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Simulation of Irradiation Damage and Defect Evolution Induced by Neutrons in LGAD

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The introduction of carbon doping in Low Gain Avalanche Detectors (LGADs) has been shown to effectively mitigate neutron-irradiation-induced acceptor removal effects. However, the microscopic mechanism behind this phenomenon remains unclear. In this study, Monte Carlo (MC) simulations model the effects of 1 MeV neutrons in critical regions in LGAD, providing data on the energy and spectrum of primary knock-on atoms (PKAs). Following this, molecular dynamics (MD) simulations are conducted with silicon lattice systems containing carbon, oxygen, and boron impurities, subject to cascades from the most probable PKAs. This allows us to trace defect formation, recombination processes, and evolution during cascade collisions, and to compile statistics on defect types and probabilities associated with each impurity after thermal equilibrium. These simulation results will compare with parameters L, K, and M from the experiment data (SIMS and CV test), providing an atomic-level explanation of how carbon doping mitigates acceptor removal. It is found that carbon impurities inhibit boron acceptor removal by competitively capturing neutron-induced Frenkel defects.

Type of presentation (in-person/online)

in-person presentation

Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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