구두발표 II-3

델타도핑된 (Ga,Mn)As 구조에서 자기적 상태의 조절

(Controlling of magnetic phase in delta doped (Ga,Mn)As structures)

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1. Introduction

Since the discovery of ferromagnetic phase in Mn doped semiconductor, a great amount of research efforts has been focused on the investigation of various physical properties magnetic semiconductor materials due to fundamental interests of physics and spintronics application purposes. Recently, it was found that external electric filed or through field induced carrier density manipulation can affect the magnetic properties of magnetic semiconductors. But, most of studies so far have considered randomly distributed magnetic semiconductor structures. In our work, we will explore the possibility of controlling of magnetic phase in double delta doped magnetic semiconductors instead. The (Ga,Mn)As structures have been chosen in our calculations. Indeed, neither experimentally nor theoretically one has studied in this structure.

2. Method

We use full potential linearized augmented plane wave (FLAPW) method to explore the issues mentioned above. The primary concern in our work is the observation of the control of magnetic phase or under what condition one can control magnetic interaction in double delta doped magnetic semiconductors. For our aim, the interlayer distance between two Mn magnetic monolayer, carrier densities, and carrier types are varied. The optimized atomic structure was achieved through force and energy minimization processes with FLAPW method. Simulation of external carrier carriers was done by changing the number of electrons in valence band.

3. Results

Through theoretical calculations, we found that the ferromagnetic exchange interaction between two Mn monolayer was favored if the interlayer distance is less than approximately 12 A. It was observed that the magnetic interaction was barely affected if the carrier type is electron. However, the exchange is strongly modified if the carrier is hole and even the magnetic phase stability displays the opposite trend. Interestingly, the calculations showed that one can controll magnetic phase if the interlayer distance is about 16 A. The ferromagnetic phase was favored if the carrier is holw, whereas the antiferromagnetic state was stable electron carrier case.

4. Summary

With FLAPW calculations, we first theoretically found that one can manipulate the magnetic exchange interaction between two magnetic monolayer in Mn doped GaAs structures. The magnetic phase change was occurred when the interlayer distance is about 16 A. The ferromagnetic interaction was stable if the Mn-Mn distance is less than 16 A although the ferromagnetic phase stability was modified by carrier type. We hope our theoretical results stimulate experimental verification.

5. 참고문헌

[1] H. Ohno, et al, Phys. Rev. Lett. V68, 2264 (1992).
[2] H. Ohno, Nature, V408, 944 (2000).
[3] T. Dietl et al, Science V301, 943 (2001).(rapid comm.) V67 020406 (2003)
[4] Jisang Hong, D.S. Wang, and R.Q Wu, Phys. Rev. Lett. V94, 137206 (2005)