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Perspectives of chemical vapour deposition for the fabrication of tungsten fibre-reinforced composite components

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Due to its unique property combination tungsten materials are the preferred choice for high-heat-flux-loaded areas in future fusion power plants. However, tungsten has a high brittle to ductile transition temperature and is prone to operational embrittlement due to high temperature and/or fast neutron irradiation. Tungsten fibre-reinforced tungsten composites utilize extrinsic mechanisms to improve the fracture toughness and thus mitigate this drawback. In these composites high strength drawn tungsten wire is used in combination with a tungsten matrix produced by chemical vapour deposition (CVD) or powder metallurgy (PM), respectively. Although little experience exists regarding the use of CVD for the production of bulk W materials this technique offers several interesting properties. In this contribution we will give an overview of the development of this production technique with a focus on recent results.
Using gaseous tungsten hexafluoride (WF6) together with hydrogen (H2), CVD allows the growing of solid tungsten on surfaces at temperatures above 350° C. Despite some success with a multilayer fibre preforms the focus in recent years has been on upscaling with a single-layer technique. Here, the upgrade both in textile techniques and CVD equipment allowed the fabrication of larger samples and the assessment of the size effect on mechanical properties. Recently, the use of yarns industrially produced from single W filaments has been established. These improved the reproducibility significantly.
However, the question of component design brought back the attention to more complex 3d structures recently. Although challenging the application of an infiltration process on textile preforms would allow a huge design freedom. The establishment of process understanding and modelling allowed to perform feasibility studies to assess the effect of process parameters like gas flow, local pressure and temperature. The combination with the tungsten fibre-reinforced copper concept offers a unique possibility for an optimized component design. Especially the improvement of joints, the load orientated fibre architecture and the possibility of larger structures are interesting. Further, the good resistance of the W fibres against irradiation embrittlement is an important benefit in view of future fusion reactor applications.

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