

Excitonic recombination of Donor bound excitons in selectively doped MQW under high magnetic fields

Autor(en): **Buhmann, H. / Stepniowski, R. / Martinez, G.**

Objektyp: **Article**

Zeitschrift: **Helvetica Physica Acta**

Band (Jahr): **65 (1992)**

Heft 2-3

PDF erstellt am: **26.09.2024**

Persistenter Link: <https://doi.org/10.5169/seals-116418>

Nutzungsbedingungen

Die ETH-Bibliothek ist Anbieterin der digitalisierten Zeitschriften. Sie besitzt keine Urheberrechte an den Inhalten der Zeitschriften. Die Rechte liegen in der Regel bei den Herausgebern.

Die auf der Plattform e-periodica veröffentlichten Dokumente stehen für nicht-kommerzielle Zwecke in Lehre und Forschung sowie für die private Nutzung frei zur Verfügung. Einzelne Dateien oder Ausdrucke aus diesem Angebot können zusammen mit diesen Nutzungsbedingungen und den korrekten Herkunftsbezeichnungen weitergegeben werden.

Das Veröffentlichen von Bildern in Print- und Online-Publikationen ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. Die systematische Speicherung von Teilen des elektronischen Angebots auf anderen Servern bedarf ebenfalls des schriftlichen Einverständnisses der Rechteinhaber.

Haftungsausschluss

Alle Angaben erfolgen ohne Gewähr für Vollständigkeit oder Richtigkeit. Es wird keine Haftung übernommen für Schäden durch die Verwendung von Informationen aus diesem Online-Angebot oder durch das Fehlen von Informationen. Dies gilt auch für Inhalte Dritter, die über dieses Angebot zugänglich sind.

Excitonic Recombination of Donor Bound Excitons in Selectively Doped MQW under High Magnetic Fields

H. Buhmann¹⁾, R. Stepniewski²⁾, G. Martinez²⁾, and B. Etienne³⁾

¹⁾ *Hochfeld-Magnetlabor, Max-Planck-Institut für Festkörperforschung
BP 166X, 38042 Grenoble Cedex, France*

²⁾ *Service National des Champs Intenses, Centre National de la Recherche Scientifique
BP 166X, 38042 Grenoble Cedex, France*

³⁾ *L2M / Centre National de la Recherche Scientifique, 196 av. Henri Ravera, 92220 Bagneux, France*

Abstract. The luminescence related to the excitonic transition of selectively doped GaAs/GaAlAs multi-quantum-wells (MQW) has been investigated under high magnetic fields up to 27 T in the temperature-range from 0.4 to 19 K. In all samples a 2D-like free exciton is observed as well as additional structures of excitonic character assigned to excitons bound to neutral (D^0, X) and ionized donors (D^+, X), with binding-energies depending on the doping location. Whereas these binding-energies do not vary with magnetic field, their relative intensities show very interesting dependences, which are analysed.

In the last years various optical methods have been used to investigate the optical properties of selectively doped MQW with different doping locations and well-sizes [1, 2, 3], and gave rise to the identification of (D^0, X) and (D^+, X) excitons. The properties of 2D-like free excitons in a magnetic field were studied theoretically [4] and experimentally [2, 5] by several groups. The investigation of donor-states in magnetic field (B) by far-infrared spectroscopy measurements showed the existence of negatively charged donor (D^-) for co-doping at the center of the well and the barrier [3]. The present work was done to investigate the behaviour of bound excitons in such special circumstances. The samples were mounted in a ^3He -cryostat with optical access via a fiber-optic system placed in the hybrid-magnet. Photoluminescence was excited using an Ar^+ -Laser (excitation line: 514 nm) and detected by a cooled GaAs-photomultiplier at the exit of a triple-Raman-spectrometer, with 0.06 meV resolution. Experiments, where the polarization of the recombination light was investigated, were done in a ^4He -cryostat with optical access via a window, mounted in a 10 T superconducting coil.

The samples (GaAs-Ga_{0.75}Al_{0.25}As MQW of 150 periods) were grown by MBE with a well-width of 10 nm and barrier-widths of 5–20 nm depending on the sample. Selective Si-doping, with growth interruption, achieves a concentration ranging from $1 \times 10^{10} \text{ cm}^{-2}$ (δ -doping) to $9.9 \times 10^{15} \text{ cm}^{-3}$ (uniform doping). A test-sample without any doping was also investigated.

The spectra of the undoped sample only show the recombination-line of the heavy-hole free exciton (HHFE), (Fig. 1), and the spin-split component in magnetic field. The intensity of the σ^+ -component remains approximately constant with B . In all samples this HHFE-line is observed, and shows the same diamagnetic shift. Its intensity does not significantly change with B . In the doped samples, additional structures appear on the low energy side of the HHFE-line, and are attributed to (D^0, X) excitons, either located near the center of the barrier (b) or near the center of the well (w). The measured binding-energies ($E_B(D^0, X(b)) = 1.5 \pm 0.05 \text{ meV}$ and $E_B(D^0, X(w)) = 2.3 \pm 0.05 \text{ meV}$) do not change with B up to 27 T and are in good agreement with published results [1]. These lines exhibit also the same spin-splitting properties as the HHFE. In samples, with a co-doping, an excitonic recombination line ($E_B \approx 3.3 \text{ meV}$) appears and grows with B . In samples, with a high compensation rate, δ -doped at the center of the well, this line is always present and has an intensity independent on B . In comparison with other experiments [6] one can assign this line to the recombination of excitons trapped on ionized (D^+)-centers in

