Neutron Detection Performance of Silicon Carbide and Diamond Detectors with Incomplete Charge Collection Properties

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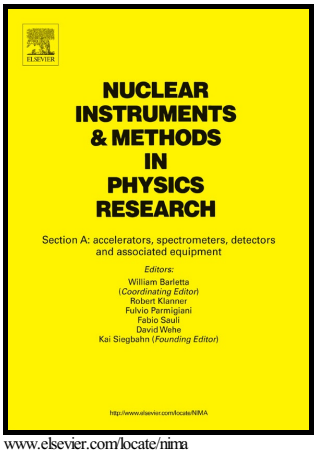

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Neutron Detection Performance of Silicon Carbide and Diamond Detectors with Incomplete Charge Collection Properties[☆].

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Abstract

The benefits of neutron detection and spectroscopy with carbon based, wide band gap, semiconductor detectors has previously been discussed within literature. However, at the time of writing there are still limitations with these detectors related to availability, cost, size and perceived quality. This study demonstrates that lower quality materials - indicated by lower charge collection efficiency (CCE), poor resolution and polarisation effect - available at wafer scale and lower cost, can fulfil requirements for fast neutron detection and spectroscopy for fluxes over several orders of magnitude, where only coarse energy discrimination is required.

In this study, a single crystal diamond detector (D-SC, with 100% CCE), a polycrystalline diamond (D-PC, with ≈4% CCE) and semi-insulating silicon carbide (SiC-SI, with ≈35% CCE) have been compared for alpha and fast neutron performance.

All detectors demonstrated alpha induced polarisation effects in the form of a change of both energy peak position and count rate with irradiation time. Despite these operational issues the ability to detect fast neutrons and distinguish neutron energies was observed.

This performance was demonstrated over a wide dynamic range (500 - 40,000 neutrons/s), with neutron induced polarisation being demonstrated in D-PC and SiC-SI at high fluxes.

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