III JOINT EUROPEAN MAGNETIC SYMPOSIA

San Sebastian, 26-30 June, 2006

Book of Abstracts and Programme

III - Gp – POSTER - 032
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 3×10^{16} cm^{-2} were implanted into GaN at 350 . The implanted samples were post annealed at 700-900 by rapid thermal annealing (RTA) in N_2 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 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 annealed-samples. These behaviors are typically obsrved in superparamagnetic or spin glass phase. In XPS measurement, for Fe 2p core level spectra the coexistence of metallic Fe (Fe^0) and Fe-N bond (Fe^{2+} and Fe^{3+}) is observed in as-implanted sample but 700-900 annealed- samples showed only Fe-N bond (Fe^{2+} and Fe^{3+}) spectra. For Ga 3d core level spctra only Ga-Ga bonds showed for as-implanted with 700-900 annealed-samples. From these, it is considered that magnetic property of our films originated from FeN structure.

[1] Kazunori SATO and Hiroshi KATAYAMA-YOSHIDA, Jpn. J. Appl. Phys. 40 (2001) L485.