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Luminescence characteristics and related damage evolution of carbon ion implanted GaN

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Statement of the Problem: Carbon doped GaN has been widely studied and applied for p-type GaN and yellow light-emitting diodes. However, the sites carbon located, related with luminescence, characteristics has not been confirmed.

Methodology & Theoretical Orientation: GaN was implanted with carbon ion using dose of 1×1017 cm^{-2} and 2×1017 cm^{-2} and energy of 30 keV and 40 keV. And then the implanted samples were annealed at 800°c for 20 min and 1 h under the N_2 atmosphere. The luminescence characteristics of carbon ion implanted GaN was evaluated by PL spectrum with wavelength of 325 nm. The lattice damage of GaN was characterized by Raman spectrum and corresponding vacancy-defect evolution before and after annealing was measured by slow positron annihilation.

Conclusion & Significance: Most of carbon atoms would be located at the interstitial sites after carbon ion implantation due to the absorption of vacancies, and no obvious luminescence could be observed. As the implanted samples were annealed, strong yellow luminescence was emitted and the vacancy for N (VN) or vacancy for Ga (VGa) was reduced resulting from the migration of interstitial carbon (C_i) and formation of complex between them. By contrast, samples with higher dose showed stronger yellow light emission, which was related with the lower migration rate of C_i and saturated concentration of C_i-V complex.

Biography

Jinlong Liu has his expertise in preparation and functional application of carbon materials including diamond, graphene, carbon dots and so on. He focuses on the mechanism of research on the carbon materials functional properties. He has researched the conductivity mechanism of H-terminated diamond and developed the MESFET devices. He also conducted research on luminescence mechanism of carbon dots prepared by micro wave heating and clarified the chemical reaction mechanism. In this work, he studied the defective evolution of carbon ion implanted GaN after annealing by slow positron annihilation, and the results will provide a framework to understand the behavior of carbon in GaN. It will be of great importance in expanding further application of C doped GaN.

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