Q-11

230K 강자성을 보이는 Fe이 치환된 게르마늄 반도체

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Ferromagnetism in Fe-doped Germanium

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1. 서론

The injection of spins into nonmagnetic semiconductors has recently attracted great interest due to the potential to create new classes of spin-dependent electronic devices. In order to inject spin-polarized currents into nonmagnetic semiconductors, many groups have tried to use ferromagnetic (FM) metals (i.e., Fe) as spin sources, forming metal-semiconductor heterostructures. However, the spin orientation of the carriers tends to be quickly lost at a ferromagnet-semiconductor interface via spin-flip scattering due to the dissimilar crystal structure and chemical bonding and the energy difference between the charge carriers in the ferromagnet and the semiconductor.[1] A more promising strategy to achieve spin injection into nonmagnetic semiconductors is to use diluted ferromagnetic semiconductor (DFS), prepared by substituting magnetic ions such as Cr^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, and Fe^{2+} into non-magnetic semiconductors.

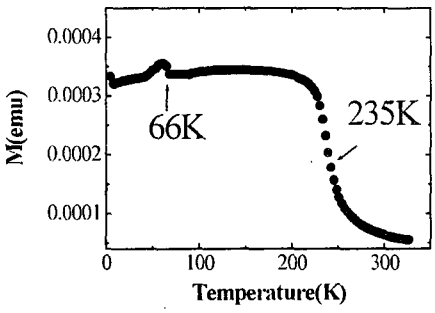
2. 실험방법

For the preparation of single-crystalline $Ge_{1-x}Fe_x$, we used high-purity (99.999%) germanium (Ge) and iron (Fe) powders as starting materials with a particle size of < –200 mesh to maximize the surface area and thereby enhance the reaction kinetics. First, the powders were weighed and loaded into thick-walled quartz ampoules. Then the ampoules were evacuated (< 10^{-6} Torr) and sealed. After encapsulation, the sealed ampoule was mixed, loaded into a vertical furnace, and heated slowly to form single-phase ($Ge_{1-x}Fe_x$). For single crystal growth, the temperature was slowly cooled at 0.5 °C/h to a point below the melting temperature (933 °C for Ge) and

thereafter at 100 °C/h. We have prepared 8 mm × 8 mm single crystals with x = 0 and 0.02.

3. 실험 결과 및 고찰

$Ge_{0.98}Fe_{0.03}$ showed ferromagnetic ordering at 274 K, as determined from temperature dependent magnetization and resistance measurements. The coersive field was 80 Oe



at 250 K.

Fig. 1 Temperature dependent magnetization (M) of $Ge_{0.98}Fe_{.02}$ in a 100 Oe magnetic field.

4. 결론

It is plausible that magnetically doped Ge and Si and related materials can open the way to room temperature spintronic devices.

5. 참고문헌

[1] G. Prinz, K. Hathaway, Phys. Today 48, 24 (1995).