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Enhancing the ionized radiation shielding, mechanical, and structure features of bismuth-reinforced tin-based alloys: Comparative investigation

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Five tin-bismuth alloys doped Sb element with composition Sn -50Bi and (92-x)Sn -8Sb-xBi (x= 10.0, 20.0, 30.0 and 40.0 wt.%) was prepared by melting pure Sn, Bi and Sb at 500 ℃ then casting at 30 ℃. The phase composition, morphology, microhardness, and mechanical behavior of the prepared alloys were characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), Vicker microhardness and tensile test technique respectively. The structure analysis of alloys is composed of matrix phase of tetragonal β-Sn, rhombohedral α-Bi, rhombohedral Sb rhombohedral SbSn and new rhombohedral Bi0.92Sb0.08 intermetallic compounds (IMCs). The results show that the suppression of the brittle SbSn as well as appearance of new Bi0.92Sb0.08 IMC in addition to crystallite size refinement due to the addition of Sb. Therefore, the creep resistance, hardness and mechanical properties of the prepared alloys are improved. It has been observed that the addition of Bi up to 40 wt.% can significantly affect the properties of Sn-8Sb alloys. Furthermore, these alloys' ability to shield against gamma radiation was investigated and evaluated in the energy range of 0.015 to 15 MeV using MCNP5 code and WinXCom software. A number of factors are computed in order to fully understand the researched alloy's radiation and neutron shielding properties. The findings showed that raising the Bi concentration improves radiation shielding qualities. The Sn-50Bi alloy demonstrated the highest shielding performance compared to other prepared alloys, common shielding materials, and recently studied alloys. The Sn-50Bi alloy had the best neutron attenuation capability. The Sn-50Bi alloy demonstrated the best attenuation performance for protons and alpha particles, making it a potential material for radiation shielding applications in industry, medicine, and nuclear waste storage.

Technical Track

Nuclear Materials

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