Iranian Journal of Physics Research, Vol. 25, No. 2, 2025
DOI: 10.47176/ijpr.25.2.22020

Experimental analysis of charge collection efficiency in semiconductor detectors using the MeV ions induced charge method

Z S Imani[1], O R Kakuee[2]*, and A A Sabouri Dodaran[1]

1. Department of Physics, Payam Noor University, PO Box 19395-3697, Tehran, Iran
2. Nuclear Science and Technology Research Institute,, Tehran, Iran

E-mail: okakuee@aeoi.org.ir

(Received 14 December 2024; in final form 12 August 2025)

Abstract

The Ion Beam Induced Charge (IBIC) analysis method is a powerful technique for investigating the charge collection efficiency (CCE) in semiconductor materials. It is also widely employed to study the effects of ionizing radiation on the performance of electronic devices and to evaluate the response of charged-particle detectors under irradiation conditions. In this work, an ^{241}Am alpha source and an ion-implanted silicon charged-particle detector were used in a vacuum chamber. By varying the detector bias voltage—thereby altering the depletion layer depth—and measuring the alpha spectra, the CCE was determined. In addition, numerical simulations were performed to estimate the CCE. The simulation results showed good agreement with the experimental data and accurately reproduced the dependence of CCE on bias voltage. By providing both experimental and simulation-based analyses of charged-particle detector performance using the IBIC method, this study contributes to a deeper understanding of detector behavior under irradiation and supports various scientific, and technological applications.

Keywords: Ion Beam Induced Charge (IBIC), Charge Collection Efficiency (CCE), Semiconductor detectors, MeV ion beams

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