§5. Activation Experiment with D-T Neutrons on Materials Relevant to Liquid Blankets

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In order to evaluate neutron activation of materials relevant to the liquid blankets such as Lithium/vanadium-alloy and Flibe/vanadium-alloy blankets, Irradiation experiments have been performed using the Fusion Neutronics Source (FNS) at JAEA. Specimens of Er, Teflon (CF_2=CF_2) and NIFS-HEAT-2 (V-4Cr-4Ti) were selected in the experiments for the evaluations of the activation of Er in the MHD coating (Er_2O_3), F in Flibe (LiF-BeF_2) and V, Cr, Ti in the structural materials, respectively. The sizes of specimens were 10 x 10 x 0.03 - 0.1 mm^3. Nb foils with 10x10x0.05 mm^3 were attached to the specimens to monitor the flux of fast neutrons. The irradiation with mono-energetic 14 MeV neutrons was conducted to examine the reactions with high energy neutrons. In addition, for the purpose of examining some important activation reactions with low energy neutrons, a Be mock-up was assembled to generate a neutron spectra with considerable low energy parts relevant to fusion blanket conditions. Fig. 1 shows the schematic cross-section of the Be mock-up.

The neutron spectra calculations were carried out using Monte Carlo transport codes MCNP-4C and JENDL3.3 files. A special routine was used in the calculations to represent generating D-T neutrons in the target [1]. The calculated spectra at the specimen location were shown in Fig. 2. The spectra without mock-up is a peak around 14 MeV while spectra at Position A and B in Be mock-up have considerable low energy parts.

After irradiation, the gamma-rays emitted from the irradiated specimens were measured with high purity Ge detectors. The activities of the nuclides were determined from the counts of the gamma-rays. The half life of the measured nuclides as followed ranges from 3.0 minutes to 43.7 hours: ^{161}Er, ^{167}Ho, ^{168}Ho, ^{171}Er, ^{18}F, ^{51}Ti, ^{52}V, ^{48}Sc. The measured activities of nuclides have been compared with the ones calculated by FISPACT-2001 code and EAF-2001 file. The comparison was shown in Fig. 3. The results showed that the calculated activities of most of products are in agreement with the experiments within 20% uncertainty. Since the reaction generating ^{168}Ho has a threshold near 14 MeV, potential source of discrepancy for ^{168}Ho could be the uncertainties in spectrum estimation around 14 MeV and the cross section data of the energy group at around 14 MeV.

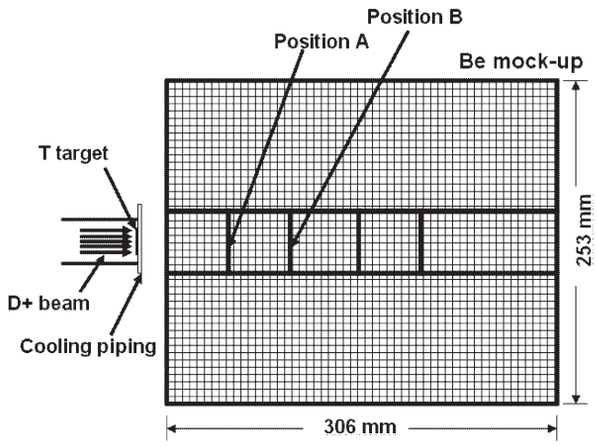

Fig. 1 Schematic cross-section view of the Be mock-up and the specimen locations

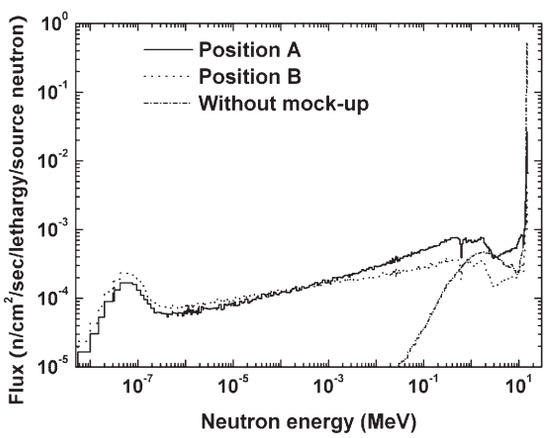

Fig. 2 Neutron spectra at locations without mock-up and Position A and Position B in Be mock-up

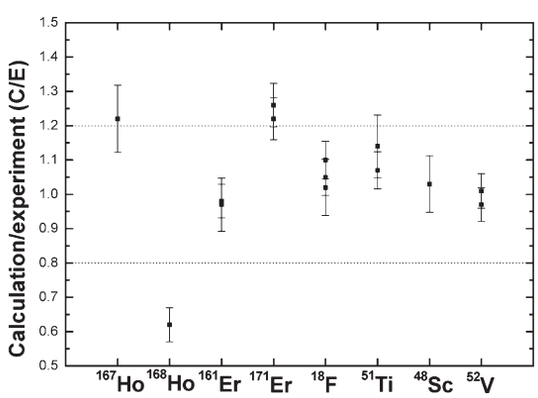

Fig. 3 Comparison of activities for nuclides between calculations and experiments

Reference

1)F. Maekawa, et al., Vol. Ⅱ: Analysis, JAERI-Research 94-044, Japan Atomic Energy Research Institute, 1994.