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Materials Development for new high heat-flux component mockups for DEMO

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Thermo-mechanical stability, oxidation and fuel management are driving issues behind the development of new plasma-facing materials for fusion. In recent years significant progress has been made in developing new material types with enhanced toughness (fibre reinforced tungsten (W) – Wf/W) compared to bulk tungsten, Smart-W, with suppressed oxidation and also new advanced copper based materials with enhanced high temperature strength.
Their properties, such as enhanced fracture toughness at RT (> 20 MPa m0.5), will be discussed. Along with mechanical properties initial tests on erosion, high heat flux (HHF) performance and hydrogen retention are available. HHF tests show that having short fibres at the exposed surface leads to their selective erosion and melting. Initial HHF tests under plasma conditions are ongoing in the linear plasma device PSI-2. Furthermore, from modelling it is shown that including fibres coated with yttria into the tungsten matrix will change the hydrogen uptake as yttria reacts as permeation barriers.
Using these new material for components- requires the development of a new highly integrated design approach – which based on exiting results will be discussed in this contribution. With this in mind we will presented the development of two classes of Wf/W-composite, based on an incorporation of continuous fibres or weaves into a CVD tungsten matrix and Wf/W based on a powder metallurgical (PM) route utilizing short fibres of few mm length.
For HHF components typically two designs are considered – a flat tile design as well as a design similar to mono-blocks. In view of manufacturing full scale HHF components test results regarding first large-scale material samples and mock-ups will be shown. In contrast to typical component designs, this material development is pointing to a divergence from classical HHF components, e.g. incorporating both monolithic and composite materials in one concept.

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