

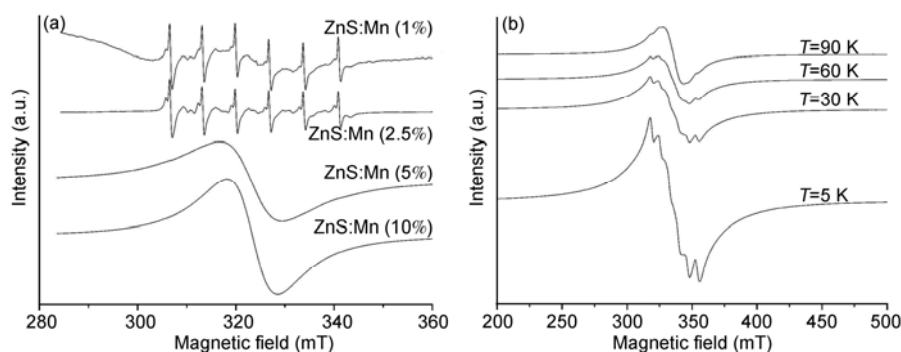
## Mn-doped ZnS is unsuitable to act as a dilute magnetic semiconductor

Dilute magnetic semiconductors (DMS) have recently been a major focus of magnetic semiconductor research. A laboratory from the University of Science and Technology of China explored the feasibility of doping manganese (Mn) into zinc sulfide (ZnS) to obtain magnetic semiconductors.

Hideo Ohno and his group at the Tohoku University, Japan, were the first to measure ferromagnetism in transition metal-doped semiconductors such as indium arsenide and gallium arsenide doped with Mn. Ever since, researchers have attempted to obtain semiconductor hosts doped with different transition metals that exhibit ferromagnetic properties.

A team of researchers from Hefei National Laboratory for Physical Sciences at the Microscale, University of Science and Technology of China, discovered that Mn-doped ZnS (ZnS:Mn) shows paramagnetic behavior and is not suitable for use as a DMS. Their work entitled "Structure characterization, magnetic and photoluminescence properties of Mn-doped ZnS nanocrystalline" was published in *Science China Physics, Mechanics & Astronomy*, 2012, Vol. 55(2).

Electron spin resonance (ESR) spectra (Figure 1(a)) of nanocrystalline ZnS:Mn show that at lower concentrations of Mn, a typical sextet centered at a  $g$ -value of 2 is associated with the allowed ( $\Delta m_s = \pm 1$ ,  $\Delta m_l = 0$ ) magnetic dipole transitions between the hyperfine-split Zeeman levels of the  ${}^6S_{5/2}$  ground state of the  $Mn^{2+}$  3d electrons. The hyperfine structure arises from the interaction between the  $S=5/2$  spin of the unpaired 3d electrons with  $I=5/2$  spin of the  ${}^{55}Mn$  nucleus. This indicates that Mn ions are distributed in the ZnS nanocrystalline lattice so that they are isolated from each other. At higher concentrations of Mn, the ions assemble together and are localized in the ZnS crystal lattice, decreasing the Mn-Mn atomic distance and increasing the dipole-dipole interaction. This causes the hyperfine structure to merge into one broad resonance. Further ESR experiments (Figure 1(b)) at low temperature also suggested that the sample was not ferromagnetic. All of the results indicated that ZnS:Mn is paramagnetic and not suitable for DMS.



**Figure 1** Room temperature ESR spectra of ZnS:Mn (a) and low temperature ESR spectra of ZnS:Mn (20%) (b).

**See the article:** Zuo M, Tan S, Li G P, et al. Structure characterization, magnetic and photoluminescence properties of Mn doped ZnS nanocrystalline. *Sci China Phys Mech Astron*, 2012, 55: 219–223

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