



ETI Annual Workshop, March 29 – 30, 2022



## Measuring Forensic Signatures of Historical Uranium Enrichment in PCTFE

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### Abstract:

Verifying historical uranium enrichment, along with historical nuclear weapons production, is crucial to international security, but a reliable forensic method which uses physical markers is not yet available. Other work in our group has demonstrated that the very low doses of radioactivity from uranium alpha emissions during the process of enrichment leave measurable, irreversible calorimetric signatures in the common enrichment facility material Teflon (PTFE). These signatures can be used to reconstruct enrichment histories at sufficient sensitivity to detect the production of one weapon's quantity of highly enriched uranium. In this work, we demonstrate that the calorimetric signatures of low levels of alpha irradiation are also detectable in chlorinated Teflon (PCTFE), a common gasket material. Additionally, we present Raman spectroscopy data that shows short-range structural changes in the material as a result of irradiation, which provide a structural explanation for observed calorimetric changes. As PCTFE has its own unique profile of calorimetric and structural changes at various relevant irradiation doses, this data allows us to construct a more complete characterization of historical enrichment when used in conjunction with the unique signatures of other common materials.