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P4.217 Fracture resistance study of tungsten wires as base material of fibre-reinforced plasma facing components

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Together with the outstanding high-temperature mechanical and physical properties, the highest melting point of all the metals and thermal stability against recrystallization make tungsten (W) one of the main armour and heat sink materials candidate. Nevertheless, its applicability as a high-performance structural material is somewhat limited due to its typically brittle character at low temperatures and rather high ductile-to-brittle transition temperature. Among several ductilization strategies, one of the promising options is the development of W-fibre reinforced W-composite materials (Wf/W), where extrinsic toughening mechanisms can be used. For a detailed failure analysis of such a composite material, it is essential to obtain a complete understanding of fracture behaviour of drawn tungsten wires which are used as a base material incorporated in the tungsten matrix.

This contribution is oriented towards the study of damage tolerance of pure and potassium doped W wires with the main focus on the influence of different heat treatments. SEM with an EBSD detector was used to determine the microstructure of the wire. Vacuum annealing in the temperature range from 900℃ - 1600℃ permits the investigation of the microstructural stability of the two materials revealing a strong stabilization for K-doped wire with shifted recrystallization to above 1600℃. The RT fracture experiments were performed on both as-received and annealed wires, followed by a detailed characterization of the fracture surfaces. In contrast to K-W wire, the pure W experiences a drop in fracture toughness by about 70% after heat treatments, followed by a transition in failure mode from knife-edge ductile to the brittle cleavage fracture. The orientation sensitive experiments, conducted in two principle crack directions in respect to the drawing direction reveal significant anisotropy of fracture properties. Furthermore, the relationship between responsible deformation mechanism and degree of deformation is made by alternating the wire diameter between 50 and 150 µm.

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