DENSIFICATION OF SiC MATRIX IN SiCf/SiC COMPOSITES FOR FUSION APPLICATION

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Due to its intrinsic properties silicon carbide (SiC) is considered as a promising material for high temperature structural applications. Low neutron activation of pure SiC, along with its high mechanical and thermal stability make SiC a candidate material for structural applications in future fusion reactors. To ensure sufficient fracture toughness and reliability of the material, SiC is proposed to be used in the form of continuous SiC-fibre-reinforced SiC composite (SiC_f/SiC) [1]. Currently developed techniques for the production of SiC_f/SiC composites involve chemical vapour infiltration (CVI) or polymer infiltration and pyrolysis (PIP) which are very slow and costly processes and result in an incomplete filling of the gaps between the fibres in the tows [2]. Therefore further attempts have based on using ceramic routes or the so called hybrid routes which combine different fabrication techniques in order to achieve a dense material.

In this work the combination of electrophoretic deposition (EPD) and polymer infiltration and pyrolysis, for the production of a dense SiC matrix in SiC_f/SiC composites, were investigated. Due to the high initial density of the EPD produced deposits (62%) only a few PIP cycles were needed to achieve a high density material [3]. The porosity measurements show that after each PIP cycle the porosity was reduced achieving ~13 % after 6 PIP cycles, with average pore diameter of ~ 0.09 µm which indicates that further densification is possible. Microstructures and thermal properties of the material were assessed and compared to the deposits consolidated by standard sintering techniques. Thermal conductivity of the deposits consolidated with PIP was significantly higher (> 40 W/mK after 3 PIP cycles) in comparison to the deposits sintered at low temperatures (1673 K) with the use of transient eutectoid (< 10 W/mK). The influence of microstructure and porosity on thermal conductivity of the material was also evaluated. Although porosity influences the thermal properties of the material to some extent, the governing parameter is crystallinity of the material.

[1] Muroga, T., Gasparotto, M. and Zinkle, S. J., Overview of materials research for fusion reactors. Fusion Engineering and Design 13, 2002.

[2] Riccardi, B., Giancarli, L., Hasegawa, A., Katoh, Y., Kohyama, A., Jones, R. H. et al., Issues and advances in SiC_f/SiC composites evelopment for fusion reactors. Journal of Nuclear Materials, 2004, pp. 329–333.

[3] S.G. Lee, J. Fourcade, R. Latta, A.A. Solomon: Polymer impregnation and pyrolysis process development for improving thermal conductivity of SiCp/SiC-PIP matrix fabrication. Fusion Engineering and Design 83, 2008, pp. 713-719.