Development and Testing of Dispersion-Strengthened Tungsten Alloys via Spark Plasma Sintering

ERIC LANG, NATHAN MADDEN, CHARLES SMITH, JESSICA KROGSTAD, JEAN PAUL ALLAIN, Univ of Illinois - Urbana — Tungsten (W) is a common plasma-facing component (PFC) material in the divertor region of tokamak fusion devices due to its high melting point and high sputter threshold [1]. However, W is intrinsically brittle and is further embrittled under neutron irradiation, and the low recrystallization temperature pose complications in fusion environments [1,2]. More ductile W alloys, such as dispersion-strengthened tungsten are being developed. In this work, W samples are processed via spark plasma sintering (SPS) with TiC, ZrC, and TaC dispersoids alloyed from 0.5 to 10 weight %. SPS is a powder compaction technique that provides high pressure and heating rates via electrical current, allowing for a lower final temperature and hold time for compaction [3]. Initial testing of material properties, microstructure, and composition of specimens will be presented. Deuterium and helium irradiations have been performed in IGNIS, a multi-functional, in-situ irradiation and characterization facility at the University of Illinois. High-flux, low-energy exposures at the Magnum-PSI facility at DIFFER exposed samples to a D fluence of $1 \times 10^{26} \text{cm}^{-2}$ and He fluence of $1 \times 10^{25} - 1 \times 10^{26} \text{cm}^{-2}$ at temperatures of 300-1000 C. In-situ chemistry changes via XPS and ex-situ morphology changes via SEM will be studied. [1] D. Naujoks, et al. Nucl. Fusion. Vol 36, No. 6 (1996) [2] S.J. Zinkle, et al. Annu. Rev. Mater. Res. 2014. 44:241–67. [3] J.R. Groza, et al. Mat. Sci. and Eng. A287 (2000) 171-177. Work supported by US DOE Contract DE-SC0014267

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Date submitted: 17 Jul 2017

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