Contribution ID: **684** Type: **not specified**

P2.112 Assessment of mechanical properties of tungsten wires for the fiber-reinforced plasma facing components

Tuesday, 18 September 2018 11:00 (2 hours)

Recent efforts dedicated to the mitigation of tungsten (W) brittleness have demonstrated that tungsten fiber-reinforced tungsten composites show toughness even at room temperature. This is caused by extrinsic mechanisms induced by the incorporated tungsten wire used as reinforcing element. High temperature operation and manufacturing of the fiber-reinforced composites might result in a change of the mechanical properties of the wires and thus to a change in the overall composite properties.
To address the issues related to the fiber properties, we investigate mechanical and microstructural properties of pure and potassium-doped tungsten wires, being heat treated in the temperature range between 900-2300℃. The mechanical tests are performed starting from room temperature up to 600℃. The microstructure of the wires in as-received, as-annealed and as-deformed conditions is investigated by a number of techniques including scanning and transmission electron microscopy employing focus ion beam for the sample preparation. Based on the light optical microscopic analysis, the engineering deformation curves are converted into actual stress - strain dataset, accounting for the local necking. The analysis demonstrates that local strain in the necking region can reach up to 50% and the total elongation monotonically increases with temperature, while the ultimate tensile strength goes down. High temperature annealing above 1600℃ makes the wire completely brittle, while K-doping shifts the threshold annealing temperature up to 2100℃. Mechanical tests performed at elevated temperatures show that the ultimate tensile strength of the wires exhibits drastic reduction for the pure W wires annealed above 1300℃. K-doped wires sustain considerable tensile strength up to at least 1900℃. K-doping clearly demonstrated the improved resistance against high temperature annealing otherwise causing sever degradation of mechanical properties in pure W wire.

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Session Classification: P2