W-Cr SOLID SOLUTION: COMPARISON OF ALLOYING IN SPS AND BY BALL MILLING

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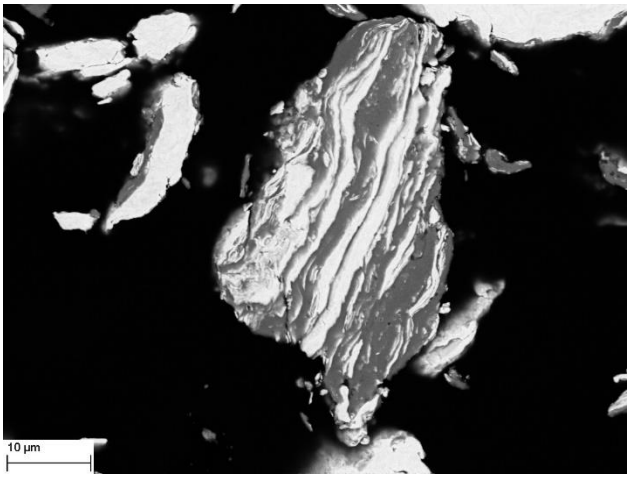
Tungsten alloys currently represent prospective candidates to replace tungsten in the first wall applications in future fusion facilities. They are anticipated to suppress unfavorable mechanical properties of commercially pure tungsten and/or to gain advantages such as ability of self-passivation under accidental conditions. The self-passivating alloys are designed to minimize possible consequences related mainly to a LOCA (Loss of Coolant Accident) event with simultaneous air ingress into the reactor vessel.

Self-passivating tungsten alloys contain additions such as Cr with the ability to form compact and thermally stable oxide scale. As soon as the oxide scale is formed, activated tungsten oxides cannot be released to the surroundings. W-Cr with 10 wt.% of Cr have shown the best passivation properties.

W and Cr are elements with a very different melting point. At the onset of tungsten melting (3422 °C) the temperature is far beyond the boiling point of chromium (2 672 °C). Thus, standard casting methods are very inconvenient for this system. Therefore, tungsten-chromium alloys are usually prepared by mechanical alloying route. However, this method possesses several drawbacks such as impurity introduction stemming out of the principles of mechanical alloying and long processing times (usually tens of hours to days).

In this study, W-Cr alloys were prepared by direct alloying in SPS. The W-Cr system possesses a miscibility gap; thus, to enhance alloying, sintering was performed above the gap. In some cases, further alloying enhancement was reached by short ball milling of W-Cr powder and subsequent sintering. The results are summarized and compared to mechanically alloyed samples. Feasibility of W-Cr alloys production by SPS alloying is discussed.



Powder particle after short ball milling process. The powder consists of pure tungsten and pure chromium layers.