
# 3RD BRAZIL MRS MEETING

October 10-13, 2004

## WORKSHOP IN SEMICONDUCTOR SPINTRONICS

**Symposium Organizers:**

J. d´Albuquerque e Castro (UFRJ)

G. Medeiros-Ribeiro (LNLS)

# WORKSHOP

## SPINTRONICA EM SEMICONDUTORES

**Monday, October 11**

8:15 **OPENING REMARKS** – J. Castro(UFRJ) and G. Medeiros-Ribeiro (LNLS)

Session Chair J. Castro (UFRJ)

**SEMICONDUCTING STRUCTURES AND DEVICES**

8:20 Invited SILICON-BASED SPIN QUANTUM COMPUTATION
B. Koiller - Instituto de Física, UFRJ

9:00 RABI OSCILLATIONS IN TWO-LEVEL SEMICONDUCTOR SYSTEMS
H. S. Brandi - Instituto de Fisica, Univ. Federal do Rio de Janeiro; A. Latge - Instituto de Fisica, Univ. Federal Fluminense; Z. Barticevic - Depto. de Fisica, Universidad Tecnica Federico Santa Maria; L. E. Oliveira - Instituto de Fisica, Unicamp (W - 05)

Session Chair J. Castro (UFRJ)

**DILUTED MAGNETIC SEMICONDUCTORS I**

9:20 THEORETICAL STUDIES OF MN IN GaAs AND TYPE-IV SEMICONDUCTORS
A. J. R. da Silva, A. Fazzio - Instituto de Física, USP, São Paulo, SP, Brasil; A. Antonelli, L. E. Oliveira - Instituto de Física "Gleb Wataghin", UNICAMP, Campinas, SP, Brasil; R. R. dos Santos - Instituto de Física, UFRJ, Rio de Janeiro, RJ, Brasil (W - 16)

9:40 TOWARDS A SIMPLE MODEL FOR DILUTED MAGNETIC SEMICONDUCTORS
R. R. Santos - IF/UFRJ, CxP 68528, 21941-972 Rio de Janeiro RJ, Brasil
(W - 13)

10:00 COFFEE BREAK

Session Chair J. Castro (UFRJ)

**DILUTED MAGNETIC SEMICONDUCTORS II**

10:20 ELECTRONIC PROPERTIES OF DILUTED FERROMAGNETIC SEMICONDUCTOR BASED ON INGAAS AND GAAS
S. C. P. Rodrigues, E. F. da Silva Jr. – UFPE, Departamento de Física; G. M.

Sipahi - IFSC-USP; C. da Cunha Lima – UERJ; L. M. R. Scolfaro - IF-USP (W - 03)

10:40 HYBRID STRUCTURES OF GAAS AND MNAS EPITAXIAL FILMS AND NANO-STRUCTURES
F. Iikawa - IFGW/Unicamp; M. J. S. P. Brasil, O. D. D. Couto, C. Adriano, C. Giles, M. Knobel – Unicamp; R. Magalhães-Paniago - UFMG/LNLS; P. V. Santos, L Däweritz - PDI-Berlin (W - 09)

Session chair G. Medeiros-Ribeiro (LNLS)

**QUANTUM DOTS**

11:00 EXPLORING SPIN-HYBRIDIZATION AND SYSTEM MAGNETIZATION IN OPTICAL SWITCHING REGIMES
V. Lopez-Richard - Dep. de Física, FFCL da Universidade de São Paulo, Ribeirão Preto-SP; S. J. Prado, A. M. Alcalde, G. E. Marques – DF, Ufscar; C. Trallero-Giner; Dep. Fisica Teorica, Universidad de La Habana, Cuba (W - 12)

11:20 ENGINEERING THE G-FACTOR OF SELF-ASSEMBLED QUANTUM DOTS
E. Ribeiro, G. Medeiros-Ribeiro, H. Westfahl Jr.– LNLS, Laboratório Nacional de Luz Síncrotron, Campinas (W - 01)

11:40 MULTILAYERS OF SIO2/PBTE QUANTUM DOT FABRICATION AS POSSIBLE INPINTRONIC DEVICE
L. C. Barbosa, E. Rodríguez, E. Jimenez, A. A. R. Neves, C. L. Cesar - UNICAMP/IFGW/CEPOF, UNICAMP (W - 02)

Session Chair G. Medeiros-Ribeiro (LNLS)

**ADVANCED FABRICATION TOOLS**

12:00 Invited PRECISE LASER CHEMICAL PROCESSING OF 3-DIMENSIONAL STRUCTURES: PROCESSES AND APPLICATIONS
M. Stuke - Max-Planck-Institut f. biophys. Chemie, Germany

12:40 LUNCH

Session Chair Bellita Koiller (UFRJ)

**SPIN TRANSPORT**

14:00 Invited QUANTUM CONDUCTANCE BEHAVIOR OF ATOMIC-SIZE MAGNETIC WIRES
D. M. Ugarte - DFA-IFGW-UNICAMP and LNLS - Instituto de Física Gleb Wataghin, UNICAMP (W - 04)

14:40 NOVEL SPIN FETS
J. Carlos Egues - Departamento de Física e Informática, Instituto de Física de São Carlos, USP (W - 17)

15:00 SPIN-PUMPING EFFECT IN METALLIC INTERFACES
R. L. Rodríguez-Suarez, L. H. Vilela Leão, A. B. Oliveira, S. M. Rezende, A.Azevedo - Universidade Federal de Pernambuco, Departamento de Física (W - 11)

15:20 Fe/Cs ON GaAs AS A POTENTIAL CONTACT FOR SPINTRONIC DEVICES
W. N. Rodrigues, L. C. de Carvalho, D. R. Miquita, E. A. Czarnobai, M. V. B. Moreira, J. C. Gonzalez, A. G. de Oliviera - Departamento de Física, Instituto de Ciências Exatas, UFMG (W - 08)

15:40 EPITAXIAL FERROMAGNETIC FILMS GROWN ON SEMICONDUCTORS
P. L. Gastelois, M. D. Martins, L. H. F. Andrade, W. A. A. Macedo – CDTN, Laboratório de Física Aplicada, Cidade Universitária, Pampulha, Belo Horizonte (W - 10)

16:00 SPIN POLARIZED TUNNELING IN HYBRID FE-ZNSE STRUCTURES: ENTERTAINMENT OR CHALLENGE?
D. H. Mosca - Departamento de Física – UFPR; J. Varalda, A. J. A. de Oliveira - Departamento de Física – UFSCar; J.M. George - Unite Mixte de Physique CNRS/Thales Domaine Corbeville, France ; M. Eddrief, M. Marangolo, V. H. Etgens - LMCP, Université de Paris (W - 14)

16:20 COFFEE BREAK AND DISCUSSIONS

W - 01 ENGINEERING THE G-FACTOR OF SELF-ASSEMBLED QUANTUM DOTS

E. Ribeiro, G. Medeiros-Ribeiro, H. Westfahl Jr.– LNLS, Laboratório Nacional de Luz Síncrotron, PO Box 6192, Campinas - SP, Brazil

The knowledge of electron and hole g-factors, their control and engineering are key for the usage of the spin degree of freedom for information processing in solid state systems. The g-factor of both carriers will be materials dependent, the effect being larger for materials with large spin-orbit coupling. Since electrons and holes can be individually trapped into quantum dots in a controllable manner, they may represent a good platform for the implementation of quantum information processing devices. Here we use self-assembled quantum dots of InAs embedded in GaAs for the g-factor control and engineering.

W - 02 MULTILAYERS OF SIO2/PBTE QUANTUM DOT FABRICATION AS POSSIBLE INPINTRONIC DEVICE

L. C. Barbosa, E. Rodríguez, E. Jimenez, A. A. R. Neves, C. L. Cesar - UNICAMP/IFGW/CEPOF, Cidade Universitaria Zeferino Vaz s/n - Campus Barão Geraldo - Campinas - SP - Brazil - CEP 13083-970

We report the successful fabrication of multilayer structures as optical switch containing layers of PbTe quantum dots (QD) spaced by 15-20 nm thick SiO2 layers. The QDs were grown by the laser ablation of a PbTe target using the second harmonic of Nd:YAG laser in an argon atmosphere. The SiO2 layers were fabricated by Plasma Chemical Vapor Deposition using tetramethoxysilane (TMOS) as precursor. The influence of the ablation time and the laser fluence on the size, size distribution and density of the quantum dots was studied by High Resolution Transmission Electron Microscopy (HRTEM). Optical absorption measurements show clearly the QDs confinement effects.We produced three sets of samples: one with 11 layers deposited on a Si (100) wafer was used for the HRTEM measurements, the other with 60 layers deposited on BK7 corning glass was used for optical measurements, and the last one consisted of only one layer of SiO2/PbTe/SiO2 grown directly on carbon film to study the morphology of a single isolated quantum dot by HRTEM. (CEPOF/FAPESP/UNICAMP/LNLS)

W - 03 ELECTRONIC PROPERTIES OF DILUTED FERROMAGNETIC SEMICONDUCTOR BASED ON INGAAS AND GAAS

S. C. P. Rodrigues, E. F. da Silva Jr. – UFPE, Departamento de Física, Av. Professor Luiz Freire, s/n , 50670-901, Recife, PE, Brazil; G. M. Sipahi - IFSC-USP; C. da Cunha Lima – UERJ; L. M. R. Scolfaro - IF-USP

Diluted magnetic semiconductors (DMS) based on GaAs and InGaAs are promising material for novel semiconductor-based “spintronic” devices. The quaternary alloy magnetic semiconductor (InGaMn)As has many potential advantages and properties which cannot be realized by ternary alloy magnetic semiconductors. For instance, the band gap energy, easy magnetization axis, and band structure can be controlled by changing the In content of (InGaMn)As. Recently, it has been reported that in such system, the use of post-annealing techniques in strained structures can raise the TC above 100 K. In this work we calculated the electronic structure of GaAs/(n x InGaAs/InGaMnAs), and analyze the behavior of its properties by varying the number of DMS layers (n) and the In content. The exchange-correlation, split-off and strain effects are taken into account in a 6 x 6 Luttinger-Kohn (LK) model. A self-consistent calculation, which solves the LK multiband effective mass equation in conjunction with the Poison equation, is performed for the electronic structure, resulting in spin-polarized energy levels [1].From these results one can determine a set of parameters that maximize the presence of polarized charge distributions in the non-magnetic layers, enhancing the mobility of the carriers in the systems. New insights can therefore be attained towards engineering applications of new spintronics device structures.

[1] S. C. P. Rodrigues et al., Cond-Mat/0407331 (2004).

W - 04 QUANTUM CONDUCTANCE BEHAVIOR OF ATOMIC-SIZE MAGNETIC WIRES

D. M. Ugarte - DFA-IFGW-UNICAMP and LNLS - Instituto de Física Gleb Wataghin, UNICAMP, C.P. 6165, 13083-970 Campinas SP, Brazil and Laboratório Nac. de Luz Síncrotron (LNLS), C.P. 6192, 13084-971 Campinas SP, Brazil

Electrical transport properties of metallic nanowires (NWs) have received great attention due to their quantum conductance behavior. Atomic scale wires can be generated by stretching metal contacts; during the elongation and just before rupture, the NW conductance shows flat plateaus and abrupt jumps of approximately a conductance quantum (G0 = 2e2/h). In spite of a large amount of experimental and theoretical work on metal nanowires, it is surprising that wires made from magnetic materials have not yet been studied in detail. In this work, the atomic structure of NWs was studied by time-resolved in situ experiments in a high-resolution transmission electron microscope, while their electrical properties using an UHV (< 10 10 mbar) mechanically controllable break junction (MCBJ). We have observed that the atom chain structure made of different magnetic or quasi-magnetic metals (Co, Pd, Pt) shows a conductance of half the conductance quantum as should be expected when a fully spin polarized current is allowed to travel through the NW. Then, our results suggest that this phenomenon occurs spontaneously for one-atom-thick ferromagnetic metal wires in zero magnetic field and at room temperature. These results open new opportunities for spin control in nanostructures.

W - 05 RABI OSCILLATIONS IN TWO-LEVEL SEMICONDUCTOR SYSTEMS

H. S. Brandi - Instituto de Fisica, Univ. Federal do Rio de Janeiro, Rio de Janeiro - RJ, 21945-970, Brazil; A. Latge - Instituto de Fisica, Univ. Federal Fluminense; Z. Barticevic - Depto. de Fisica, Universidad Tecnica Federico Santa Maria; L. E. Oliveira - Instituto de Fisica, Unicamp

Rabi oscillations in coherent optical excitations in bulk GaAs and quantum dot two-level systems may be converted into deterministic photocurrents, with the impurities or dots providing the tag for each qubit. Here we perform a theoretical analysis of the time evolution of the two-level occupations, and the corresponding effects on the photocurrent. Present field-dependent results on the recombination rates related to a donor two-level system in bulk GaAs are found in good agreement with the corresponding experimental data. Moreover, theoretical calculations through optical Bloch equations on excitonic two-level systems indicate that the nature underlying the dephasing mechanism, which has previously remained as an open question, may be associated with the inhomogeneous broadening of the exciton line in the In(x)Ga(1-x)As two-level QD system.

W - 06 SPIN CORRELATION OF DOTS IN AN AHARONOV-BOHM RING

M. A. Davidovich, V. M. Apel, E. V. Anda - Departamento de Física, PUC-Rio, Rua Marquês de São Vicente, 225, Rio de Janeiro, Brasil, CEP: 22453-900; G. Chiappe - DF-UBA

In the last years the interest in double-dot systems has been renewed since they are expected to be basic building blocks for quantum computing. In this work we study a system constituted by two dots, each one embedded into one arm of a ring that is threaded by a magnetic flux and connected to two leads. The charging of the dots is obtained by the application of gate potentials to the dots. For gate potentials such that there are two electrons inside the dots we find that the dot spins are ferromagnetically correlated if no magnetic field crosses the ring, but are uncorrelated if the ring is crossed by a flux equal to half a quantum of magnetic flux. In both cases the dots are in the Kondo regime. However these are different Kondo states. While in the case of half a quantum of magnetic flux the system is in the usual S=1/2 Kondo regime in the case of zero flux it is in a Kondo state of total spin S=1, a triplet state. The dependence of the dot-dot spin correlation on the magnetic flux threading the ring is discussed. Using a method where a cluster containing the two dots and some contact sites are exactly diagonalized and then embedded into the rest of the system, we obtain the spin-spin correlation as well as the conductivity of the system as a function of the applied gate potentials for different values of the magnetic flux.

W - 07 SILICON-BASED SPIN QUANTUM COMPUTATION

B. Koiller - Instituto de Física, UFRJ, Cx. Postal 68528, 21941-972 RJ, Brasil

Proposals for silicon-based quantum computer (QC)architectures involve shallow donor bound electron states in performing logic operations, where electronic and nuclear spins are natural candidates for qubits. Critical analysis of the feasibility of Si-based QCs demands a realistic description of the underlying electronic structure. We show that, due to the Si band-structure characteristics, proper control over the QC operations pose stringent constraints on the donor positioning in the fabrication and manipulation of donor-based spin quantum gates.

W - 08 Fe/Cs ON GaAs AS A POTENTIAL CONTACT FOR SPINTRONIC DEVICES

W. N. Rodrigues, L. C. de Carvalho, D. R. Miquita, E. A. Czarnobai, M. V. B. Moreira, J. C. Gonzalez, A. G. de Oliviera - Departamento de Física, Instituto de Ciências Exatas, UFMG, CP 702, 30123-970, Belo Horizonte, MG

Contacts allowing the injection of spin polarized current in devices for spintronic are a challenge yet. Cesium is known for reducing the electron affinity of GaAs when deposited in tinny amounts as low as monolayers fractions. Using Cs as a interlayer prior the deposition of Fe on GaAs could allow for a convenient system for spin injection.
Here we will show preliminary results on the chemistry of this system as accessed by in-situ x-ray photoelectron spectroscopy.

W - 09 HYBRID STRUCTURES OF GAAS AND MNAS EPITAXIAL FILMS AND NANO-STRUCTURES

F. Iikawa - IFGW/Unicamp, CEP-13083-970, CP-6165, Campinas-SP, Brazil; M. J. S. P. Brasil, O. D. D. Couto, C. Adriano, C. Giles, M. Knobel – Unicamp; R. Magalhães-Paniago - UFMG/LNLS; P. V. Santos, L Däweritz - PDI-Berlin

MnAs is a promising candidate for integration of magnetic and semiconductor structures, a subject of considerable fundamental and technological interest. Research on this material has won a great impulse since the growth of high quality MnAs films by Molecular Beam Epitaxy was achieved. MnAs nano-structures also were fabricated by implanting Mn atoms into GaAs followed by thermal annealing. As the bulk material, MnAs epitaxial films and nano-structures present a first order magnetic and structural phase transition between a ferromagnetic-hexagonal and a paramagnetic-orthorhombic phases around room temperature. However, the constrain of the MnAs heterostructures imposed by the GaAs leads to a coexistence of both phases over a wider range of temperatures and a shift of the average phase transition temperature to higher or lower temperatures according to the MnAs accommodation on GaAs substrate. In this work, we present recent results of a systematic macroscopic analysis of the structural and magnetic phase transition in MnAs epitaxial films and nano-structures using X-ray scattering, SQUID and magneto-optical Kerr Effect techniques. The magnetic and structural properties of the phase transition are discussed considering the effect of the coexistence of both phases. We also discuss the origin of the behavior of the phase transition temperature in these systems.

W - 10 EPITAXIAL FERROMAGNETIC FILMS GROWN ON SEMICONDUCTORS*

P. L. Gastelois, M. D. Martins, L. H. F. Andrade, W. A. A. Macedo – CDTN, Laboratório de Física Aplicada, Cidade Universitária, Pampulha, Belo Horizonte, Brazil, CP 941

Hybrid ferromagnetic / semiconductor structures (FM/SC) have attracted enormous attention due to its great potential for spintronics devices. The development of such devices is related to efficient spin injection, which depends drastically on the magnetism at the FM/SC interface. We point out the possibility of investigating epitaxial FM/SC without the need of growing the FM and the SC layers at once in a single growth system, and show our recent experiences in obtaining high quality Fe monolayers on SC surfaces. As an example we present results for the growth, structure and magnetic anisotropy of Fe on ZnSe. The ZnSe film, prepared at the LMCP, was grown on GaAs(100), covered with an excess of amorphous Se in order to avoid oxidation or contamination in air, and than sent to us. At the LFA/CDTN the samples were introduced into the MBE system and submitted to heat treatments to eliminate the Se protective layer and to induce a clean and ordered Zn-rich ZnSe(100) surface. Epitaxial Fe monolayers were then sucessfuly grown, as confirmed by electron diffraction techniques (LEED and RHEED). The magnetism of the Fe films was investigated in-situ (UHV) by MOKE magnetometry. We present also some results on the epitaxy of Fe (and Co) on commercial epi-ready GaAs(100). This experience opens an excelent opportunity for studies on epitaxial FM/SC systems, in collaboration with other groups.

* work in collab. with V. Etgens (LMCP, Paris) & G. Rossi and co-workers (TASC-INFM, Trieste).

W - 11 SPIN-PUMPING EFFECT IN METALLIC INTERFACES

R. L. Rodríguez-Suarez, L. H. Vilela Leão, A. B. Oliveira, S. M. Rezende, A.Azevedo - Universidade Federal de Pernambuco, Departamento de Física, 50670-901, Recife, PE, Brasil

Many spintronic devices such as the spin valve and magnetic tunneling junction are associated with the flow of spin-polarized charge-current. In these systems both charge current and spin current coexist. More recently, the concept of a pure spin-current with no charge-current has been theoretically predicted [1]. This pure spin-current would be generated by a ferromagnetic reservoir undergoing ferromagnetic resonance (FMR) and has been identified as a spin-pump. Here we present direct evidence of the spin-pumping effect by measurement of a dc voltage generated in magnetic/non-magnetic interfaces undergoing ferromagnetic resonance. Metallic bilayers and trilayers of Py/NM/FeCo and Py/NM (Py=permalloy and NM=Ta, Cu, Ag, W, Pd, Cr), sputter deposited on Si(001), were investigated by FMR. Two metallic electrodes attached in the plane of the sample are used to measure the d.c. voltage generated by the pure spin-current pumped from the ferromagnetic layer into the non-magnetic layer. The generated dc voltage exhibits a strong dependence on the thickness and chemical nature of the NM layer and on the incident RF power. These challenging results might be interpreted as due to the spin accumulation induced by the imbalance of the electrochemical potential across the FM/NM interface and on the plane of the films. [1] A. Bratas et al, Phys. Rev. B 66, 060404 (2002); J.E. Hirsch, Phys. Rev. Lett. 83, 1834 (1999).

W - 12 EXPLORING SPIN-HYBRIDIZATION AND SYSTEM MAGNETIZATION IN OPTICAL SWITCHING REGIMES

V. Lopez-Richard - Dep. de Física, FFCL da Universidade de São Paulo, Ribeirão Preto-SP; S. J. Prado, A. M. Alcalde, G. E. Marques – DF, Ufscar; C. Trallero-Giner; Dep. Fisica Teorica, Universidad de La Habana, Cuba

We have addressed spin-related topics, concerning spin-hybridization tuning with external magnetic field and thoroughly described the correlation between conflicting effects, such as: interband coupling, Zeeman splitting, spin-orbit interaction and magnetization, that strongly influence the electronic structure and the system optical response. These concepts have been treated within a multiband electronic structure calculation that includes the effects of confinement and exchange within the same theoretical framework. The calculations have been applied to 2D and 0D nano-structures with different shapes. Anomalous anisotropic behaviors have been obtained as the result of the spin-orbit interaction and magnetization. We have also explored an exchange-induced intrinsic property of the electronic structure in diluted magnetic semiconductor quantum dots in order to propose an externally controlled optical switching device. Various confinement shapes, dot sizes and host material compositions are used in order to optimize the device operation. The excitonic optical switching can be established within well-defined temperature and magnetic impurity composition ranges. We are proposing a clear method for the implementation of this optical device working in two well-defined regimes. Two other device applications are suggested.

W - 13 TOWARDS A SIMPLE MODEL FOR DILUTED MAGNETIC SEMICONDUCTORS

R. R. Santos - IF/UFRJ, CxP 68528, 21941-972 Rio de Janeiro RJ, Brasil

Spintronics aims at incorporating the manipulation of both spin and charge degrees of freedom into devices. To this end, several aspects of spin transport, dynamics and relaxation must be understood, which, in turn, can be achieved by means of simplified models incorporating the basic physical mechanisms. One of the possible routes towards full-scale applications is through III-V semiconductors doped with Mn, such as (Ga,Mn)As, the Diluted Magnetic Semiconductors (DMS); doped II-VI compounds, such as CdTe or ZnSe, though displaying lower critical temperatures for magnetic order, play an important role in pinpointing the mechanisms at play. Here we present an overview of basic experimental data for DMS, as well as some microscopic models proposed to describe them. We will pay special attention to some mechanisms which are still a matter of debate, and discuss the predictions of the models; further insight is given by discussing how the physics of the Kondo effect, the Kondo lattice, spin-glasses, localization transitions, and so forth, fit in.

W - 14 SPIN POLARIZED TUNNELING IN HYBRID FE-ZNSE STRUCTURES: ENTERTAINMENT OR CHALLENGE?

D. H. Mosca - Departamento de Física – UFPR, C. P. 19091, 81531-990 Curitiba PR, Brazil; J. Varalda, A. J. A. de Oliveira - Departamento de Física – UFSCar, C. P. 676, 13565-905 São Carlos SP, Brazil, J.M. George - Unite Mixte de Physique CNRS/Thales Domaine Corbeville, France ; M. Eddrief, M. Marangolo, V. H. Etgens - LMCP, Université de Paris 6 et Paris 7, Paris Cedex, France

Hybrid magnetic heterostructures with metallic iron as ferromagnetic electrodes and ZnSe barriers are candidates for tunneling magnetoresistance (TMR) studies and applications due to several advantageous conditions: favorable matching between Fe and ZnSe lattices, stable chemistry and magnetism at the interface, coherent spin lifetime as long as a fraction of a microsecond in n-type undoped ZnSe, electronic pinning of the Fe–Fermi level position at 1.6 eV above the valence–band maximum with a corresponding Schottky-barrier height of 1.1 eV, and a carrier concentration dominated by electrons in a well know electronic band structure including impurity/defect states in the energy band gap $E_G$ = 2.7 eV. Furthermore, several theoretical investigations have recently predicted that the conductance of Fe/ZnSe/Fe trilayers, with reasonably thick ZnSe barriers, could exhibit TMR as large as 100%. However, the large mismatch in conductivity between a ferromagnetic metal and a semiconductor and possible chemical incompatibility lead to difficult problems. Relevant TMR values are observed only at relatively low temperatures, except for the recent results where a TMR of about 10% has been reported at room temperature. In this talk, we report on recent experiments performed on Fe/ZnSe/Fe planar junctions and granular systems consisting of Fe nanoclusters embedded in ZnSe layers. Tunnel magnetoresistance via localized mid-gap states through a ZnSe semiconducting barrier, which can change in sign the effective spin polarization of tunneling electrons, is described and discussed.

W - 15 PRECISE LASER CHEMICAL PROCESSING OF 3-DIMENSIONAL STRUCTURES: PROCESSES AND APPLICATIONS

M. Stuke - Max-Planck-Institut f. biophys. Chemie, P.O. Box 2841, D-37018 Goettingen, Germany

This talk will focus on recent advances in precise laser chemical processing of materials surfaces with special emphasis on the generation of 3-dimensional structures by spatially controlled energetic beams including laser-direct-write from suitable gaseous precursor mixtures. The relevant processes will be discussed and identified for applications such as the generation of small cages for touch-free trapping, handling and transfer for small neutral species in solution. Short video sequences will show the unique possibilities. In addition, a new laser ablation processing scheme for materials will be described for fast, efficient and smooth nano-machining of organic fibers including the dragline of spider silk [1].

[1] A. Moore, M. Koch, K. Mueller, M. Stuke
"Precise laser ablation processing of black widow spider silk"
Appl. Phys. A 77 (2003) 353-357

W - 16 THEORETICAL STUDIES OF Mn in GaAs AND TYPE-IV SEMICONDUCTORS

A. J. R. da Silva, A. Fazzio - Instituto de Física, USP, São Paulo, SP, Brasil; A. Antonelli, L. E. Oliveira - Instituto de Física "Gleb Wataghin", UNICAMP, Campinas, SP, Brasil; R. R. dos Santos - Instituto de Física, UFRJ, Rio de Janeiro, RJ, Brasil

We have performed a systematic study of the nature of Mn in semiconductors, using total energy ab initio calculations within the density-functional theory. We will discuss results for Mn in GaAs and in Si, Ge and SiGe. Results for $Ga_{1-x}Mn_xAs$ diluted magnetic semiconductors (DMS) unambiguously show that a quasi-localized ? hole, with predominant p-like character, surrounds the fully polarized Mn ? $d^5$-electrons. Calculations indicate that the holes have a rather localized character, thus rendering effective-mass descriptions of hole states open to challenge. We obtain estimates for the distance dependence of the effective Mn-Mn exchange interaction for different Mn concentrations and configurations, and effects of disorder on these interactions will be discussed. We then address the following question: since ferromagnetism in the Mn(x)Ge(1-x) compound has been reported by more than one group, would it be possible to grow a similar Mn(x)Si(1-x) ferromagnetic material? Since the main difference between Mn in Si and Ge is the fact that it prefers to be interstitial in Si, whereas it is substitutional in Ge, we investigate the origin of this difference. For that, we study the properties of interstitial and substitutional Mn impurities in both Si and Ge bulk crystals, as well as in the alloy Si(1-x)Ge(x). We show that volume effects are not the main reason Mn prefers to be a subsitutional impurity in pure Ge, and chemical effects, therefore, play an important role. Using realistic models of Si(1-x)Ge(x), we show that for $x > 0.16$ substitutional Mn in Ge-rich neighborhoods become more stable than interstitial Mn, which may allow the growth of Si-based diluted magnetic semiconductors. We will also present results for Mn in the Si(100) surface and in SiGe heterostructures.

W - 17 NOVEL SPIN FETS

J. Carlos Egues - Departamento de Física e Informática, Instituto de Física de São Carlos,Universidade de São Paulo

In my talk I will present two novel spin-FET proposals, namely: (i) a quasi-onedimensional ballistic setup with s-o induced interband coupling which provides enhanced spin control [3] and (ii) a robust two-dimensional non-ballistic spin transistor [4] which benefits from a unique interplay of two distinct s-o interactions, Rashba and Dresselhaus. The enhanced capability of our setup (i) relies on the coherent transfer of electrons between two s-o coupled subbands. Spin-polarized electrons can be further spin rotated via additional side gates controlling the width of the channel and hence the s-o interband coupling strength. This extra rotation d ? can,
in principle, be tuned independently of that described by R ? . The non-ballistic spin FET proposal (ii) conveniently relaxes the very stringent constraint of ballistic channels in the original proposal of Datta and Das. Due to a 'partial' cancellation of the Rashba and Dresselhaus s-o interactions for a particular value of the gatecontrollable a coupling, we can fix the direction of the effective magnetic field the electrons precess around, thus eliminating the Dyakonov-Perel and Elliot-Yafet types of spin dephasing processes. In other words, for tuned Rashba and Dresselhaus couplings the electron spinor is k-independent thus making momentum scattering ineffective in relaxing the electron spin.