Damage Profiles and Implantation Characteristics of 50 keV N, Al, and In Ions in GaAs for Semiconductor Device Applications

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Abstract

This study investigated the atomic-level damage and defect generation caused by the interaction of 50 kev energy ions with a GaAs substrate. Nitrogen (N), Aluminium (Al), and Indium (In) ions were used to analyse variations in backscattering, vacancy formation, and ion penetration behaviours. Nitrogen ions produced 6299 backscattered ions, whereas Aluminium and Indium ions generated 5462 and 87 backscattered ions, respectively. Vacancy analysis revealed that Nitrogen ions created 282 vacancies per ion, while Aluminium and Indium ions produced 487 and approximately 592.8 vacancies per ion, respectively. Ion penetration characteristics showed that the longitudinal ranges were 882 Å for Nitrogen, 552 Å for Aluminium, and 192 Å for Indium, while the corresponding longitudinal straggles were measured as 404 Å, 288 Å, and 87 Å. The radial range and radial straggle values mirrored this trend, with Nitrogen ions spreading up to 616 Å, Aluminium ions up to 387 Å, and Indium ions confined to 88 Å. These results highlight that lighter ions like Nitrogen penetrate deeper with broader scattering, while heavier ions like Indium cause more localised damage near the surface. This study provides crucial insights into defect engineering and damage profiles in ion-implanted GaAs substrates for advanced semiconductor applications.

Keywords

50 kev ions, Ion implantation, GaAs substrate, Atomic-level defects, Vacancy generation, Backscattered ions, Longitudinal range, Radial straggle, Ion-material interaction, Semiconductor damage analysis.