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P3.124 W2C reinforced tungsten: thermo-mechanical and microstructural properties

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Lately, tungsten has gained considerable attention of the fusion scientific community due to its performance at high temperatures. On the other hand, tungsten is affected with a serious reduction of strength at elevated temperatures, latter being one of the main drawbacks of its usefulness as a plasma facing material in fusion reactors.1 Therefore, the main aim of this work has been to improve the material properties to sustain plasma-facing conditions when being installed in divertor as a monoblock, especially to be able to resist high thermal loadings during operation. Among the available options, we selected reinforcement of tungsten by incorporation of carbide nanoparticles, wherein the reinforcement should not chemically react with the matrix. In this respect, W2C nanoparticles offer an interesting option.
WC nanoparticles and graphene were used as a carbon source. Both used precursors resulted in the formation of W-W2C composites, due to high-temperature reaction with W powder during sintering. Using field assisted sintering technique (FAST, 1900℃, 60 MPa, 5 min), only two phases were detected in the sintered composite: cubic W and hexagonal W2C, which implies complete reaction regardless of the carbon precursor used. In addition to thorough microstructural and phase analysis, thermo-mechanical properties at room and elevated temperature of the as-sintered and samples aged at 1600 ℃ for 24 h were evaluated. The results confirm that presence of small W2C grains enhance densification of tungsten and inhibit the tungsten grain growth at high temperatures up to at least 1300 ℃. Results of thermo-mechanical measurements indicate that small amount (i.e. 5 wt %) of W2C reinforcements improve mechanical properties of the material, while the thermal conductivity of the composite does not drop below 100 W/m K at 1000 ℃. The obtained results suggested WC nanoparticles as the most convenient precursor for the formation of W2C in tungsten matrix.

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