Contributions of tungsten-fibre reinforced tungsten composites to divertor concepts of future fusion reactors

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Tungsten is due to its unique properties a prominent candidate for highly loaded areas in a future fusion reactor. In this respect the development of advanced tungsten materials is essential for sophisticated divertor concepts. Promising candidates are tungsten fibre-reinforced tungsten composites (Wₚ/W) which utilize extrinsic toughening mechanisms and therefore overcome the intrinsic brittleness of tungsten. Tungsten composites have been successfully produced and tested during the last years and the focus is now put on the technological realisation of Wₚ/W based divertor targets. Besides the huge particle and energy fluxes the divertor targets will face severe challenges like an increase of the DBTT due neutron irradiation and potentially strong recrystallization at least during thermal transients further promoting thermal fatigue. In this contribution we critically discuss the aspects of a divertor concept based on Wₚ/W in respect to these challenges.

As the toughening mechanisms in Wₚ/W are purely mechanical, toughening is still active after embrittlement and thus the effect of operational embrittlement is mitigated. Potassium doped wire used as fibres in Wₚ/W show an excellent high temperature performance up to 2000 K and allow therefore an increase of the operation temperature. The good toughness of Wₚ/W at room temperature allows the extension of the temperature window to lower temperature. Targeted fibre positioning could be used to strengthen and toughen critical parts like regions with stress concentration or high risk of crack initiation. On the other hand, the use of composites raises new aspects within classical divertor materials and plasma wall interaction issues. E.g. composites feature many internal interfaces which might have an impact on thermal conductivity and hydrogen retention. For a successful realisation a strong collaboration of materials and fusion experts as well as design engineers is necessary.

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