MAGNETIC AND STRUCTURAL PROPERTIES OF Fe ION-IMPLANTED GaN.

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GaN is a very promising host material for making dilute magnetic semiconductor (DMS).[1] Magnetic ions of Fe, Co and Ni as well as Mn ion offer also suitable properties for DMS. We have investigated the magnetic and structural properties of Fe ion-implanted GaN by using high resolution x-ray diffraction (HRXRD), superconducting quantum interference device (SQUID) magnetometer, and x-ray photoelectron spectroscopy (XPS). 2-μm thick GaN epilayer was prepared, and 80 KeV Co⁺ ions with a dose of 3x10¹⁴ cm⁻² were implanted into GaN at 350 °C. The implanted samples were post annealed at 700-900 °C by rapid thermal annealing (RTA) in N₂ atmosphere. XRD results did not show any peaks associated with second phase formation and only the diffraction from the GaN layer and substrate structure were observed. The magnetization curve at 5 K show clear ferromagnetic behavior for 800 and 900 °C annealed-samples. In zero field-cooled (ZFC) and field-cooled (FC) magnetization measurements, the irreversibility and a cusp-like behaviour of the ZFC curve were observed for 800 and 900 °C annealed-samples. These behaviors are typically observed in superparamagnetic or spin glass phase. In XPS measurement, for Fe 2p core level spectra the coexistence of metallic Fe (Fe⁰) and Fe-N bond (Fe²⁺ and Fe³⁺) is observed in as-implanted sample but 700-900 °C annealed- samples showed only Fe-N bond (Fe²⁺ and Fe³⁺) spectra. For Ga 3d core level spectra only Ga-Ga bonds showed for as-implanted with 700-900 °C annealed-samples. From these, it is considered that magnetic property of our films originated from FeN structure.