PD18

The Ferromagnetisms of GaMnN Grown via Molecular Beam Epitaxy Using a Single GaN Precursor

C. X. Gao[1], F. C. Yu[1], Chandra Sekar P. V[1], D. J. Kim*[1], H. J. Kim[1], Y. E. Ihm[1], C. G. Kim[2] and C. S. Kim[3]

[1]School of Nano Science and Technology, Chungnam National University, 220 Gung-Dong, Yu-Seong Gu, Daejeon, 305-764, Korea
[2]Korea Research Institute of Chemical Technology, Daejeon 305-600, Korea
[3]Korea Research Institute of Standard and Science, Daejeon 305-606, Korea

*Corresponding author: dojin@cnu.ac.kr, Phone: +82 42 821 6639, Fax: +82 42 823 4224

Since the discovery of ferromagnetism in diluted magnetic semiconductor (DMS), it is expected to establish a new material for spintronic devices, where both of the intrinsic properties, charge and spin, of electron could be exploited simultaneously. The material having Curie temperature higher than room temperature is a crucial requirement for practical device applications. GaMnN is addressed to be a potential candidate signifying critical temperature exceeding room temperature. Therefore, GaMnN inspired intriguing attentions of researchers in recent decades. Prior to device applications, it is powerful to fully understand the origin of ferromagnetism in GaMnN. If so, it will show great benefit for practical applications. However, by far, comparative arguments to the ferromagnetism origin in DMS occurred among researchers, due to their different experiment methods, technics and groups. So far, for the mechanisms of the ferromagnetism in GaMnN, except the bound magnetic polaron and the giant magnetic moments of small Mn_xN clusters, two varies of ferromagnetisms prevail: Zener's p-d exchange [1] and double exchange mechanisms [2]. Up to date, the mechanism of the ferromagnetism origin in GaMnN was not fully understood. Controversy is proceeding among researchers. Herein, we will firstly make a clear distinguish of the mechanisms theoretically and then exhibit our experiment results obtained using a single GaN precursor via molecular beam epitaxy (MBE) through Mg and Be doping in GaMnN at different substrate temperature. Discussion and analysis are performed and their possible ferromagnetic mechanisms are suggested. We expect it is favorable to understand the ferromagnetisms in GaMnN.

Two series GaMnN films were grown on sapphire (0001) substrate via MBE. Single molecular GaN precursor source of $Me_2Ga(N_3)(NH_2{}^tBu)$ and solid source of Mn, Mg and Be were used. The temperature of the dopant cell for Mn was fixed at 900℃. Besides the same basic experiments conditions, one series is Mg codoped GaMnN at the substrate temperature 700℃ with the dopant cell temperature of Mg varied in the ranges of 320-350℃; another series is Be codoped GaMnN at the substrate temperature 620℃ with the dopant cell temperature of Be varied in the ranges of 900-920℃. The crystal structures were examined using XRD with Cu Kα1 radiation. The film resistivities and thickness were measured by the four-point probe method and α-step profile, respectively. SQUID was used to measure the magnetic properties of the films.

Two series of GaMnN films were grown by Mg codoping and Be codoping within the same basic experiment conditions to investigate the ferromagnetism mechanism in GaMnN films. In terms of their film resistivity variations, carrier-mediated ferromagnetism and d-d exchange interaction between Mn atoms were discussed and proposed to be possible to describe the ferromagnetisms in GaMnN.

REFERENCES

[1] T. Dietl, H. Ohno, F. Matsukura, J. Cibert, and D. Ferrand, Science, **287**, 1019 (2000).
[2] H. Akai, Phys. Rev. Lett. **81**, 3002 (1998).

PE01

Magnetic Properties of Iron Sulfides Doped with 3d Transition-Metals

Eng Chan Kim*

Department of Physics, Yeungnam University, Kyongsan 712-749, Korea

*Corresponding author: eckim@yumail.ac.kr, Phone: +82 53 810 2343, Fax: +82 53 814 6141

It is found by Mössbauer measurements on $M_{0.025}Fe_{0.975}S$ (M=Sc, Ti, V, Cr, Mn, Co, Ni, Cu) that the 3d-transition metal impurities profoundly effect both the crystallographic and spin rotation transitions of iron sulfide.

The purpose of this research is to report the effect of 3d trantition- metal on then and Morin (spin-flip) transitions as well as on the superexchange interactions in iron sulfides.

It is noteworthy that both $V_{0.025}Fe_{0.975}S$ and $Co_{0.025}Fe_{0.975}S$ have Morin transition temperatures T_M which are distinctly different from that of FeS; furthermore, the directions of changes of T_M ae opposite for $V_{0.025}Fe_{0.975}S$ and $Co_{0.025}Fe_{0.975}S$.

A vanadium impurity of 2.5 % of the metal atoms in the iron sulfide makes the crystallographic transition take place rapidly in a narrow temperature region of about 15 K, while the α transition in FeS takes place over a wide temperature range of about 200 K. It is also found that the α transition for $V_{0.025}Fe_{0.975}S$ has a hysteresis width of 5 K.

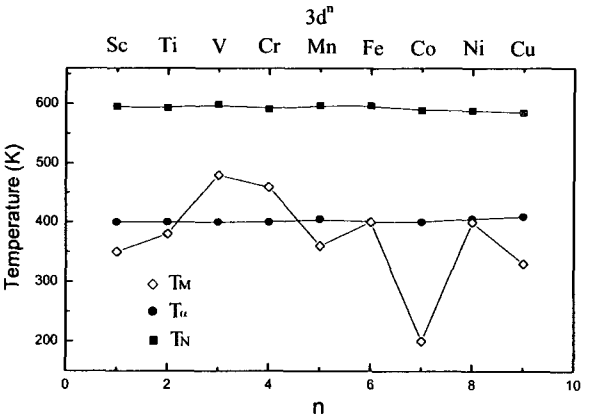

Fig. 1. Compositional dependence of Néel temperature T_N, α transition temperature T_α, and the Morin transition temperature T_M.