Poster Presentation

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Iron implanted CuInSe2 thin film - A diluted magnetic semiconductor

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Room temperature diluted magnetic semiconductor is important for the applications of spintronics. However, most of them are wide bandgap materials. In this report, the electronic structure and magnetic properties of an iron ion implanted on CuInSe2 (a small bandgap of 0.9 eV) semiconductor thin film was studied. The n-type CIS thin films were prepared by molecular beam epitaxy method. The ion implantation was done with an acceleration voltage of 72 keV. The concentrations of implanted Fe atoms were varied from 2E14 to 1E17 cm-2, and annealed at 400 ℃. Room temperature ferromagnetic property was observed with SQUID. At high doping level, the zero-field and non-zero field cool measurements show that these two curves merged at the temperature slightly higher than the room temperature, which implies that at high doping level, the ferromagnetic property is originated from a Fe cluster with the blocking temperature slightly higher than the room temperature. While at low doping level, the zero-field and non-zero field cool measurements show two curves almost identical. They did not show any evidence of an existence of blocking temperature even down to 5 K, which implies no Fe clusters are formed at low dose and a diluted magnetic semiconductor could be existent.
According to the analysis of the X-ray absorption spectra, the valence state of the implanted iron in the CIS thin films is zero at the highest doping level, and +2 for the lower iron doping concentrations. it means that the iron atoms segregated from CuInSe2 matrix and form iron clusters. For the iron with valence state of +2, it reveals that the iron atoms may occupy a substitutional site. In the XRD, the [312] diffraction peak of the CIS film shifts toward high angles as the iron dose increases at low doses, which implies that iron atoms would replace the copper atom sites because of the radius of the copper atom is smaller than that of iron. A possible explanation on this low bandgap diluted magnetic semiconductor will be proposed.

Keywords: diluted magnetic semiconductor, CuInSe2, ion implantation