

Development of enriched ^{12}C CVD diamond targets for astrophysical $^{12}\text{C}(\alpha, \gamma)^{16}\text{O}$ reaction measurements

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The $^{12}\text{C}(\alpha, \gamma)^{16}\text{O}$ reaction is a pivotal process in nuclear astrophysics. Due to its extremely low cross section ($\sim 10^{-17}$ barn) within the Gamow window, directly measuring this reaction is highly challenging. An irradiation-resistant ^{12}C -enriched target is a key technique for the direct measurement of the $^{12}\text{C}(\alpha, \gamma)^{16}\text{O}$ reaction. In this work, we developed a ^{12}C -enriched diamond target on Mo substrates using the chemical vapor deposition (CVD) method. The target demonstrates excellent stability under bombardment with a high-intensity proton beam. A 1.5% deterioration in ^{12}C thickness was observed after bombardment by a 270 keV, 2 mA proton beam with a charge of 125 C, indicating a significant improvement over typical carbon targets. The $^{13}\text{C}/^{12}\text{C}$ ratio in the target was determined to be $(1.1 \pm 0.3) \times 10^{-4}$, indicating no contamination was introduced during the CVD process. A method for determining the hydrogen content in coatings based on nuclear reactions is presented. The upper limit of the hydrogen content in the diamond ^{12}C -enriched target was found to be 0.075%. The irradiation-resistance capacity and isotopic purity of the target meet the requirement for direct measurement.

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