



# Traceable surface sources by functionalization for initial mapping of nuclear facilities

Dilan Tuzun, Valérie Lourenço, Lucille Chambon, Yann Kergadallan

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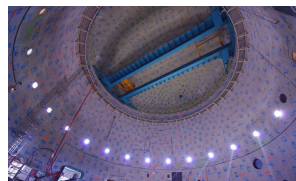
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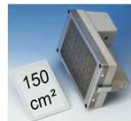
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Dilan Tüzün, Valérie Lourenço, Lucille Chambon, Yann Kergadallan  
Université Paris-Saclay, CEA, List, LNHB, Saclay, France

## Context and Challenges



Commercial source



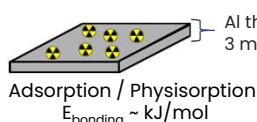
### Needs

- Reliable contamination measurements
- Calibration of measurement systems

### Aim

- Traceable activity and emitted flux
- Large surface areas
- Non-contaminating surface (use on-site)
- Complex shapes

Commercial sources:  
RN dried + protected

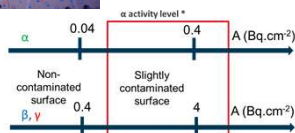


Use of **functionalization**

- Strong chemical bonds → **No cover layer**
- Thin sources → **Minimize self-absorption**

### Challenges

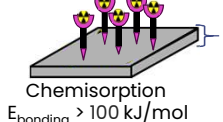
- Discrimination between non-contaminated surfaces and **low-level contaminated surfaces**
- Very large areas
- Non-flat surfaces



### Chosen substrates

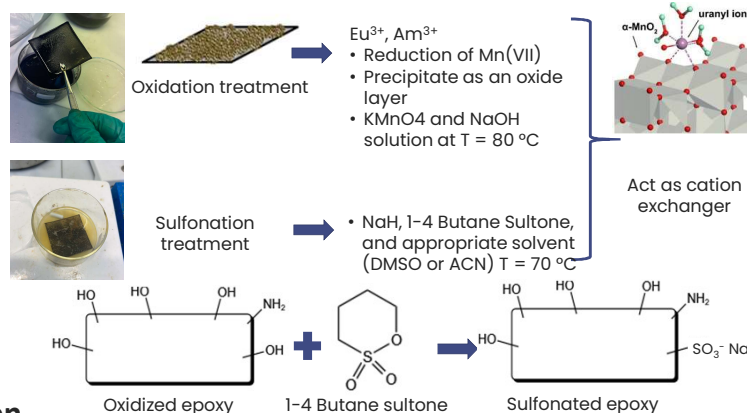
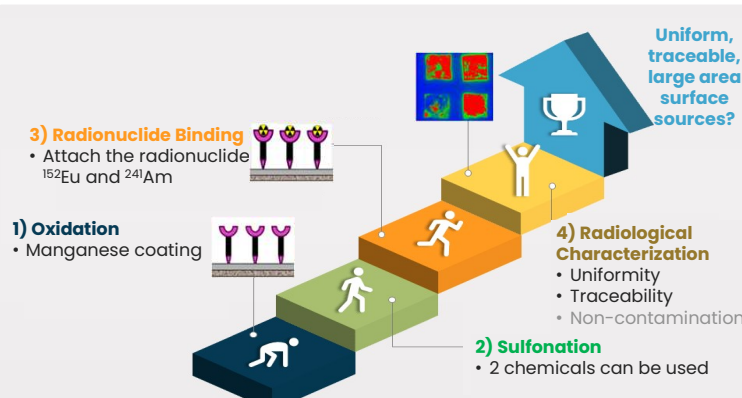
- Aluminum foil
- **Polymeric surfaces**

Our approach: chemical bonds  
RN-surface

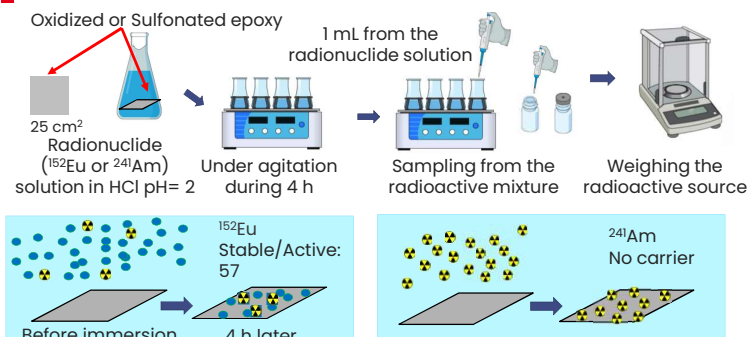


Emitted particles

## Our Approach

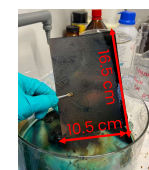
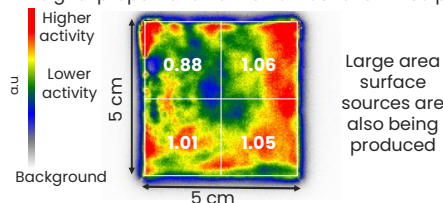


## Experimental set up & radiological characterization



### Analysis after RN binding: Autoradiography

- Signal proportional to the number of emitted particles



- Oxidized (J1)  $^{241}\text{Am}$ : Uniformity (St. dev.): 92%

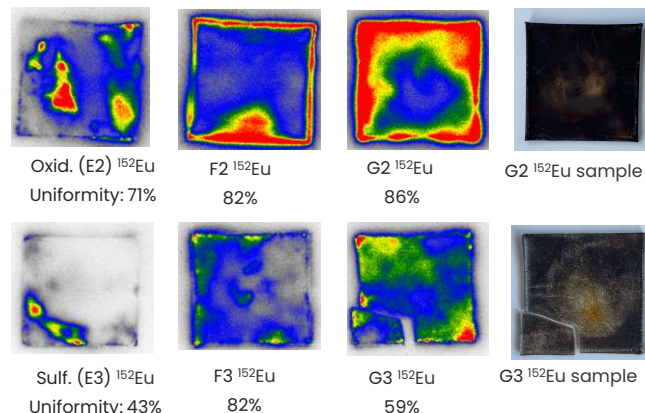
10.5 x 16.5 cm²  
Oxidized sample

Total amount of element in solution in both cases: ~0.45 picomole

Oxidated Samples	RN	% LSC activity decrease	Max activity bound (Bq/cm²)
Oxidized (E2)	$^{152}\text{Eu}$	(83.5 ± 2.7)%	20.0 ± 0.6
Oxidized (F2)	$^{152}\text{Eu}$	(98.0 ± 2.9)%	17.0 ± 0.5
Oxidized (G2)	$^{152}\text{Eu}$	(96.5 ± 2.8)%	20.5 ± 0.6
Oxidized (J1)	$^{241}\text{Am}$	(95.5 ± 2.8)%	19.0 ± 0.6

Sulfonated Samples	RN	% LSC activity decrease	Max activity bound (Bq/cm²)
Sulfonated (E3)	$^{152}\text{Eu}$	(55.0 ± 2.5)%	12.5 ± 0.6
Sulfonated (F3)	$^{152}\text{Eu}$	(87.5 ± 2.7)%	15.5 ± 0.5
Sulfonated (G3)	$^{152}\text{Eu}$	(86.0 ± 2.7)%	17.0 ± 0.5
Sulfonated DMSO (H6)	$^{152}\text{Eu}$	(76.5 ± 2.6)%	15.5 ± 0.5

We have produced surface sources with activities ~17 Bq/cm².  
The surface activity **can be tuned** to meet specific needs.  
**Reproduce complex shapes including roughness**



Oxidized samples resulted in higher uniformity

Upcoming studies

- Non-contamination tests
- $^{244}\text{Cm}$  binding ( $\alpha$ )

