

Curie temperature of Ferromagnetic (Ga, Mn)N Epitaxial Films

J. M. Lee¹, M. H. Ham¹, J. M. Myoung¹, J. Y. Chang², S. H. Han² and W. Y. Lee^{1*}

¹ Department of Materials Science and Engineering, Yonsei University, Seoul 120-749, Korea

² Nano Device Research Center, Korea Institute of Science and Technology, POB 131, Seoul 130-650, Korea

*Corresponding author: e-mail: wooyoung@yonsei.ac.kr, Phone: +82 2 2123 2834, Fax: +82 2 312 5375

The recent discovery of ferromagnetic ordering in Mn-doped GaN semiconductors with Curie temperature exceeding room temperature has generated intense interest in spintronics for device applications [1-3]. In particular, the estimation of Curie temperature in the GaMnN system is an important activity that has been guided by mean field theoretical considerations. In the present work, we present the magnetic properties of the epitaxial (Ga_{1-x}Mn_x)N films with nominal Mn concentration ($x=0.1 - 0.73$ %) grown by plasma-enhanced molecular beam epitaxy (PEMBE) on sapphire (0001) substrates. The Mn profiles were found to be uniform for the films throughout the entire thickness in the range 0.7–1.0 μm with no appreciable segregation by secondary ion mass spectroscopy (SIMS). Ferromagnetic ordering for the films is clearly seen in the temperature range 4 – 300 K. The M - T curves were fitted with theoretical equations based on the mean field theory in order to estimate Curie temperature (T_c). T_c was found to be in the range 550 – 700 K, depending on the Mn content. However, T_c of the (Ga,Mn)N film with $x = 0.3$ % was observed to be 270 K from the temperature-dependence of magnetization difference $\Delta M=(M_{FC} - M_{ZFC})$ between field-cooled (FC) and zero-field-cooled (ZFC) magnetization curves taken at 500 Oe (see Fig. 1). The Curie temperature is in good agreement with the fact that the extra-ordinary Hall effect was found to appear in the range 4 – 250 K. We discuss the implication of the mean field approximation and experimental results for Curie temperature in further details.

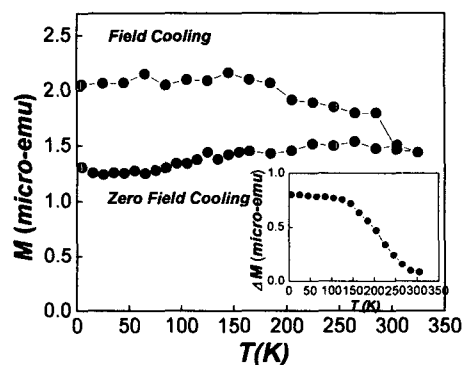


Fig.1. Temperature dependence of ZFC and FC magnetization for the (Ga_{1-x}Mn_x)N films with $x = 0.3$ % in a magnetic field of 500 Oe

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