SCALE Users Group

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TL/OSL/EPR theory









 σ^* anti-bonding









Department of **NUCLEAR ENGINEERING**









- Personnel dosimetry
- Film badges
- Thermoluminescent dosimeters (TLD)
- Optically stimulated luminescent dosimeters (OSLD)



Radiat Prot Dosimetry (2013) 153 (1): 1-22



Figure 1. Historical trends for personnel dosimetry including on the left, an early film badge design¹, center DOELAP accredited TLD designs still in use², and on the right is the current trend of an OSLD³.



¹ https://www.orau.org/ptp/collection/dosimeters/ornlfilmmod2film.htm

² https://www.suro.cz/cz/rms/tld

³ http://www.landauer.com

Combined EPR/TL/OSL analysis potential



High

energy

photor

Hole

traps

Valence band



Retrospective Dosimetry with EPR

- 1. Hayes RB, Abdelrahman FM. (2020) Low level EPR dosimetry of a commercial sugar. *Appl. Radiat. Isot.* **157**, 109038 https://doi.org/10.1016/j.apradiso.2020.109038
- 2. Abdelerahman FM, Hayes RB. (2019) Validating a Protocol for Low Level EPR Dosimetry of Sugar, *Trans. Amer. Nucl. Soc.* **121**, 1075-1078.
- 3. Hayes RB, O'Mara RP, Abdelrahman F. (2019) Nuclear forensics via the electronic properties of particulate and samples. *ESARDA Bulletin* **59**, 21- 28, December 2019



Ubiquitous gamma detection at the natural background level









Consortium for Nonproliferation Enabling Capabilities Hayes RB, O'Mara RP. (2019) Retrospective dosimetry at the natural background level with commercial surface mount resistors. *Radiat. Meas.* **121**, 42-48.



Ubiquitous spectrometers

2.0

1.5

0.5

Dose (Gy)

- From the fitted data: $\mu(E) \approx 2.7 \pm 0.3 \text{ cm}^{-1}$
- Using XCOM attenuation data calculated for a common brick:

 54.3 ± 7 keV



O'Mara RB, Hayes RB. (2018) Dose deposition profiles in untreated brick material. *Health Physics* **114**(4), 414-420.



UF₆ assay (ORIGEN for neutrons)



Decay gammas calculated with ORIGEN and ^{234m}Pa Bremsstrahlung calculated with mcnp







Decay gamma spectra outside a canister using mcnp



Transmitted Bremsstrahlung



Enabling Capabilities

Components of UF₆ have distinct dose deposition profiles



CNEC |

Consortium for Nonproliferation Enabling Capabili

Hayes RB. Retrospective uranium enrichment potential using solid state dosimetry techniques on ubiquitous building materials *J Nuc Mat Mgmt.* **47**(2), 4-12, 2019

Department of

Ubiquitous gamma cameras



S

locations



Relative dosimeter location (cm)



Hayes RB, O'Mara RP. (2020) Retrospective characterization of special nuclear material in time and space. *Radiat. Meas.* **133**, 106301.

3D imaging – unpublished



Ryan O'Mara (submitted)











Stickers, paint and other tags?

- Al₂O₃ frit used in elastic adhesive sandpaper options
- Al₂O₃ is the same material which after doping is used for commercial OSLD's in radiation worker dosimetry for ascribing official dose







IAEA smears and removable contamination surveys





Consortium for Nonproliferation Enabling Capabilities





Hayes RB, O'Mara RP, Abdelrahman F. Nuclear Forensics via the Electronic Properties of Particulate and Samples. *41st ESARDA Annual Meeting*. May 14-16, 2019, Stressa, Italy. ISBN 978-92-76-08679-6, doi:10.2760/159550, JRC116881

> http://www.biodex.com/nuclearmedicine/products/radiopharmac y/decontamination/wipe-test-kits



Many other fun toys for experiments but maybe another day?

















