Dependence of Ferromagnetic Properties on Carrier Transfer in $(Ga1-_xMn_x)N$

H. C. Jeon[1], H. S. Kim[1], T. W. Kang[1] and T. W. Kim[2], J. G. Kang[3] and K. J. Chang[3]

[1]Quantum-functional Semiconductor Research Center, Dongguk University, Seoul, Korea, [2]Advanced Semiconductor Research Division of Electrical and Computer Engineering Center, Hanyang University, Seoul, Korea, [3]Department of Physics, Korea Advanced Institute of Science and Technology, Daejeon 305-701, Korea

* E-mail : twkang@dongguk.edu

Recently, extensive efforts have been undertaken to increase the Curie temperature (T_c) of the diluted magnetic semiconductor (DMS) materials due to their potential applications for many promising spintronic devices operating at high temperatures. Among these types of DMS materials, $(Ga_{1-x}Mn_x)As$ DMS have been mostly studied. However, since the highest T_c obtained from the $(Ga_{1-x}Mn_x)As$ has been 172 K, which is too low for practical applications. As alternative DMS materials with the high T_c, $(Ga_{1-x}Mn_x)N$ DMSs are of current interest because their $T_c$values can be as high as room temperature, based on theoretical calculations. Theory predicts that the ferromagnetic properties observed in GaMnN material system depends on the occupancy of the Mn energy band in GaMnN and the position of the Fermi level relative to this band. Carriers (holes) in the Mn energy band are needed to mediate ferromagnetic interaction: the depletion and enhancement of carrier concentration in the band will change the ferromagnetic properties of GaMnN. Even though many studies concerning the growth and characterization of $(Ga_{1-x}Mn_x)N$ have been carried out, systematic studies are required to understand the carrier-mediated ferromagnetism which is assumed to play an important role in enhancing the Tc by increasing hole carrier concentrations. This work will demonstrate this concept by studying the carriers to mediate ferromagnetism in various GaMnN structure, hence affecting the ferromagnetic properties of the GaMnN.