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Swift Heavy Ion irradiation of III-N semiconductors: ion tracks and point defect formation

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AlN, GaN and InN were irradiated at room temperature with monatomic Swift Heavy Ions and high energy fullerenes. Despite a common crystallographic structure, these compounds show much contrasted response towards the electronic energy deposition. Transmission Electron Microscopy in both plane-view and cross-sectional modes is used to characterize ion tracks. AlN shows a remarkable resistance towards track formation. InN is the most sensitive and shows partial decomposition inside the tracks, likely into N2 and In metallic clusters. In GaN tracks are observed, containing amorphous pockets, but high fluence irradiation does not give an amorphous layer because of recrystallization induced by track overlapping. In AlN, below the electronic stopping power threshold for tracks formation, optical absorption was studied in-situ at 15 K. Point defects inducing an absorption band at 4.7 eV are created. Detailed analysis of the influence of both electronic and nuclear stopping powers indicates a synergy between electronic excitations and elastic collisions. For the heaviest projectiles, the enhancement of the color center creation yield amounts to two orders of magnitude due to the electronic energy loss. An enhancement by electronic stopping power of point defect creation or of point defect mobility is also evidenced by TEM observations.

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