

## §8. Radiation Effects on Ceramic Insulation Materials for Liquid Li Self-Cooled Blanket System

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In NIFS and its collaborative universities, the ceramic coating technique has been examined for the reduction of MHD pressure drop in the liquid Li blanket system and some new ceramic materials have been found to be electrically and chemically stable even in high temperature liquid Li. Under high dose rate of radiations, however, ceramic insulators suffer degradation of insulation properties due to the RIC (radiation induced conductivity). This effect is unavoidable in intense radiation environment such as a fusion reactor and is one of the key issues in the selection of insulation materials used for the fusion blanket. In the present study, the RIC of some ceramic materials for liquid Li blanket system were examined under 14 MeV neutron and Co-60 gamma ray irradiations.

Three kinds of plate and disk specimens,  $Y_2O_3$  ( $5.0 \times 5.0 \times 1.0\text{mm}^3$ , supplied from TEP Corp.),  $Er_2O_3$  ( $7.5\text{mm} \phi \times 1.0\text{mm}$ , TYK Corp.) and  $CaZrO_3$  ( $15\text{mm} \phi \times 3.5\text{mm}$ , TYK Corp.) and three kinds of coating specimens made on stainless steel plate by RF sputtering method<sup>1)</sup>, AlN ( $2.5 \mu\text{m}$  and  $7.0 \mu\text{m}$  in thickness) and  $Y_2O_3$  ( $2.5 \mu\text{m}$  in thickness) were irradiated at room temperature with 14 MeV neutrons at FNS facility of JAERI. Also, three kinds of disk ( $10\text{mm} \phi \times 1.0\text{mm}$ ) specimens,  $Y_2O_3$ ,  $Er_2O_3$  and  $CaZrO_3$  were irradiated at room temperature with Co-60 gamma rays. Thin Pt or Ag electrodes were made on both sides of the disk and plate specimens and on the coating specimens by sputter deposition or evaporation process. The conductivity of all specimens was approximately  $10^{-14} - 10^{-13} \text{ S/m}$  without radiations. The induced current flowing in the specimen under a bias voltage was measured during irradiation.

Both the neutron and gamma ray induced currents were approximately proportional to the

neutron or gamma ray flux under a given bias voltage. Also, ohmic characteristics were observed in the relation between the bias voltage and radiation induced current. Fig. 1 shows results of the present experiments together with  $Al_2O_3$  data measured under various irradiation conditions. Although the measured values of the RIC of the present new specimens were on the whole two order larger than that of  $Al_2O_3$ , extrapolation of these values satisfies the allowable level of  $10^{-2} \text{ S/m}$  for the application to the liquid Li blanket system<sup>2)</sup>. Further RIC experiments and discussion on these specimens are necessary in the region of higher dose rate and temperature. Also, similar irradiation experiments with pulsed ion beams are to be performed for the examination of the influence of material parameters such as grain boundaries, cracks, impurities and others.

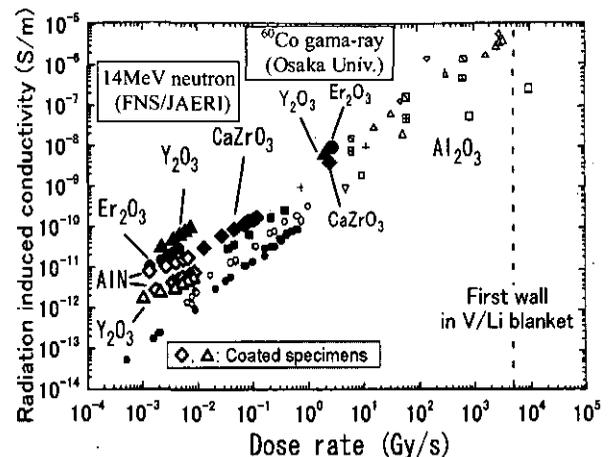


Fig. 1. Radiation induced conductivities of ceramic coating materials under 14 MeV neutron and Co-60 gamma-ray irradiations. Previous results for  $Al_2O_3$  are shown for comparison.

(Plots for  $Al_2O_3$ : T. Shikama, JAERI-Research 98-053, pp.11-18)

### References

- 1) A. Sawada, A. Suzuki, T. Terai and T. Muroga, will be published in J. Nucl. Mater..
- 2) A. Suzuki, T. Muroga, B. A. Pint, T. Yoneoka and S. Tanaka, Fus. Eng. Des. 69 (2003) 397-401.