

## Co ion-implanted GaN and its magnetic properties

W. Kim\*, H.J. Kang\*, S.K. Oh\*, S.S. Shin\*\*, J.H. Lee\*\*, J.H. Song\*\*, S.K. Noh\*\*\*, S.J. Oh\*\*\*\*, S.J. Kim\*\*\*\*\*, and C.S. Kim\*\*\*\*\*

\* *Department of Physics, Choungbuk University, Cheongju, Korea*

*E-mail: [wckim@chungbuk.ac.kr](mailto:wckim@chungbuk.ac.kr)*

\*\* *Korea Institute of Science and Technology, Seoul, Korea*

\*\*\* *Korea Research Institute of Standards and Science, Daejeon, Korea*

\*\*\*\* *Korea Basic Science Institute, Daejeon, Korea*

\*\*\*\*\* *Department of Nano and Electronic Physics, Kookmin University, Seoul, Korea*

GaN is a very promising host material for making dilute magnetic semiconductor (DMS) because its Curie temperature ( $T_c$ ) is above room temperature according to the theoretically computed value [1]. 2- $\mu\text{m}$  thick GaN epilayer was prepared, and 80 KeV  $\text{Co}^-$  ions with a dose of  $3 \times 10^{16} \text{ cm}^{-2}$  were implanted into GaN at 350 °C. The implanted samples were post annealed at 700 °C by rapid thermal annealing (RTA) in  $\text{N}_2$  atmosphere for 5 min to recrystallize the samples. We have investigated the magnetic and structural properties of Co ion-implanted GaN by using high resolution x-ray diffraction (HRXRD), secondary ion mass spectrometry (SIMS), atomic force microscopy (AFM), superconducting quantum interference device (SQUID) magnetometer, and x-ray photoelectron spectroscopy (XPS). 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. SIMS profiles of Co implanted into GaN, both before and after annealing at 700 °C have shown a projected range of  $\sim 390 \text{ \AA}$  with 7.4 % concentration and that there is little movement in Co. AFM measurement shows the forms of surface craters for as-implanted and 700 °C annealed samples. XPS measurement showed the metallic Co2p core levels and the metallic valence band spectra for as-implanted and 700 °C-annealed samples. The magnetization curve and temperature dependence of magnetization taken in zero-field-cooling (ZFC) and field-cooling (FC) conditions showed the features of superparamagnetic system in film.

1. T. Dietl, et al., *Science*, vol. 287, 1019, (2000).