

Dilute magnetic semiconducting behaviour of Fe doped CdSe nanoparticles

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Cadmium Selenide (CdSe) has become an interesting member of the II-VI semiconductor family due to its high photosensitivity and suitable band gap (1.74 eV at 300 K) [1]. Iron is a prominent dopant in II-VI semiconductors and is thus very suitable as a model system to study the influence of the host crystal to an impurity ion [2]. In the present work we have prepared pure and Fe (5% and 10%) doped CdSe nanoparticles (hence forth referred as CdFeSe1 and CdFeSe2 respectively) using the soft chemical technique which is an inexpensive route with less instrumentation and operated at room temperature. The x-ray diffraction (XRD) pattern indicates the cubic structure of the synthesized materials. The absence of any peak for Fe ions (in the XRD patterns of CdFeSe1 and CdFeSe2) indicates the complete substitution of Fe ions in CdSe lattice sites without any secondary phase or precipitate in the samples. We have carried out the transmission electron microscope (TEM) of CdSe, CdFeSe1 and CdFeSe2 respectively to find out the shape and size of the synthesized nanoparticles. SAED pattern supports the cubic structure of the materials.

Raman spectrum of the samples is taken in the range of 80-500 cm^{-1} . The Raman spectra are analyzed to obtain the 1st and 2nd order phonon modes (longitudinal and transverse optical modes) of the samples. The spectra exhibit a number of deconvoluted peaks along with the main peaks. A sum of 9 Lorentzian peaks is used to fit each of the Raman spectra.

The field cooled (FC) and zero field cooled (ZFC) magnetization (M) of the samples are measured as a function of temperature. Figure 1 shows the magnetization vs. magnetic field (M-H) curve at 5 K for CdFeSe2. From this figure we can say that the sample is antiferromagnetic in nature showing the value of $M = 51 \text{ emu/gm}$ for $H = 10 \text{ kOe}$. We have extracted the ferromagnetic contribution of the

sample from this curve (as shown in the inset of Figure 1) for which $M = 12 \text{ emu/gm}$. So the ferromagnetic contribution of the sample at 5 K is about 23 %. We have also calculated the same for CdFeSe1.

The temperature (T) dependence of the inverse molar magnetic susceptibility ($1/\chi_m$) of CdFeSe1 and CdFeSe2 at the field of 500 Oe is plotted to find out the effective Bohr magneton of the sample. A linear fit to the experimental data at higher temperatures by Curie-Weiss law yields a Curie-Weiss constant (Θ) for CdFeSe1 and CdFeSe2 of 50.79 K and 242.5 K respectively. The effective Bohr magneton number (P_{eff}) of CdFeSe1 and CdFeSe2 nanomaterials is found to be $1.389 \mu_B$ and $1.9007 \mu_B$ per formula unit respectively using the following equation $P_{\text{eff}} = 2.827 (C)^{1/2}$, where C is the Curie constant.

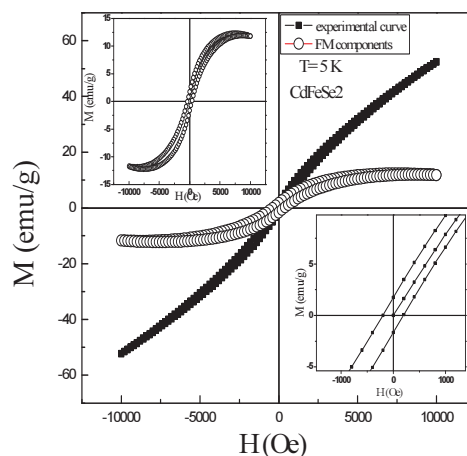


Figure 1: M-H curve of CdFeSe2

References

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