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加速器质子辐照镓镍合金靶与铌-镓胶囊封装靶制备 ^{68}Ge 研究

摘要

本研究对比了通过质子辐照两种靶件制备生产 68Ge 的方法：镓镍合金靶件和铌-镓胶囊封装靶件。基于回旋加速器同位素辐照靶站要求，镓镍合金靶件通过优化电沉积工艺，在铜靶托上电镀得到镓镍合金层。而铌-镓胶囊封装靶件采用耐液态金属镓腐蚀的铌作为封装外壳，内部填充天然金属镓而制得。两种靶件经回旋加速器上质子束进行辐照，生成的 68Ge 随后使用树脂柱进行分离纯化。结果表明，镓镍合金靶件表面光滑、牢固性良好，但其较低的靶材载量和易受热损伤的特性限制了其大规模应用。铌-镓胶囊封装靶件具有更高的靶材载量，在辐照条件下的稳定性和安全性更优，但由于镓的熔点低，其对铌外壳焊接和整体密封性能要求较高。在 68Ge 的分离纯化方面，电镀靶的溶解过程为开放式操作，会引入大量杂质，需要结合螯合树脂和凝胶树脂进行分离纯化。而铌-镓胶囊封装靶件可实现封闭操作，杂质水平更低，分离纯化更具优势。

关键词

锗-68；镓镍合金靶件；铌-镓胶囊封装靶件；分离纯化

Abstract

This study compares the production of 68Ge using proton irradiation on two types of targets: an electroplated gallium-nickel alloy solid target and a niobium-encapsulated capsule with natural gallium. The alloy target was prepared on copper via electroplating, while the capsule was designed and fabricated to be irradiated in a cyclotron. The generated 68Ge was then separated and purified using resin columns. Results show the electroplated target had a smooth surface and good adhesion, but its low loading capacity and vulnerability to thermal damage limit its use for large-scale production. The niobium-encapsulated target, with its higher loading capacity, improved stability and safety under irradiation, though it requires precise welding and sealing due to gallium's low melting point. For the separation and purification of 68Ge, the dissolution of the electroplated target is an open operation that introduces significant impurities, necessitating a combined purification process using both chelating and gel resins. In contrast, the niobium-encapsulated target allows for a closed operation, resulting in lower impurity levels and offering distinct advantages for subsequent purification.

Keywords

germanium-68; gallium-nickel alloy target; Niobium-encapsulated gallium capsule target; separation and purification

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