Radiation Induced Conductivity of Proton Conductive Ceramics Under 14 MeV Fast Neutron Irradiation

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Proton conductive ceramics are applied as high temperature protonic conductors in electrochemical devices as well as tritium breeding materials in fusion devices. Further applications for tritium monitors during reactor operation or tritium collectors from vacuum pumping gas and tritium compounds (oxidized tritium, tritiated water vapor) are expected, because hydrogen extraction performances from hydrogen molecular, methane and water have been confirmed and evaluated by using the closed-end type proton conductive ceramic tubes.

In the present study, electronic and protonic conductions of typical proton conducting oxide ceramics ($SrCe_{0.95}Yb_{0.05}O_{3-\delta}$) which were perovskite-type were investigated at room temperature and 373 K under 14.1 MeV fast neutron irradiation at the facility of Fast Neutron Source (FNS) in Tokai Research Establishment of Japan Atomic Energy Research Institute (JAERI). The average fast neutron flux was about 3.0×10^{12} n/m^2 s. The accompanying gamma-ray dose rate was less than 1 μGy/s. The relation between current and voltage at room temperature and 373 K during the irradiation at several fast neutron fluences was observed and compared with those without radiation. The radiation-induced conductivity (RIC), calculated using Ohm's law from the measured current and applied voltage, decreased with increase of the irradiation fluence and became nearly a constant at the neutron fluence of about 1.0×10^{17} n/m^2, due to radiation-induced defects and annihilation of sub-bands, produced oxygen vacancies and impurities such as hydrogen, in the band gap. The radiation damage did not recover at room temperature and 343 K after the irradiation. Then, the RIC at room temperature only slightly incresed with further irradiation. This increase is probably caused by the electronic and protonic excitations by high-energy neutrons.