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Radiation background studies for superconducting Sn-Bi bolometers

The India-based tin detector (*TIN.TIN*) proposes to explore neutrinoless double beta decay (NDBD) in ^{124}Sn by employing an array of cryogenic tin-based bolometers, which will be operated at ~10 mK. However, pure tin is susceptible to tin pest, an allotropic phase transition of tin near ambient conditions which results in the cracking and disintegration of the tin sample. This poses a concern for the longevity of the bolometer array. Sn-Bi alloys are resistant to tin pest and suitable for the fabrication of superconducting bolometers.

The present work reports the radiation background studies for Sn-Bi bolometers and its suitability for NDBD. The Sn-Bi crystals were synthesized in the laboratory and subsequently assessed for radiopurity in the TIFR low background experimental setup (TiLES). No additional γ lines or enhancements compared to the ambient background were found at the measured sensitivity level. Neutron activation of Sn-Bi (0.08% and 4.53% Bi by wt.) was performed at the Pelletron Linac Facility, TIFR Mumbai. No activation channels from Bi or any possible impurities in the crystal were measured. All the activity could be attributed to products produced from neutron activation channels in Sn.

^{209}Bi can decay by emitting an α particle of ~3.1 MeV. However, the α decay is extremely rare, having a half-life of $2 \times 10^{19} y$ (comparable to the typical half-life of a $\beta\beta$ candidate). The background from surface activity of ^{209}Bi was estimated using GEANT4 simulations. The anticipated internal background from U/Th impurities was also simulated and compared to the background from ^{209}Bi α decay. The β decay from ^{214}Bi (product of the ^{238}U chain) was found to be the limiting background, while the radioactivity of ^{209}Bi had negligible effect on the background ($\sim 10^{-5} cts.keV^{-1}.kg^{-1}.y^{-1}$).

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