

Magnetic properties of Ge-Cr magnetic semiconductors fabricated by thermal evaporation

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Magnetic semiconductors are expected to play a key role in spin manipulation and hence spintronic device applications. So far, much work has been done on magnetic semiconductors based on III-V such as Ga-Mn-As. Recently, however, materials based on group IV attracted much attention, Ge-based materials being of particular interest. Ferromagnetic order was reported by Choi et al. in bulk crystals of Ge-Cr [1], but this was not confirmed in a more recent work by Kioseoglou et al. for thin films grown by molecular beam epitaxy [2]. In the previous works, the amount of Cr in the alloys was very small, typically less than 4 at.%. This is because the solubility of Cr in Ge is very much limited in a *crystalline* form. This limitation can be avoided by forming an *amorphous* phase and it is the main motivation of the present work. Ge-Cr alloys over a wide composition range up to 40 at.% Cr were fabricated by thermal evaporation. Microstructural analyses including x-ray diffraction and transmission electron microscopy show no obvious crystalline precipitates. Magnetic measurements by using a SQUID and an alternating gradient magnetometer show a ferromagnetic ordering even up to room temperature. Saturation magnetization is very small being less than 0.1 emu/cc for compositions smaller than 10 at.%, but it is increased greatly at high Cr contents, the highest value being 3 emu/cc at a Cr content of 29 at.%. The present results, though preliminary, may indicate that amorphous Ge-Cr thin films are suitable for spintronic device applications.

References

- [1] S. Choi et al., Applied Physics Letters, 81, 3606 (2002).
- [2] G. Kioseoglou et al., Applied Physics Letters (to be Published).