Trial Fabrication of Beryllides as Advanced Neutron Multiplier

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DEMO reactors require advanced blanket functional materials of neutron multiplier and tritium breeder which have higher stability at high temperature. Development of advanced neutron multiplier and advanced tritium breeder has been started between Japan and the EU in the DEMO R&D of the International Fusion Energy Research Centre (IFERC) project as a part of the Broader Approach activities from 2007 to 2016. Metal beryllium is considered as the neutron multiplier in the pebble bed type test blanket modules for ITER. On the other hand, advanced neutron multipliers with lower swelling and higher stability at high temperature are desired in pebble bed blankets, which will give big impact on the DEMO design such as the blanket operating temperature. Development of beryllium intermetallic compounds (beryllides) as advanced neutron multiplier has been started.

In this study, it reports on the preliminary results of beryllides synthetic using a plasma sintering method. The plasma sintering results in starting powder particle surface activation that enhances powder particle sinterability and reduces high temperature exposure. The main processes of the plasma sintering consist of plasma generation, resistance heating and pressure application (see Fig.1). Synthetic of intermetallic compound starts with mixed elemental powder particles. In this process, the starting powder particle is loaded in the punch and die unit. This powder particle is resistance heated while the uniaxial pressure is still applied to the sample in the sintering mold.

Preliminary sintering test of Be-Ti intermetallics was carried out using mixed with Be and Ti powder particles. The melting point of $Be_{12}Ti$ is 1873 K. The purity and powder particle size of Be and Ti elements are 99.9wt% and <50µm, respectively. The formations of $Be_{12}Ti$, $Be_{17}Ti_2$ and Be_2Ti intermetallics were identified at 1273 K for 20 min under 50 MPa pressure using starting mixed powder particles of Be and Ti. From the result of this preliminary sintering test, it is assumed that the beryllides could be directly synthesized by the plasma sintering method from mixed powder particles of Be and Ti at a lower temperature than melting point (see Fig.2). In this report, trial synthetic results of beryllides such as $Be_{12}V$, $Be_{12}W$, $Be_{12}Zr$ and other beryllides will be also present.

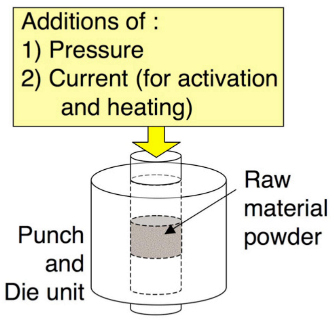

Figure 1: Schematic of the plasma sintering process.

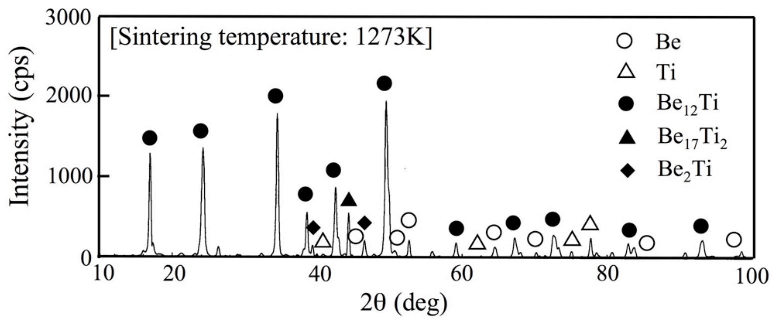

Figure 2: XRD profiles of plasma sintered beryllides.