Impurity concentration determination in 6H-SiC

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The intensity ratio between intrinsic and extrinsic components in the photoluminescence (PL) spectra reflects the impurity concentration. This behaviour has previously been used for impurity concentration calibration in various semiconductors such as Si, GaAs, InP and diamond. It was recently proposed to be applicable in the case of the nitrogen donors in 6H-SiC [1]. However we will show in this paper that careful experimental conditions must be chosen in this case. The investigated samples were grown by the chemical vapour deposition technique and covered the range of net impurity concentration of 1×10^{14} to $1 \times 10^{17} \text{ cm}^{-3}$. N-type, p-type, uncompensated and compensated materials were used. The PL spectra were recorded in the near band gap emission of the 6H-SiC at various temperatures between 4.2K and 35K. The intensity ratio between the nitrogen bound exciton (BE) and the free exciton (FE) is shown to be dependent on the excitation power and the temperature used during the PL experiments and also on the the degree of compensation.

[1] L.L. Clemen, M. Yoganathan, W.J. Choyke, R.P. Devaty, H.S. Kong, J.A. Edmond, D.J. Larkin, J.A. Powell and A.A. Burk jr, presented at the ICSCRM, nov 1-3 1993, Washington DC

Far-infrared Magneto-optical Studies of D⁰ Band in Doped GaAs-AlGaAs Multiple Quantum Well Structures

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D⁰ ion, a shallow donor which binds two electrons and is negatively charged, could be found in GaAs quantum well (QW) when both the QW and the potential barrier are doped with n-type impurities. As the D⁰ concentration in QW increases, it can be expected that D⁰ level will broaden into a D⁰ band, which is also known as the upper Hubbard band. In this paper we report far infrared magneto-optical studies of the properties of D⁰ band. The samples used in this study are GaAs/Al_xGa_{1-x}As multiple QW structures grown by molecular beam epitaxy. The width of the GaAs QWs are 200 Å and the width of the AlGaAs potential barriers are 600 Å. All samples are δ-doped at the center of the QWs and at the center of the potential barriers. The doping concentration in the wells and in the barriers are the same and are $2 \times 10^{10} \text{ cm}^{-2}$, $4 \times 10^{10} \text{ cm}^{-2}$, $8 \times 10^{10} \text{ cm}^{-2}$, and $16 \times 10^{10} \text{ cm}^{-2}$, respectively. Far-infrared magneto-transmission measurements were performed using a slow scan Fourier transform spectrometer in conjunction with a 9T superconducting magnet. At high magnetic fields and T=5K, three-peak structures are observed for the sample with lowest doping concentration. These three peaks are attributed to electron cyclotron resonance (CR), intra-D⁰ ($1s \rightarrow 2p^+$) transition and intra-D⁰ ($1s^2 \rightarrow 1s^2 2p^+$) transition, respectively. As the impurity concentration increases, intra-D⁰ transition gradually shifts to lower energy, loses its absorption intensity and finally merges with intra-D⁰ transition. In the temperature dependent studies, different behavior are observed for samples with different doping concentration at high magnetic fields. For the sample with doping concentration of $4 \times 10^{10} \text{ cm}^{-2}$, as the temperature increases, intra-D⁰ transition loses its absorption intensity while the absorption intensities of CR and intra-D⁰ transition increase. This behavior is consistent with a model

calculation which treats D⁰ and D⁺ as isolated centers with well-defined binding energies. For the sample with doping concentration of $16 \times 10^{10} \text{ cm}^{-2}$, between T=5K and T=30K, intra-D⁰ transition could not be identified, the spectra are dominated by intra-D⁺ transitions. A D⁰ band with broad bandwidth is needed to understand such a behavior. We'll also discuss the significance of our experimental results on the interpretation of metal-insulator transitions in doped semiconductor systems.

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Doping Efficiency and Compensation Mechanism in N-Doped ZnSe

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After the success of low resistance p-type doping in ZnSe using a radical N source, there is growing interest in the doping efficiency of N-doped ZnSe because of its applications for blue-green laser devices. However, when the N concentration exceeds above 10^{18} cm^{-3} , a doping efficiency abruptly decreases, showing strong self-compensation.

Through the first-principles pseudopotential method, we calculate the formation energies for various N-related defects including native ones and find that a compensation effect of N-N complexes on acceptors is very significant in highly N-doped ZnSe. We find that a substitutional acceptor N_{Se}^- is most stable among the defects, while the broken-bonding configuration with C_{3v} symmetry is a metastable state against the T_d -symmetry structure. The estimated maximum acceptor density is about 10^{18} cm^{-3} under Se-rich condition, in good agreement with experiments. However, for N concentrations above 10^{18} cm^{-3} , the neutral N_2 molecule at an interstitial site is energetically favorable and neutralizes the acceptor activity, lowering doping efficiency. Under Zn-rich condition, since the N atom prefers to occupying the Se sublattice as a substitutional, the maximum carrier concentration is increased up to about 10^{19} cm^{-3} , giving rise to higher doping efficiency. However, the acceptors are still compensated by the [100]-split interstitial N-N complexes which behave as a double donor at higher N concentrations.

DONOR PROPERTIES OF Sc IMPURITY IN CdTe AND ZnTe CRYSTALS

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Studing low-temperature ex-