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Application of Modern Autoradiography to Nuclear Forensic Analysis

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Highlights

- Digital autoradiography was adopted for nuclear material characterization
- Methods, limitations, and best practices were discussed
- High sensitivity, wide dynamic range, and covers scales from 50 µm to 40 cm
- Reveals activity heterogeneity and areas of interest for further microanalysis
- Higher-enrichment domains are easily identified in uranium samples

Abstract

Modern autoradiography techniques based on phosphorimaging technology using image plates (IPs) and digital scanning can identify heterogeneities in activity distributions and reveal material properties, serving to inform subsequent analyses. Here, we have adopted these advantages for applications in nuclear forensics, the technical analysis of radioactive or nuclear materials found outside of legal control to provide data related to provenance, production history, and trafficking route for the materials. IP autoradiography is a relatively simple, non-destructive method for sample characterization that records an image reflecting the relative intensity of alpha and beta emissions from a two-dimensional surface. Such data are complementary to information gathered from radiochemical characterization via bulk counting techniques, and can guide the application of other spatially resolved techniques such as Scanning Electron Microscopy (SEM) and Secondary Ion Mass Spectrometry (SIMS). IP autoradiography can image large 2-dimenstional areas (up to 20 x 40 cm), with relatively low detection limits for actinides and other radioactive nuclides, and sensitivity to a wide dynamic range (10^5) of activity density in a single image. Distributions of radioactivity in nuclear materials can be generated with a spatial resolution of approximately 50 µm using IP autoradiography and digital scanning. While the finest grain