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Generation of isotope-enriched 152Sm from 153Gd production waste

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Samarium-153 is a part of chemicals used for therapy of cancerous growth and inflammatory disease of bone tissue. 153Sm is generated by irradiating 152Sm in either a nuclear reactor or charged-particle accelerator.
A natural mixture of samarium isotopes contains only 26.75% of 152Sm; when irradiated, the specific activity of the generated 153Sm is not enough to use it for the nuclear medicine purpose. Therefore, the initial material enriched in 152Sm is used to produce 153Sm. Nowadays, the material is enriched by an electromagnetic mass-separation.
JSC SSC RIAR produces 153Gd from europium targets irradiated in the BOR-60 reactor. When irradiating europium in a fast spectrum, a short-lived isomeride 152mEu generates, of which decay takes place in two directions: generation of 152Gd (72%) and generation of 152Sm (28%). The generated 152Sm is practically monoisotopic. Impurities of other samarium isotopes result from reaction 153Sm(n,γ) and threshold reactions with a participation of fast neutrons. When extracting 153Gd from irradiated targets, it is purified from impurities, including samarium, europium and terbium. Thus, highly-enriched stable isotope 152Sm is a side product of the 153Gd production and it can be separated from the production waste. Under this work, an experimental sample of 152Sm was separated from a fraction resulted from the purification of commercial batches of 153Gd. The separation and purification were performed by an extraction chromatography using sorbent DAF/Teflon. The DAF content was 25%wt. The 152Sm-containing solution was evaporated to dryness. The residual was dissolved in 50ml of 0.1M HNO3 and the solution was then put through a column 50ml in volume. Samarium, europium and gadolinium were eluted with 0.65M HNO3 1.2l in volume. The activity of impurity isotopes in the column effluent was measured using gamma-spectrometry; the samarium content was evaluated by an atomic-emission analysis.
As a result, a 99.52%-enriched experimental sample 152Sm(NO3)3*6H2O was generated, of which enrichment exceeds the one of 152Sm in the commercial off-the-shelf chemicals produced by the electromagnetic mass-separation. The content of other samarium isotopes is as follows: 147Sm –0.01%, 148Sm - 0.02, 149Sm - 0.19, 154Sm –0.26%. The content of radioactive isotopes 152Eu and 154Eu makes up ~560 and 620Bq/g, respectively.

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