on the interface, exhibit in-plane magneto-crystalline anisotropy. Appropriate nanostructurization of such layers results in patterning-induced strain relaxation, which introduces into narrow stripes of the material a shape-dependent magnetic anisotropy in addition to the magneto-crystalline anisotropy of the parent (Ga,Mn)As layers. This patterning-induced magnetic anisotropy offers an additional degree of freedom that can be used in device operation.

In our preliminary investigations we examined two types of nanostructures fabricated from (Ga,Mn)As ferromagnetic layers. One of them has been the three-arm nanostructure [1], and the other - the cross-like nanostructure composed of two perpendicular nanostripes crossing in the middle of their lengths [2]. The latter structure is especially interesting as it allows, in principle, for full electrical control of the device. The underlying idea is that the magnetization in a nanostripe is forced to be directed along its long axis, while in the area of stripes intersection it is determined rather by the crystalline anisotropy of parent layer. Domain walls (DWs), separating regions of different magnetization directions, contribute an extra resistance to the total electrical resistance of a nanostripe, owing to spin-dependent scattering of charge carriers passing through the region of inhomogeneous magnetization of DW, in a rate depending on the spin misalignment. Manipulating the magnetization directions in the stripes by means of an external magnetic field, or electric current passing through the stripes, allows reaching either of two electrical states of each stripe that distinguish themselves by different resistances. In the present work we have studied those effects in more details using cross-like naostructures fabricated from (Ga,Mn)As layers, grown by the low-temperature molecular-beam epitaxy method, and next patterned by the electron-beam lithography and chemical etching. We interpret the obtained results in terms of DWs rearrangement and also discuss the contribution of anisotropic magneto-resistance to the observed effects.

Acknowledgments: This work has been partially supported by the Polish Ministry of Science and Higher Education under Grant No. N N202 129339.

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36.27 Tue 16:00 Poster area, 222

Spin-Polarized Photoemission from group-IV heterostructures — •Federico Bottegoni, Alberto Ferrari, Giovanni Isella, Stefano Cecchi, Daniel Chrastina, and Franco Ciccacci — LNESS-Dipartimento di Fisica, Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milano, Italy

The possibility to generate a spin-polarized electron population in the conduction band of III-V semiconductor compounds upon excitation with circularly polarized light, known as Optical Orientation, has been thoroughly studied in the early eighties [1]. This technique, combined with the Negative Electron Affinity (NEA), achievable by the alternate deposition of Cs and O_2, has paved the way to the study of optical electron spin initialization and the observation of the subsequent dynamics in the conduction band of GaAs-based heterostructures [2]. Nevertheless, the major issue of such compounds is their low integrability with nowadays Si-based electronics. It is well known that the "quasi-direct" nature of Ge at the Γ point of the Brillouin zone allows, as in III-V semiconductors, to generate an optically spin-oriented electron population [3], which can be further increased by reducing the symmetry of the system, even though in this case the alternate deposition of Cs and O_2 can only lower the Electron Affinity of the sample down to a few hundreds of meV above the bottom of the conduction band, without reaching NEA conditions. However, until recently, technological issues due to the misfit between Si and Ge have prevented the fabrication of high quality SiGe heterostructures. We present Spin-Polarized Photoemission (SPPE) measurements performed on group-IV heterostructures, including bulk samples, Quantum Wells and strained layers. The SiGe heterostructures were grown by Low Energy Plasma Enhanced Chemical Vapor Deposition (LEPECVD) [4]. The strain-induced removal of the Heavy Hole and Light Hole degeneracy allows to exceed the 50% polarization limit that affects bulk structures. In particular, we report an electron spin polarization up to $P = 62\%$ from Ge/$Si_{1-x}Ge_x$ samples [5]. By varying the stoichiometry of the $Si_{1-x}Ge_x$ alloy, we are able to control the compressive biaxial strain of the Ge epilayer, and consequently the energy splitting between heavy hole (HH) and light hole (LH) states, so that a correlation between the strain degree and the measured maximum electron spin polarization has been experimentally determined. Moreover, by symmetry arguments, we can estimate the degree of strain-induced orbital mixing between LH and split-off (SO) states, which results increased with respect to the case of bulk Ge.

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36.29 Tue 16:00 Poster area, 223

Electron-nuclei spin dynamics in II-VI semiconductor quantum dots — Claire Le Gall, Adalberto Brunetti, •Hervé Boukari, and Lucien Besombes — CEA-CNRS group "Nanophysique et semiconducteurs", Institut Néel, CNRS & Université Joseph Fourier, Grenoble, France

Individual electron spins in quantum dots are a promising system to store quantum information due to their expected long coherence time. However, in the commonly studied III-V semiconductor quantum dots, the hyperfine interaction of the electron with the fluctuating nuclear spins governs the time scale on which an electron spin can be stored in the absence of external magnetic field. Continuous pumping of electrons can generate a dynamical nuclear spin polarization through hyperfine mediated spin flip-flop. It has been proposed that a full polarization of the nuclei could cancel the decoherence induced by the fluctuating hyperfine field. Alternatively, nuclear spins could be suppressed completely by using quantum dots based on isotopically purified II-VI materials since Zn, Cd, Mg, Se and Te all have dominant isotopes without nuclear spins.

We report on the dynamics of optically induced nuclear spin polarization in individual CdTe/ZnTe quantum dots. Individual quantum dots containing a single electron obtained by modulation doping have been studied. The triplet state of the excited charged exciton is identified in photoluminescence excitation spectra. Negative photoluminescence polarization, optical pumping of the resident electron and nuclear spin polarization build-up are observed in time-resolved optical pumping experiments when the quantum dot is excited at higher energy than the charged exciton triplet.

In the optical pumping regime, the formation of a dynamical nuclear polarization is also probed by the magnetic field dependence of the polarization rate of the negatively charged exciton. Strong variations of the nuclear spin polarization are observed when the magnetic field is scanned around zero tesla. The acceleration of the dipole-dipole interaction between the nuclear spins when the external field compensate the Knight field is responsible for a decrease of the nuclear spin polarization at low negative magnetic field. The feedback process occurring in the dynamics of coupled electron and nuclear spins when the Overhauser field compensates the applied magnetic field leads to a strong increase of the nuclear spin polarization at low positive magnetic field. The magnetic field dependence of the polarization rate of the charged exciton reveals that the nuclear spin fluctuations are the dominant process in the dephasing of the resident electron. We demonstrate that this dephasing is efficiently suppressed by a large dynamic nuclear spin polarization at zero magnetic field.

The build-up of nuclear spin polarization at zero magnetic field reaches the microsecond range at high excitation intensity. Relaxation time of the coupled electron-nuclei system in a range of 10 microseconds is observed at zero magnetic field and increases by one order of magnitude under an external magnetic field of a few milli-Tesla. We will discuss mechanisms responsible for the fast initialisation and relaxation of the diluted nuclear spins in these II-VI semiconductor quantum dots.

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Strain-Induced Reduction of Surface Roughness Dominated Spin Relaxation in MOSFETs — Dmitri Osintsev, Zlatan Stanojevic, Oskar Baumgartner, •Viktor Sverdlov, and Siegfried Selberherr — Institute for Microelectronics, TU Wien, Gußhausstraße 27-29, A-1040 Vienna, Austria

Silicon is the basic element of modern charge-based microelectronics. At the same time silicon possesses several properties attractive for spin-driven applications: it is composed of nuclei with predominantly zero spin and is characterized by small spin-orbit coupling. Long distance spin transfer has already been demonstrated. However, large experimentally observed spin relaxation in electrically-gated lateral-channel silicon structures may become an obstacle in realizing spin driven devices [1], and a deeper understanding of fundamental spin relaxation mechanisms in silicon is urgently needed [2].

We investigate the surface roughness induced spin relaxation in silicon spin field-effect transistors. To accurately describe the band structure in the presence of the intrinsic spin-orbit interaction a $\mathbf{k}\cdot\mathbf{p}$ Hamiltonian has been generalized to include the spin degree of freedom. The spin-orbit term $\tau_y \otimes (k_x\sigma_x - k_y\sigma_y)$ with

$$\Delta_{so} = 2\sum \frac{\langle X_1|p_j|n\rangle\langle n|[\nabla V \times \mathbf{p}]_j|X_{2'}\rangle}{E_n - E_X},$$

couples the states with the opposite spin projections from the opposite valleys. The value Δ_{so} =1.27meVnm was computed using the empirical pseudopotential method. We solve the Hamiltonian numerically. In the presence of strain and confinement the four-fold degeneracy of the lowest subband is partly lifted, however, the degeneracy of the eigenstates with the opposite spin projections, $\Uparrow\rangle$ and $\Downarrow\rangle$ is preserved. The degenerate states are chosen to satisfy $\langle\Uparrow|\sigma_z|\Downarrow\rangle = 0$.

The surface roughness scattering matrix elements are proportional to the product of the subband function derivatives of the corresponding wave functions at the interface. We demonstrate that the intersubband spin relaxation matrix element mixing the up- and down-spin states from the two opposite valleys is reduced with strain rapidly. Thus, applying uniaxial stress along the [110] direction suppresses spin relaxation and can be used to boost both, mobility and spin lifetime.

This work is supported by the European Research Council through the grant #247056 MOSILSPIN.

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