Abstract

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"Optically detected magnetic resonance of Arsenic antisite-related defects in semi-insulating bulk and low temperature MBE-grown GaAs"

With the Magnetic Circular Dichroism of the optical Absorption (MCDA) and MCDA detected Electron and Electron Nuclear Double Resonance (MCDA-EPR/ENDOR) at K- and W- microwave frequency bands the EL2 defect in semi-insulating LEC GaAs and native defects in low temperature MBE grown GaAs (LT-GaAs) have been investigated.

Former K-band MCDA-EPR/ENDOR spectra of the EL2 defect were difficult to interpret because of higher order effects such as a pseudo-dipolar nuclear couplings and forbidden transitions. So far the structure of the EL2 defect has remained under debate. The high field EPR/ENDOR is the only way to eliminate the undesirable influence of those effects. However, for the high field MCDA-EPR/ENDOR measurements the development of light accessible high frequency microwave cavity was necessary. That was achieved. With new W-band Fabry-Pérot resonator (TEM_{00q}) it was possible to eliminate the undesirable pseudo-dipolar nuclear couplings and measure unambiguous ENDOR spectra.

With the high field (W-band) MCDA-ENDOR two neighbor shells of the EL2 defect were detected. The angular dependencies of the first (nearest) ^{75}As neighbor shell show within the range of experimental error T_d symmetry. The higher (5^{th} (^{75}As)) neighbor shell detected with W-band ENDOR is split into two subshells indicating a pair defect inspite of the high symmetry of the nearest neighbors. However, the cause of the symmetry lowering can not contribute significantly to the shf interactions. A Ga-vacancy (V_{Ga}) without a nuclear spin is a probable candidate of such a disturbance. Therefore, an As_{Ga}^{+}-V_{Ga}^{3-} model can be suggested as an alternative model of the EL2 defect in agreement with recent calculations (H.Overhof - department of theoretical physics of the University of Paderborn). The As_{Ga}-As_i model, which is one of the most discussed models, can be excluded since it is not supported by the W-band MCDA-EPR/ENDOR experiments.

The magneto-optical investigations of native mainly As_{Ga}-related defects in as-grown (200°C) and annealed LT-GaAs show that the defect properties are greatly influenced by the annealing temperature. The samples were prepared with a lift-off technique allowing beyond the gap energy (1.5eV) measurements. By measuring the tagged MCDA spectra As_{Ga}-related defects with different optical properties were observed in as-grown and annealed material. LT-GaAs annealed at 500°C exhibits an MCDA shape characteristic for the EL2 defect. In addition to the As_{Ga}-related spectra, two superimposed MCDA-EPR spectra were observed. One of them was attributed to the V_{Ga}-related defect. The bleaching efficiency of the defects in LT-GaAs is very much reduced and shifted to higher photon energies compared with the EL2 defect, even after annealing to 500°C, where apparently several properties of the EL2 (also spin-lattice relaxation) are modified.