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Removal of Rn-222 daughters from metal surfaces

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Content

Surface contamination with long-lived daughters of Rn-222 is of great interest for experiments looking for rare events. These include the detection of low energy solar neutrinos, searches for neutrino-less double beta decay or searches or dark matter. Decays of Pb-210, Bi-210 and finally Po-210 may contribute significantly to the experiments' background, especially when they appear close or directly in the active volumes.

We will present the first measurements of natural contamination of metal surfaces with Po-210 (U-238 chain, T1/2 = 138 days). Measurements were performed with an ultra-low background, large-areas alpha spectrometer. The instrument allows to study the surface contamination down to about 100 alpha decays per day and per m2. Copper, stainless steel and titanium samples of the size of 43x43 cm and 1 mm thick were investigated. The assay showed no detectable surface contamination of stainless steel and copper covered with a protective foil against contamination with the air-born Po-210. Unprotected surfaces of titanium and commercial ETP (electroformed) copper showed significant surface polonium activity.

By attributing the counts in the registered spectra in the range of 1.5 MeV to 6 MeV to sub-surface Po-210 we could also investigate the bulk Po-210 contamination (alphas coming from different depths can populate the spectrum up to the 5.3 MeV, which including the energy resolution of the device, was extended to 6 MeV). The estimated sensitivity for the bulk contamination for e.g. copper is about 50 mBq/kg, which is presently the best limit (assuming secular equilibrium in the Pb-210 – Bi-210 – Po-210 it hold also for Pb-210). Significant amounts of polonium were detected in stainless steel, titanium, and unexpectedly also in the ETP copper.

We also studied the two most popular surface cleaning methods, which are etching and electro-polishing. They were applied to the investigated copper, stainless steel and titanium samples. In the course of this study we established for the first time an etching procedure, which influences (reduces) significantly the copper surface activity. For stainless steel and titanium reduction by one order of magnitude was achieved. Electro-polishing of copper and steel reduced their surface Po-210 by a factor of about 20, what is consistent with our previous studies performed for samples artificially loaded with high Po activity.

Summary

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