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Local atomic structure of Pd and Ag in the SiC containment layer of TRISO fuel particles fissioned to 20% burn-up

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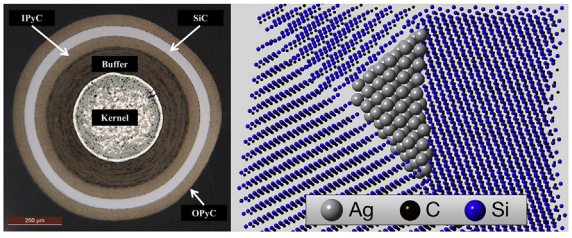
GRAPHICAL ABSTRACT



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ABSTRACT

The structure and speciation of fission products within the SiC barrier layer of tristructural-isotropic (TRISO) fuel particles irradiated to 19.6% fissions per initial metal atom (FIMA) burnup in the Advanced Test Reactor (ATR) at Idaho National Laboratory (INL) was investigated. As-irradiated fuel particles, as well as those subjected to simulated accident scenarios, were examined. The TRISO particles were characterized using synchrotron X-ray absorption fine-structure spectroscopy (XAFS) at the Materials Research Collaborative Access Team (MRCAT) beamline at the Advanced Photon Source. The TRISO particles were produced at Oak Ridge National Laboratory under the Advanced Gas Reactor Fuel Development and Qualification Program and sent to the ATR for irradiation. XAFS measurements on the palladium and silver K-edges were collected using the MRCAT undulator beamline. Analysis of the Pd edge indicated the formation of palladium silicides of the form Pd_xSi ($2 \leq x \leq 3$). In contrast, Ag was found to be metallic within the SiC shell safety tested to 1700 °C. To the best of our knowledge, this is the first result demonstrating metallic bonding of silver from fissioned samples. Knowledge of these reaction pathways will allow for better simulations of radionuclide transport in the various coating layers of TRISO fuels for next generation nuclear reactors. They may also suggest different ways to modify TRISO particles to improve their fuel performance and to mitigate potential fission product release under both normal operation and accident conditions.

1. Introduction

Tristructural-**iso**tropic (TRISO) encapsulated fuel particles are an established technology used in high-temperature gas-cooled nuclear reactors (HTGRs) [1,2]. Fuel performance envelopes are

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