Electrical and magnetic properties of GaMnN with varying the concentrations of Mn and Mg

F.C.Yu, K.H.Kim, K.J.Lee, H.S.Kang, J.A.Kim, D.J.Kim, K.H.Baek, H.J.Kim and Y.E.Ihm

Department of Materials Engineering, Chungnam University, Daejon 305-764, Korea

C.S.Kim

Materials Evaluation Center, Korea Research Institute of Standard and Science, Daejon 305-606 Korea

S.H.Yoo and C.G.Kim

Korea Research Institute of Chemical Technology, Daejon 305-600, Korea

S.J.Oh

Korea basic science institute

Ⅲ-Ⅴferromagnetic semiconductor has attracted great attention as a potential application for spintronics due to a successful demonstration of spin injection from ferromagnetic GaMnAs into semiconductor. GaMnN may be one of the possible candidates for room temperature operation.

Samples were grown on sapphire (0001) substrate at 650^{0}C via molecular beam epitaxy with a single precursor of ($Et_2Ga(N_3)NH_2CH_3$) and solid source of Mn at different Mn source temperature. The background pressure is low 10^{-10}Torr and the samples growth pressure was 1.4×10^{-6}Torr.

All the samples were grown with varying Mg flux for two different Mn flux; one is series 'H' grown at T_{Mn}=790^{0}C showed homogeneous solid solution and the other is series 'P' grown at T_{Mn}=830^{0}C in which the precipitation of Mn_3GaN was observed in XRD measurement. All the samples of these two series showed the magnetic property at the room temperature after measurement with superconducting quantum interference device (SQUID). For P series samples we can see there were no others magnetic materials in the samples except GaMnN and Mn_3GaN from XRD measurement. As we know Mn_3GaN is paramagnetic at room temperature because Curie temperature Tc of Mn_3GaN is ~200K. So the magnetic property was caused by GaMnN at room temperature. And because of carrier induced magnetism, the magnetization of samples increased dramatically with the increasing of Mg concentration that was observed from SQUID measurement. The samples after measured by electron probe x-ray microanalysis (EPMA) and temperature depending resistivity measurement showed that the conductivity enhanced with the increasing of concentration of Mg. And for P series samples the conductivity were further enhanced with high Mn concentration. Furthermore, from SQUID measurement samples showed that the magnetization also will enhance with the increasing the concentration of Mg, and will be further enhanced with high Mn concentration for P series samples.

From our experiment we can see that the magnetic property of two series samples were caused by GaMnN at room temperature; and increasing concentration of Mg can enhance conductivity and magnetization of samples; and also the high concentration of Mn can further enhance conductivity and magnetization.