Short-Lived Fission Product Signatures of Actinide Content for TRISO Fuels

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Nondestructive analysis (NDA) techniques are a major tool for material control & accountancy in nuclear facilities. NDA methods have already been established for quantifying the burnup of fuel used in traditional reactors using isotopic surrogates for uranium and plutonium. In this work we are investigating the capabilities of burnup quantification and actinide-based characterization (e.g. enrichment and Pu content) using a new NDA method (Microcalorimetry, μCal). μCal can measure actinide content directly, with approximately 3x better energy resolution and sensitivity to lower energies compared to High Purity Germanium (HPGe) detectors.

We irradiated pure samples of natural uranium and ^{239}Pu, and more complex mixtures of actinides that closely mimic the uranium and plutonium content of irradiated TRISO fuel at the High Flux Isotope Reactor. The samples were prepared and irradiated for 60-90 seconds and measured by HPGe and μCal simultaneously 45 seconds post-irradiation. Using the excellent resolution and list-mode capabilities of μCal, half-lives and energies of short-lived fission products are estimated and considered as signatures of actinide content. This is directly compared to HPGe, where the fission products are visible in the spectrum. This work lays the groundwork to using these low-energy gamma emissions to characterize advanced nuclear fuels.

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