

Surface functionalization to provide flexible surface sources

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poster

During the decommissioning and dismantling process, the initial cartography of all the surfaces is vital in classifying potential future waste, depending on their radioactivity level. Contamination monitors, commonly used to measure the surface contamination, need to be calibrated in terms of emitted flux or Bq.cm⁻² using adequate surface sources. The major drawbacks of existing reference sources is that they are not representative of real sites and their surface areas are limited (<150 cm²) [1]. The objective of this study is to produce uniform, traceable, flexible surface sources with limited radiation self-absorption (for alpha and beta emitters). These sources should be non-contaminating, meaning that the radioactivity is strongly attached to their surfaces. Furthermore, the surface areas targeted are larger than those of the existing sources. To produce sources that are both thin and non-contaminating, a functionalization approach was chosen. The goal is to introduce ligand groups, which are able to bind to a radionuclide (RN), onto the surface by grafting a bi-functional molecule (Fig 1). In this context, we can consider different substrates, such as aluminum foil and polymeric surfaces. In particular, sources prepared using aluminum foil can be flexible, and they can be compared with existing sources, also made of aluminum, which comply with ISO 8769 standard [1].

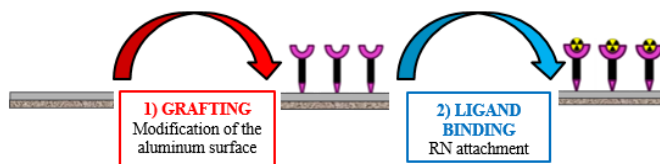


Fig. 1: Grafting and ligand binding steps

A two-sided literature investigation was carried out, to find the optimal molecule, to allow both the functionalization of the aluminum surface and the RN binding. As a result, three chemicals were selected. Then, four sequential steps were undertaken to produce surface sources by functionalization. The first step was cleaning, to degrease and remove any residues on the surfaces. Then, the samples were etched, to release hydroxide bonds that can be utilized in the grafting step. Next, the etched samples were immersed in different grafting solutions, prepared using the chosen chemicals. The experimental methods were optimized by varying parameters such as the concentration of the chemicals, the reaction time and the drying conditions. Each sample was analyzed by Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) spectroscopy and Scanning Electron Microscope (SEM) characterization methods. The ATR-FTIR spectra indicated that the grafting reactions were achieved between the spacer molecules and surface. The SEM images of the samples also showed a modification of the surface morphology after grafting. The RN binding experiments were carried out with ¹⁵²Eu, used as a chemical surrogate for ²⁴¹Am. Liquid scintillation counting and autoradiography were performed to evaluate the success of the RN binding on the grafted surface.

[1] ISO 8769:2016, Reference Sources — Calibration of Surface Contamination Monitors - Alpha, Beta and Photon Emitters