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P2.128 New route towards micro-structuring tungsten as stress relieving concept

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In order to realize a commercial feasible fusion reactor, the life time of plasma facing materials (PFM) and components (PFC) is one of the key issues. Steady state loads in the range of 10 MW/m^2 and in addition millions of transient events with 0.6 - 3.5 GW/m^2 represent a huge challenge and lead to severe damages. As first wall, tungsten armor on a low activating structural steel is planned. However, the difference of their thermal expansion coefficients causes large thermal stresses during operation and the cyclic heat loads can lead to a detachment of the tungsten armor. In addition, surface roughening and cracking caused by the repeating incident of transient events can drastically increase the erosion rate. In order to reduce both types of stresses a promising new concept and first results are presented.
Tungsten wires (Ø between 100 µm and 200 µm), which are relatively cheap and easily available from the light bulb industry, are coiled on a square shaped spool. Cutting the edges into slices of different thicknesses, dozens of samples were successfully produced at once. Slices of 1 mm thickness placed in between steel and bulk tungsten can drastically reduce the thermal stress due to the flexibility provided by the ductile wires. At the same time a similar heat conductivity like bulk tungsten is achieved in direction of main heat flux. Supporting FEM simulations are presented. Taking this idea further, the possibility to use 5 mm thick slices directly as PFM is investigated. As the typical crack distance after transient loading is in the range of some hundred µm, wires with smaller diameters could withstand the stresses, reducing the damage to the surface. With high heat flux tests on wires vs. bulk we show the high potential of this concept.

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