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# Advanced Electron Microscopy Study of Fission Products in a TRISO Coated Particle Neutron Irradiated to 3.6 X 1021 N/cm² Fast Fluence at 1040 ºC

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**Abstract :** Tristructural isotropic (TRISO)-coated fuel particles are designed as nuclear fuel for high-temperature gas reactors. TRISO coating consists of layers of carbon buffer, inner pyrolytic carbon (IPyC), SiC, and outer pyrolytic carbon. The TRISO coating, especially the SiC layer, acts as a containment system for fission products produced in the kernel. However, release of certain metallic fission products across intact TRISO coatings has been observed for decades. Despite numerous studies, mechanisms by which fission products migrate across the coating layers remain poorly understood. In this study, scanning transmission electron microscopy (STEM), energy dispersive X-ray spectroscopy (EDS), high-resolution transmission electron microscopy (HRTEM) and electron energy loss spectroscopy (EELS) were used to examine the distribution, composition and structure of fission products in a TRISO coated particle neutron irradiated to 3.6 x 1021 n/cm² fast fluence at 1040 ºC. Precession electron diffraction was used to investigate characters of grain boundaries where specific fission product precipitates are located. The retention fraction of 110mAg in the investigated TRISO particle was estimated to be 0.19. A high density of nanoscale fission product precipitates was observed in the SiC layer close to the SiC-IPyC interface, most of which are rich in Pd, while Ag was not identified. Some Pd-rich precipitates contain U. Precipitates tend to have complex structure and composition. Although a precipitate appears to have uniform contrast in STEM, EDS indicated that there may be composition variations throughout the precipitate, and HRTEM suggested that the precipitate may have several parts different in crystal structure or orientation. Attempts were made to measure charge states of precipitates using EELS and study their possible effect on precipitate transport.

**Keywords :** TRISO particle, fission product, nuclear fuel, electron microscopy, neutron irradiation
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