IFERC Newsletter

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Status of DEMO R&D Activity

Highlights on Neutron irradiation experiments of BFMs

In this task, the irradiation of the solid advanced breeder and multiplier materials (i.e. beryllium based and orthosilicate) was planned to be done in Russia at INM. Due to the recent limitation in the collaboration with Russia, large part of 2022 was dedicated in finding alternative solutions. Two reactors have been identified in substitution:

- BR-2 reactor (SCK/CEN in Belgium) for neutron irradiation of the samples to be used for Post Irradiation Experiments (PIEs);
- WWR-K reactor (INP in Kazakhstan) for the in-situ tritium release experiments.

JA side has started to contact each reactor facility to share information and irradiation specifications. In parallel to this investigation of reactors' specifications, the preliminary samples' fabrication by plasma sintering has started, and a database is being established Furthermore, an optimization study of samples' fabrication by plasma sintering has been undergoing, as shown in Fig-1.

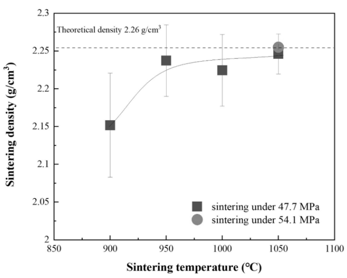

Fig-1: Sintering temperature vs sintering density

It was clarified as a result of beryllide fabrication that the density increased as the plasma sintering temperature increased. Analyses of Surface SEM images of each beryllide fabricated by plasma sintering at different temperatures (900, 950, 1000 and 1050 °C for 20 min under 47.7 MPa) show that high sintering density (over 95 %) is achieved except for the case of 900 °C.

Fig-2 shows an SEM image with indentation and cracks, used to evaluate the fraction toughness of $Be_{12}Ti$. The fracture toughness value of $Be_{12}Ti$ sintered at 1050 °C under 54.1 MPa was estimated to be 2.43 $MPa{\cdot}m^{0.5}$, by a JIS R1607 (Japanese Industrial Standard R1607) which is a similar to that for $Be_{12}Ti$ fabricated by hot isostatic pressed (HIP) with 2.4 ± 0.3 $MPa{\cdot}m^{0.5.}$

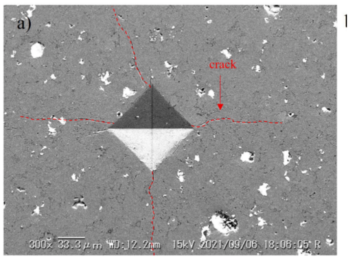

Fig-2: SEM image for measuring crack with Vickers hardness by indentation fraction (IF) method.

EU side has started the definition and the implement of the neutron irradiation experiment for EU Neutron Multiplier (EUNM) in BR2 reactor, the following tasks have been agreed:

- Neutron-physical and thermal-physical calculations, development of the rig design.
- Preparation of the test facilities and test procedures for the irradiation test.
- Irradiation of EUNM in the BR2 reactor.
- Transportation of irradiated EUNM samples from SCK·CEN to KIT.

The EUNM samples for irradiation include Be pebbles with 1 mm in diameter, produced by the rotating electrode method (REM) (NGK, Japan), Be pebbles of irregular shape with 1-2 mm in size (UMP, Kazakhstan), intermetallic compounds beryllides of two kinds, titanium beryllide $TiBe_{12}$ and chromium beryllide $CrBe_{12}$.

The beryllide samples for compression tests are cylinders (diameter of 2.2 ± 0.05 mm and height of 2.6 ± 0.15 mm). Those for thermal-programmed desorption (TPD) tests and thermal conductivity measurements are pellets (diameter of 7 ± 0.05 mm and height of 1.5 ± 0.15 mm), and mock-up as cylinders (diameter of 12 mm and height of 6 mm). These samples should be irradiated for the post-irradiation examination (PIE) in KIT.

The irradiation test of EUNM samples should be performed using a low-temperature (LT) rig and a high-temperature (HT) rig. The damage dose on all EUNM samples must reach at least 3 dpa (in steel) in several months (up to 1 calendar year) during irradiation in the BR2 reactor.

(DEMO R&D Task-3 TROs)