured tungsten material. Mechanical tests (such as compression test) are currently ongoing with different test samples. Plasma exposure experiments are also undertaken in order to evaluate how the new nanometric W material sustains plasma erosion. All these results will be presented in this contribution.

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