T-P25

Study on Mn and Zn related deep levels and crystallinity of p-type InMnP:Zn by using deep level transient spectroscopy

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Diluted magnetic semiconductor (DMS) is a kind of material that has both magnetic and semiconductor properties. It can be achieved by injection of magnetic impurities such as Mn, Fe, and Co into the typical III-V or II-VI semiconductors. Recent decades, many researchers are developing and investigating the DMS materials and their physical properties to make new-function spin devices. The InP material is a kind of III-V semiconductor a candidate of DMS material together with GaAs, InAs, etc. Nevertheless, narrow band gap DMSs such as InP and GaAs have a comparatively low T_C at 110 ~ 170 K both predicted by theory and confirmed by experiment. However, GaMnAs and InMnP are still promising materials for accomplishing the properties of a DMS. In the researching field of DMS, perfect substitutions of cations by magnetic impurities without damages of the crystallinity are very important. The generated defects can hinder ferromagnetic channeling, as the result ferromagnetic properties of the DMS are reduced. Most of DMS researchers are using high-resolution TEM, XRD, PL, and XPS techniques to confirm the crystallinity and existence of secondary phase. However, these characterization methods only can show properties of extremely small part of DMS material. Typical characterization methods such as thermal stimulated current, admittance spectroscopy, and deep level transient spectroscopy (DLTS) are more suitable to confirm the properties of DMS. These methods can show states of magnetic impurities and non-magnetic impurites, secondary phase, and crystal damages, etc.

We studied the properties of magnetic impurities and non-magnetic impurities of p-type InMnP:Zn co-doped with Zn by using electrical measurements such as capacitance-voltage (C-V), DLTS, and photo induced current transient spectroscopy. In the InMnP:Zn used in this study, ion implantation to InP:Zn and post annealing methods are used to achieve the effective substitutions of the In^{+}-cations by Mn^{2+}-magnetic ions.