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# Tungsten Composite Materials for Fusion First Wall applications

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The development of advanced materials is essential for sophisticated energy systems like a future fusion reactor. For a fusion power plant multiple issues with respect to materials and components need to be evaluated. Brittle behavior is the limiting factors when operating any W based plasma facing components (PFCs) in a tokamak. This is particularly crucial when considering material degradation from neutron-induced transmutation and embrittlement. Here tungsten fiber-reinforced tungsten composites (Wf/W) can mitigate these issues by utilizing extrinsic toughening mechanisms and therefore overcoming the intrinsic and neutron embrittlement. Extrinsic toughening for Wf/W is achieved similar to other composites by incorporating an interface between fiber and matrix allowing for additional energy dissipation without relying on intrinsic material properties such as ductility. The use of Wf/W could broaden the temperature window of W significantly and mitigate problems of cracking occurring typically in cyclic high heat flux loading.
Wf/W as a material has been successfully produced and tested during the last years and the focus is now put on the technological realization for the use in PFCs as well as the further enhancement of production methods. Here we present a way to utilize Wf/W composites for divertor applications by a fabrication route based on the both chemical vapor deposition or infiltration (CVD, CVI) of W and powder metallurgy (PM) .
Mock-ups based on the ITER typical design can be realized by the implementation of Wf/W-flat tiles or monoblock like approaches. In both cases, varying geometries for the introduction of fibers can be envisioned. For the CVD route, the furthest developed method is a concept based on a layered deposition approach allowing the production of flat tiles in the required geometry. One fiber layer after the other is positioned and ingrown into the W-matrix until the final sample size is reached. For the PM route development is progressing towards the use of pressure assisted sintering methods like field assisted sintering (FAST) and hot isotactic pressing (HIP). For multi-fiber PM –Wf/W special care needs to be taken developing a method for incorporating fiber and powder, while for the CVD Wf/W already large multi-fiber composites can be achieved. PM Wf/W has only recently been shown to be able to achieve multi-fiber Wf/W.

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