Recent work using scanning tunneling spectroscopy (STS) revealed that acceptors in III/V semiconductors appear strongly anisotropic and their mirror asymmetry regarding the (001) plane depends on the binding energy $E_b$. While the energetically deep acceptor Mn in GaAs has a symmetric cross like shape [1], shallow acceptors like Zn show an asymmetric triangular feature [2]. We analyzed the relatively deep acceptor Mn in InAs ($E_b = 30\, eV$) by STS and find a dependency of the shape on the depth below the (110) surface. Deeper Mn acceptors appear as a cross with a low asymmetry which is reproduced by a bulk tight-binding model (TBM). Mn acceptors closer to the surface show an strong asymmetry of the cross resulting in a triangular feature. A possible explanation is the strengthening of the symmetry by surface relaxation. The influence of the acceptor on the conduction band (CB) has also been studied by STS and TBM calculations. The CB density of states shows a suppression close to the Mn which is surrounded by an oscillation reflecting the anisotropy of the acceptor state.

by spatially resolved I(V)-spectroscopy.

The dopant atoms are identified by their bias dependent topographic and spectroscopic properties. In addition to the known features at negative and small positive voltages, our measurements on single donors show an additional transport channel for larger positive bias voltages. The current distribution has a circular symmetric structure. The diameter is bias dependent, and can extend up to several nanometers around the donor. The minimal bias voltage of the current onset is localized above the donors. We discuss different scenarios - including tip induced band bending - that can lead to the observed ring-like shapes.

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GaMnAs grown on (001), (311) and (110) GaAs — Ursula Wurstbauer, Dieter Schuh, and Werner Wegscheider — Universität Regensburg

In order to realize new spintronic devices based on Mn-doped GaAs heterostructures, one has to understand in detail and improve the properties in GaMnAs. For this reason, an accurate control of the effective Mn x concentration and the carrier density is necessary in this hole mediated ferromagnetic semiconductor GaMnAs. So far it is known, that these parameters critically depend on the incorporation of Mn atoms in the host lattice and on lattice defects, mainly As antisites and Mn interstitials, both acting as double donors, which are caused by the unavoidable low temperature MBE growth. In our experiments, we have grown GaMnAs layers on differently oriented GaAs substrates to compare the influence of growth and post-growth-treatment parameters on the Mn incorporation and, hence on \( T_C \). We obtain the carrier density \( p \) by measuring the anomalous Hall Effect and the concentration of As-antisites from the lattice constant of LT-GaAs layers by X-ray diffraction. Further we show, that by avoiding As-antisites with a low \( \text{As}_4/\text{Ga} \) flux ratio and by reducing the Mn-interstitials by post growth annealing the carrier density and corresponding \( T_C \) increases to 152K for layers grown on (001) GaAs, to 110K for layers on (311)A and 89K for layers on (110). In addition, the possibility to overgrow cleaved (110) surfaces with GaMnAs of a high quality enables the growth of more complicated heterostructures like magnetic bipolar heterojunctions. We acknowledge the support by the DFG via SFB 689.