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Layered W-WC composites prepared by FAST

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One of the main difficulties of designing fusion reactor is the development of plasma-facing materials that have to be resilient to the proximity of plasma. Pure tungsten is a primary candidate for this material but has to be strengthened either with particles or fibers to improve its' brittleness at moderate temperatures and inhibit recrystallization as well as grain growth at higher ones.
To limit the W grain growth, we proposed the incorporation of tungsten carbide particles in tungsten matrix. Samples were prepared from W and WC powder mixtures and consolidated with field assisted sintering technique (FAST). Layered W-WC composites with the gradually increased content of carbide phase were prepared to tailor the thermal conductivity of the material for monoblock of divertor. The layering will reduce thermal shocks and control heat transfer to the copper-based cooling system.
We have already confirmed, that sintering of W and WC particles by FAST induces in-situ high-temperature reaction with the final composition of cubic W with hexagonal W2C phase. W-W2C composites exhibit high density and improved mechanical properties at room and elevated temperatures. If the W2C content in the composite is 5 wt % or higher, W-grain growth is inhibited even after aging at 1600℃ for 24 h, due to the pinning of W grain boundaries with smaller W2C. The mechanical properties of aged samples did not impair, and chemical composition remained unchanged. Layered composites with the gradually increased content of W2C was successfully prepared. If the difference in the carbon content between two layers is too high, the growth of elongated W2C grains is induced. XRD and EBSD analyses confirmed that these elongated W2C grains had preferred orientation (0,0,2). The microstructures of such phases were thoroughly examined.

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