Low dimensional systems, nanostructured materials, and nanomagnetism

2 - 1 – Structural distribution of Co in impregnated ZSM-5 zeolites

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We report the main results on the Co distribution over a zeolite of structrure ZSM-5 with 2.8% of cobalt ions incorporated by wet impregnation, as determined by using scanning electron microscope (SEM) in both secondary (SE) and transmission (STEM) modes and Energy Dispersive Spectroscopy (EDS) with JEOL JSM-7500F. Each size distribution of Co particles originates a different contribution to the magnetization giving a ferromagnetic behavior in a wide range of temperatures, to which superparamagnetic contributions from the smallest particles are superimposed.

2 - 2 – Nanoestructured magnetic graphite: synthesis and properties

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Employing a controlled oxidation process in the vapor phase we have modified pristine graphite to make it ferromagnetic. SEM and other techniques indicate that the oxidation process introduces structural defects in the graphene sheets, like pores or exposed borders and, that we have found give rise to the ferromagnetic signal. The origin of the ferromagnetic signal is complex, as shown by magnetization curves where anomalies such as FC-ZFC splitting and the presence of multiple magnetic transitions are observed. Ferromagnetic impurities, like Fe are found in the commercial graphite, and spectroscopic techniques have been used to determine the amount and influence on the total magnetic signal. Calculation of the strength of the magnetic signal produced by impurities was determined to be insufficient to explain the total magnetization of the sample confirming that the signal is intrinsic to the modified graphite sample. MFM measurements also confirm that the majority of the magnetic signal comes from the edges of the abovementioned pores, in spite of that, it can be appreciated that the magnetic signals are not exclusively associated with the pores. At T = 300 K, the saturation magnetic moment, the coercive field and the remnant magnetization are 0.25 emu/g, 350 Oe and 0.04 emu/g, respectively. The stability of the magnetic signal has also been confirmed by performing measurements on the same samples separated by a 6 months period without observation of any significant change. Theoretical studies account for the observed behavior showing that the edges of pores and borders of exposed planes may generate the conditions for the appearance ferromagnetism in this type of materials, offering the theoretical support for our experimental results.

2 - 3 – Survival Probability of a Local Excitation in a Non-Markovian Environment: Self-Consistent Fermi Golden Rule, Zeno and Anti-Zeno effects.

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The decay dynamics of a local excitation interacting with non-Markovian environment, modeled by a semi-infinite tight-binding chain, is exactly evaluated. We identify distinct subsequent regimens for the dynamics: (i) early quadratic decay of the initial-state survival probability up to a spreading time t_S, (ii) exponential decay governed by a self-consistent Fermi Golden Rule rate, and (iii) asymptotic behavior governed by quantum diffusion of return processes, leading to an inverse power law decay. At this last crossover time t_R a survival collapse becomes possible, bringing the survival probability down by several orders of magnitude. Estimates of crossovers times between the distinct regimens, t_S and t_R, allow assessments of the range of applicability of the Fermi Golde Rule, and give the theoretical conditions for the observation of Zeno and Anti-Zeno effect, respectively.

2 - 4 – Theoretical analysis of the Ru on GaN (0001) reconstructions.

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We report first principles calculations to analyze the ruthenium adsorption and diffusion on GaN(0001) surface with a 2x2 geometry. The calculations were performed using the Generalized Gradient Approximation (GGA) with ultrasoft pseudopotential within the Density Functional Theory (DFT). The surface is modeled using the repeated slabs approach. To analyze the most favorable ruthenium adsorption model we considered T1, T4 and H3 special sites. We find that the most energetically favorable structure corresponds to the Ru-T4 model, while the ruthenium adsorption on top of a gallium atom (T1 position) is totally unfavorable. The ruthenium diffusion on surface presents a small energy barrier of 0.612 eV. The most stable reconstruction presents a lateral relaxation of some hundredth Å. We compared the density of states of the clean GaN(0001) surface and with ruthenium adatom.

2 - 5 – Intrinsic leakage and dynamics of a mesoscopic Josephson device for quantum computation

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We study the dynamics of the Josephson flux qubit, which consists on a mesoscopic SQUID loop with three Josephson junctions operated at or near a magnetic flux of half quantum. We perform simulations of the time dependent Schrödinger equation when the system is started in the ground state. The intrinsic leakage from the two lowest energy levels of the qubit computational subspace to higher energy levels is calculated, when pulses in the magnetic field are applied. We analyze resonant rf field pulses of intensity f_p, calculating the time averaged leakage. For low f_p we obtain that the leakage is quadratic in f_p and we compare with a perturbative calculation. We study the dependence of the leakage with device parameters (Josephson coupling constants) obtaining the optimum case for minimum leakage. The effect of magnetic flux noise will also be discussed.

2 - 6 – Magnetic structure in the amorphous $(Fe_xNd_{1-x})_{0,6}B_{0,4}$ nanoparticle compounds

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We studied the internal magnetic order in several samples of amorphous nanoparticles of Fe-Nd-B obtained by chemical route. The samples chosen have different relative composition Fe/Nd in order to study the effect of chemical composition in the magnetic properties. Magnetic characterisation was made as a function of temperature and applied magnetic field. In every case these measurements can be described as a ferromagnetic contribution which saturates, characteristic of ferromagnetic monodomains, plus a paramagnetic one. Experimental results are described by a simple model which represents the saturated magnetisation by the Bloch law, and the paramagnetic one, by the Curie law. This model allowed us to study the nanoparticle behaviour as a function of the applied field and temperature for different chemical compositions. The fact that the magnetisation can be split in two components is an evidence of the internal magnetic structure of the particles, which is analysed in the frame of the core-shell model. The behaviour of the coercive field, H_c, also supports the picture of a core-shell magnetic structure.

2 - 7 – Size dependence of the anisotropy constant in antiferromagnetic Cr_2O_3 nanoparticles

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Surface and size effects in magnetic particles have been a subject of increasing interest in the past few decades. When the size of the particles is reduced to nanometric scale, the surface to volume ratio increases and as a result the surface effects become more and more important, affecting the internal magnetic order and the magnetic phase transitions. In a recent work [1] we have reported a study of the magnetic behaviour of Cr_2O_3 nanoparticles systems as a function of the particles size. We showed that the parameters that characterize the AFM system, as the exchange and anisotropy field constants, are strongly modified when the size of the nanoparticles is reduced. In particular, we have observed a decrease of more than one order of magnitude in the anisotropy constant, from K=3.8 10^4 to 8.7 10^2 erg/g, when the sized was reduced from bulk to 30 nm.

In this work we continue with the study of the magnetic properties of the Cr_2O_3 system when the

size of the nanoparticles is further reduced to $\sim$ 8 nm. The smallest nanoparticles present superparamagnetic behaviour with a blocking temperature of T_B $\sim$ 28 K. As a consequence of the size reduction we observed an enhancement in the surface spin disorder manifested in the enlargement of the coercive field up to 1400 Oe. In addition we have observed an important reduction of the Nèel temperature to $\sim$ 270 K. We calculated the evolution of the anisotropy field as a function of the nanoparticle size. Finally we analyze which contribution, the magnetocrystalline or the surface anisotropy, governs the magnetic behaviour when the surface to volume ratio increases.

[1] D. Tobia, E. Winkler, R.D. Zysler, M. Granada and H.E. Troiani, Phys. Rev. B **78**, 104412 (2008)

2 - 8 – Radio-Frequency Heat Generation in Magnetic Nanoparticles: Influence of Particle Size

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The study of magnetic nanoparticles (MNPs) as heating agents in oncology protocols has attracted considerable attention in recent years. Magnetic hyperthermia consists in increasing the temperature of the tumor through alternating magnetic field acting on MNPs previously incorporated in that tissue. Nanoparticles are promising agents to increase the effectiveness of the heating process and the control of the affected area to avoid damage in the healthy tissues. In fact, Magnetic hyperthermia based in MNPs is already used in testing protocols as complementary technique of radiotherapy and chemotherapy in the treatment of breast and cerebral tumors, but the optimization of the absorption mechanism of ac power by the mono-multidomain MNPs and the delivering of the absorbed power to the living tissues are still open questions. In the present work, we have performed the systematic study of the Fe_3O_4 MNPs with controlled size from 3 to 25 nm, in order to determine the relevant parameters involved in the absorption power. Samples were prepared by decomposition of $Fe(acac)_3$ at high temperature (540 K or 640 K) in the presence of a long-chain alcohol and surfactants, producing well-crystalline MNPs with narrow grain size distribution (diameter distribution width as good as 0.13) covered by a organic layer (oleic acid), avoiding agglomeration and increasing the chemical stability of the particles. Morphological and magnetic characterizations were performed by TEM and experiments in a SQUID magnetometer. Absorption power (SPA) was measured in a commercial ac applicator with f = 250 kHz and field amplitude of 20 mT (model DM100 by nB nanoscale Biomagnetics). According to our results, there is a straight correlation between the power absorption and the grains size of the particle, with an optimum diameter of $< d > \sim$ 17 nm for absorption (350 W/g of Fe_3O_4 MNPs). This result was explained in terms of a model considering Néel and Brown relaxation mechanisms. Superficial chemistry of the particle was also changed to increase the biocompatibility of the systems.

2 - 9 – Structural and magnetic characterization of the incommensurate phase in TiOCl

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The TiOX (X=Cl, Br) compounds have been recently identified as spin-Peierls materials with an unconventional incommensurate intermediate phase between the dimerized and the uniform ones. We modelize the TiO bilayer of TiOCl as an array of one dimensional antiferromagnetic chains coupled to a phononic model containing the elastic intra and interchain coupling. We characterize the structure of the incommensurate phase by minimizing the free energy of XY chains with respect to the positions of the Ti ions. In addition, using numerical Density Matrix Renormalization Group calculations, we study the magnetic correlations of a Heisenberg chain with modulated exchange corresponding to the structural incommensuration. We carefully analyze the conditions for the appearance of a magnetic incommensuration induced by the structural one.

2 - 10 – A method for the study of surface segregation in multicomponent alloys

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Changes in composition of an alloy between its bulk and surface can have a profound effect in the technological application of any given material. It is often the case that surface segregation can alter the surface composition in either beneficial or detrimental ways, thus requiring a detailed quantitative description of the phenomenon in order to make the necessary changes in the bulk alloy composition to either enhance or inhibit specific segregation behaviors. This, in turn, requires that the method used to describe the segregation patterns accurately deals with arbitrary number of elements, as minority additions can substantially alter the properties of the material and its interaction with the environment in which they are used. Exploiting the ability of the BFS method for alloys to handle arbitrary number of elements without loss in accuracy or simplicity in the calculation of the energetics, we introduce a model for the determination of surface segregation profiles in multicomponent alloys. The model relies on a mean field approach based on the regular solution thermodynamic theory and the BFS method for the calculation of the energy. Details of the formalism are discussed, in addition to an application to the Cu-Ni binary system and ternary Cu-Al-Ni alloys, for which experimental and theoretical background exists.

2 - 11 – Angular dependence of magnetic properties in Ni nanowire arrays.

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The study of arrays of magnetic nanowires is a topic that has attracted considerable interest, due to their promising technological applications mainly in the high-density information storage. The angular dependence of the magnetic properties of arrays of nanowires produced inside the pores of anodic alumina membranes have been measured, and a simple model based on Stoner-Wohlfarth theory is used to explain the angular dependence of remanence and coercivity of the nanowires. The dominant reversal mode in the array is trough the propagation of a transversal domain wall. In the model we used here, the coherent rotation of the magnetization inside the wires is replaced by the domain wall width in the case of transverse reversal mode. We have also considered the magnetic interactions among the wires and the agreement with the experimental results is very good.

2 - 12 – Andreev levels in a graphene-superconductor surface.

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In order to consider the Dirac-like spectrum of graphene we employ the Bogoliubov de Gennes-Dirac formalism to determine the quasiparticle Andreev levels in a surface NS (normal-superconductor). The normal region is characterized by a width a while the superconducting region is semi-infinite and both regions are made of doped graphene. The quasiparticle energy spectrum is originated by the Andreev reflections that occur in the NS interface. It is shown that this spectrum depends of the width of the normal region and the Fermi energy in each region. When the Fermi energy in the normal metal is lower than the gap of the superconductor region the spectrum is affected by specular Andreev reflections. The equation that is obtained to find the spectrum is very general and we solved it for some particular cases. Finally we analyze the contribution of the Andreev levels to the DC Josephson effect in a SNS junction whose energy spectrum presents a similar behavior to this obtained for the surface.

2 - 13 – Structural and magnetic studies of Fe_2O_3 /SiO_2 granular nanocomposites

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In the present work we have studied the synthesis of Fe_2O_3/SiO_2 nanocomposites by mechanical alloying technique, using Fe and SiO_2 powders as precursors for milling. After 340 hours of milling, according to X-Ray Diffraction analysis, the sample consists essentially of hematite and amorphous silica. TEM images of this sample indicate that the hematite particles are embedded and surrounded by the amorphous

silica. Moreover, a broad particle size distribution is observed, ranging from 5 to 50 nm. Another 2-3 nm-diameter particles are observed, but they are not yet identified. Mössbauer spectra at room temperature show a paramagnetic doublet, which may correspond to a non-crystalline phase in the sample, and a sextet which corresponds to hematite. Magnetic properties were investigated by means of hysteresis curves obtained at different temperatures (5-300 K) and zero-field-cooled (ZFC) and field-cooled (FC) magnetization curves (with an applied field of 100 Oe). The hysteresis curves were fitted by the sum of two contributions: ferromagnetic and superparamagnetic, and the temperature dependence of the coercive field was analyzed by means of the Stoner-Wolfarth model. The broad particle size distribution observed by TEM techniques is reflected in the temperature dependence of magnetization, which presents a blocking temperature higher than 300 K. No evidence of Morin transition is found down to 5 K, as expected for nanometer´s particles.

2 - 14 – Study of transport properties in superconducting junctions of double insulating barrier

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In this work we analyze the Tomasch effect in superconductors of high critical temperature. For this, we study a system of double insulating barrier, N_1ISIN_2 (N: Normal Metal, I: insulator and S: Superconductor) from Bogoliubov de Gennes equations. We find that the differential conductance presents resonances when the applied voltage changes. These resonances are originated by the formation of quasibound states in the superconducting region. Additionally we study the non-local Andreev reflection when an electron that coming from normal region N_1 is scattered as a hole in the normal region N_2. We developed an analytical model in order to find the energies of the quasibound states and its lifetime; this model allows us to calculate the voltage at which each resonance appears and its width. We analyze the dependency of the transmission coefficients with the thickness of the superconducting layer. Finally, we discuss as these results can be used in measures of differential conductance in these systems.

2 - 15 – Complex magnetic internal order in structurally disordered Ni nanoparticles

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A detailed study of the magnetic properties of colloidal Ni nanoparticles (~ 5.2 nm) that do not present long range order is presented. Two magnetic contributions were observed at high temperatures (>25 K), a dominating paramagnetic one and a ferromagnetic contribution, detected by ferromagnetic resonance and low field magnetic measurements. Interestingly, the ferromagnetic behavior does not follow a classical superparamagnetic description. The effective anisotropy increases at low temperatures due to interactions among the ferromagnetic clusters, which leads the system to a frustrated state.

2 - 16 – Studies of the effective magnetic anisotropy in GaMnAs as a function of the Mn implantation energy

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Magnetic semiconductors have a variety of applications in storage and data processing. In particular, GaAs can exhibit magnetic properties when doped with Mn, either by epitaxial growth or ion implantation. There are discrepancies in literature related to the orientation of the easy axis of magnetization in this type of system, probably due to variations in growth parameters or sample preparation as temperature and annealing time. In this work, Mn and As ions were co-implanted on semi-insulating GaAs substrates, keeping the Mn and As dose equal in all samples. The As implantation energy was the same but, as a main parameter for comparative analysis, the Mn energy were varied for each sample. Rapid thermal annealing (RTA) was done at 750^oC. Magnetic measurements were made using a commercial SQUID magnetometer.

We have analyzed the dependence of the effective anisotropy regarding the Mn implantation energy. Hysteresis cycles have shown that sample magnetization depends on the crystallographic direction, changing the effective easy axes orientation. TEM measurements help us to understand some of the magnetic behavior. (Supported by: CNPq and FAPESP)

2 - 17 – Specific heat anomaly in large-diameter multiwall carbon nanotubes

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We present micro-calorimetric specific heat measurements on different multiwall carbon nanotubes of large outer diameter, as a function of temperature in the range 10-120 K. A clear anomaly at 60 K with the shape of a peak is present, and both the height and the characteristic temperature are independent of magnetic field and do not exhibit thermal hysteresis. These features suggest that the anomaly may be caused by a structural change. The anomaly is also unaffected by induced intertube disorder. We associate this anomaly with a melting of orientational dislocations of individual tubes within a multiwall nanotube, an effect that was theoretically predicted to occur in carbon nanotubes but never observed experimentally.

2 - 18 – Calorimetric characterization of the system: $Fe_{73.5}Si_{13.5}Nb_{3-x}Mo_xB_9Cu_1$ (x = 0, 1, 1.5, 2 and 3)

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Different continuous heating Differential Scanning Calorimetry measurements were performed on amorphous $Fe_{73.5}Si_{13.5}Nb_{3-x}Mo_xB_9Cu_1$ (x = 0, 1, 1.5, 2 and 3) ribbons obtained by the melt spinning technique. It was observed that the gradual replacement of Nb by Mo reduced the FeSi as well as boride onset temperatures. The Curie temperature of the amorphous slightly diminished from 322 K for x=0 to 314.5 K for x=3 (error ± 0.5 K). Continuous heating runs Differential Thermal Analysis were also carried out on the amorphous ribbons and crystalline master alloys for a more comprehensive study.

2 - 19 – Resonant states in heterostructures of graphene nanoribbons

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Recently, graphene sheets (single atomic layers of graphite) were successfully isolated and have been shown to be stable under room conditions [1]. These graphene layers may be lithographed to get patterned nanoribbons (GNRs) which could be used to make large-scale integrated circuits [2]. The electronic and transport properties of GNRs are strongly influenced by their type of edges along the ribbon. They may present either metallic or semiconducting behavior depending of the ribbon width.

In this work we analyze the effects on the transport properties of armchair graphene nanoribbons, of the presence of attached structures that distort the perfect ribbon edges [3]. We consider a GNR heterostructure formed by a double symmetrical barrier system in a crossbar configuration. To describe the electronic and transport properties of these nanostructures we use a π-band tight-binding model and the formalism of the Green functions, adopting real-space renormalization techniques [4].

We perform calculations of the density of states and conductance for different configurations of double barrier systems focusing our study on the effects of the separation, width and height of the barriers on the quantum transport along the nanodevice. Our results show the apparition of a serie of peaks in the conductance. The number of these resonances increases with the separation between the barriers, showing a clear evidence of the presence of resonant states in the conductor. Changes in the barrier dimensions allow the modulation of the resonances in the conductance, making possible to obtain a complete suppression of electron transmission for determined values of the Fermi energy. We also will present preliminary results for the current of the different device configurations using the Landauer formalism at zero temperature.

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2 - 20 − Low temperature electrical resistance in $Nd_{60}Fe_{30}Al_{10}$ melt spun alloys

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Melt spun $Nd_{60}Fe_{30}Al_{10}$ glass forming alloys are known to contain small hcp Nd crystals, very small crystalline motes (1.2 ± 0.5 nm) of a $Nd_6Fe_{14-x}Al_x$ ($2 < x < 5.5$) δ-type phase and small clusters of a metastable μ-type ($Nd_{37}Fe_{58}Al_5$) crystalline phase, all embedded in an amorphous matrix. These alloys show coercivities up to 0.5 T at room temperature, arising in this rather complex nanostructure, which is very sensitive to the quenching rate. In this article we report the behavior of the electrical resistivity observed, in the 4K-300K range, in $Nd_{60}Fe_{30}Al_{10}$ samples melt spun at different wheel speeds, between 5 m/s and 40 m/s. In ribbons cooled at 5 m/s the electrical resistance monotonously increases with temperature, exhibiting a metallic regime in the entire temperature range. For quenching rates above 20m/s and up to 40 m/s, the resistance curve goes through a maximum at about 80K, passing from a metallic behavior at low temperatures to a semiconductor-like regime, with resistance monotonously decreasing as temperature increases up to 300 K. The magnetic hysteresis properties of the samples cooled at different rates were measured in the same temperature range and then correlated with the electrical transport behavior observed. It is found that the features observed in the resistance curves are related with different magnetic orderings in the δ phase (a paramagnetic to antiferromagnetic transition near 270 K and a spin reorientation transformation near 80K).

2 - 21 − Stripe-domains in Permalloy films as observed by ferromagnetic resonance and magnetic force microscopy

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In this work we present results on Permalloy thin films (50, 100 and 250nm) grown by sputtering onto glass substrates. For the thinnest film a single magnetic resonance line is observed when the field is applied along the film plane. The thicker films evidence two and three absorptions (100nm and 250nm respectively) for the same conditions. These multiple absorptions seem to be related to the observation of stripe-domains by magnetic force microscopy (MFM) in the thickest film, indicative of up-down modulation of the magnetization along the film normal. On the intermediate thickness (100nm) the only feature we were able to observe by MFM was a perpendicular instability with a vortex-like shape near a sample edge. Micromagnetic calculations (J. B. Youssef et al Phys. Rev. B (2004) **69**, 174402) indicate that a small perpendicular anisotropy originates this perpendicular instability of the magnetization and the stripe-domains which develop above a critical thickness of about 280nm. These domains have been associated with multiple absorptions in the microwave range, as calculated by dynamic micromagnetism. Our experimental results indicate that the critical thickness is smaller than previously reported and that FMR present clear features of magnetization instabilities before the stripe-domains are formed.

2 - 22 − Achievement of SnO_2 nanotubes for gas sensor

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Tin dioxide in the form of thin films has increasing attention for producing gas sensor. Their advantages are good sensitivity and a low power consumption. It has been reported a single square shaped SnO_2 nanotube to ethanol [1]. Several advantages like higher active surface area, flexibility in surface modification for chemically or biologically selective catalysis, accelerated transport of gas/liquid and drastically enhanced electrical transport properties have been reported.

A SnO_2 nanotube sheet sensor has also been characterized [2]. SnO_2 nanotubes have been synthesized using a polycarbonate template method [3-5]. The material was characterized by X-ray diffraction

analysis and scanning electron microscopy. The electrical measurements show that these films have a higher sensitivity respect to the conventional SnO_2 sensors.

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2 - 23 − DC Four point resistance of a 1D pumped wire with an impurity

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In this work we studied the behavior of the dc voltage drop in a periodically driven 1D wire with an impurity sensed by voltages probes that are weakly coupled to the system. Using perturbation theory in the coupling of the voltage probe we derived analytical expressions for the DC four point resistance and the voltage profile along the wire which are valid in the adiabatic regime. Beyond the adiabatic regime exact numerical results are shown.

2 - 24 − Synthesis and magnetic properties of iron particles embedded in mesoporous MCM-41.

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Granular materials with particle sizes in the range 1-10 nm may exhibit novel magnetic and chemical properties due to their extremely small proportions. A critical obstacle in assembling a nanoscale material is often the high reactivity from the large surface ratio and the spontaneous production of macroscopic-sized agglomerates, lacking the unique properties. One of the promising matrices for magnetic nanoparticles is mesoporous silica. In particular, MCM-41 type molecular sieves modified with Fe appear as very attractive materials. In this work, iron species were loaded into the mesopores of MCM-41 by a wetness impregnation procedure using $Fe(NO_3)_3$ as precursor; different Fe^{+3} concentrations were used. Reduction treatments were applied under H_2 flow, at 623K and 873K respectively. The composites were characterized by X-ray diffraction (XRD), diffuse reflectance ultraviolet-visible (DRUV-vis) and superficial area (BET). The magnetization vs temperature was studied following the zero field cooling (ZFC) and field-cooling (FC) protocols in the range 5-300K; hysteresis loops up to 1.5T were measured at different temperatures. XRD patterns confirmed a MCM-41 structure for all the matrices but the structure parameters and their areas were affected by the impregnation method. The UVvis analysis showed that depending on the reduction treatment, different iron species appear. The hysteresis loops were described by the superposition of a diamagnetic contribution originated in the host, and superparamagnetic and ferromagnetic contributions arising in wide or even bimodal distributions of iron containing cluster/particle sizes in the samples.

2 - 25 − How do magnetic nanotubes interact?

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Since the discovery of carbon nanotubes in 1991, intense attention has been paid to tubular nanostructures. In particular, magnetic nanotubes are the focus of growing interest due to the existence of techniques that lead to the production of highly ordered arrays. These particles offer an additional degree of freedom as compared to nanowires; not only can the length, L, and the external radius, R, be varied, but also the internal radius, a. In this way, nanotubes may be suitable for applications in biotechnology, where magnetic nanostructures with low density, which can float in solution, become much more useful for in vivo applications. These tiny magnetic tubes could provide an unconventional solution for several research problems, and a useful vehicle for imaging and drug delivery applications.

Clearly, for the development of magnetic devices based on those arrays, knowledge of the magnetostatic interaction between the tubes is of fundamental importance. However as usual the effects of interparticle interactions are complicated by the fact that the dipolar field felt by each element depends upon the magnetization state of all elements in the array. In this poster we show an analytical model for the full long-range magnetostatic interaction between two nanotubes exploring the possibility of varying the magnetic coupling as a function of the tubes position. We start by calculating the magnetic field generated

by a ferromagnetic tube assuming that it is continuum material. From the expression for the field, we can calculate if the field is attractive or repulsive at any point in space. Next, we put another magnetic tube near the first one and calculate the interaction energy between them. This energy is then given by a complex expression that has to be numerically solved. However, assuming that the tubes investigated satisfy that the length is bigger than the radius of the tube, we can expand the previously obtained energy and finally obtain a simple analytical expression for the magnetic interaction. This simple expression is an excellent tool for understanding the interactions between magnetic nanotubes in any positions in an array. We can thus identify whether two tube will be ferromagnetically or antiferromagnetically coupled.

Our results are intended to provide guidelines for the production of barcode-type nanostructures with prospective applications such as biological separation and transport.

2 - 26 – Thermal evolution of $FePt/Fe_3O_4$ bimagnetic nanoparticles: an in situ X-ray absorption spectroscopy study

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FePt nanoparticles with strong magnetic anisotropy are of great interest due to their potential application in data storage medium. Special attention is being focused in investigating the mechanism involved in the transformation from disordered fcc to an ordered fct structure with high coercitivity and high anisotropy, in addition to the effect of coalescence of particles with annealing. In this work, oleic acid and oleylamine coated $Fe_{67}Pt_{33}$ nanoparticles were synthesized by a wet chemical procedure. TEM and XRD results revealed that the as prepared FePt nanoparticles of average size 4 nm are composed by FePt and Fe_3O_4 phases. In situ Pt L_3 and Fe K-edges XANES experiments were performed to investigate the thermal evolution of these $FePt/Fe_3O_4$ nanoparticles. To this aim, the initially disordered alloy was annealed under inert atmosphere up to 873 K. Modifications of the XANES features allowed us to detect changes in the Pt and Fe electronic states and local environments. We attribute these alterations to the decomposition of the surfactant and the partial evolution towards the ordered state that takes place at 840 K. In addition, the as-prepared and annealed nanoparticles were characterized by EXAFS, magnetometry and Mössbauer spectroscopy.

2 - 27 – Crossover between different magnetization reversal modes in arrays of magnetic nanotubes

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Magnetic nanoparticles have attracted increasing interest among researchers of various fields due to their promising applications in hard disk drives, magnetic random access memory, and other spintronic devices. In addition, these magnetic nanoparticles can be used for potential biomedical applications, such as magnetic resonance imaging, cell and DNA separation, and drug delivery. To apply nanoparticles in various potential devices and architectures, it is very important to control the size and shape and to keep the thermal and chemical stability of the nanoparticles.

Recently, magnetic nanotubes have been grown that may be suitable for applications in biotechnology, where magnetic nanostructures with low density, which can float in solutions, become much more useful for in vivo applications. In this way tiny magnetic tubes could provide an unconventional solution to several research problems and a useful vehicle for imaging and drug delivery applications. Although the magnetic behavior of nanowires has been intensely investigated, tubes have received less attention, in spite of the additional degree of freedom they present; not only the length L and radius R can be varied, but also the thickness of the wall, d_w. Changes in thickness are expected to strongly affect the mechanism of magnetization reversal, and thereby, the overall magnetic behavior. However, systematic experimental studies on this aspect were lacking for a long time, mostly due to the difficulty in preparing ordered nanotube samples of very well-defined and tunable geometric parameters.

In this poster the magnetization reversal in ordered arrays of iron oxide nanotubes of 50 nm outer diameter grown by atomic layer deposition is investigated theoretically as a function of the tube wall thickness d_w. We start by modeling the magnetization reversal and calculate H_c for the systems reported experimentally by Bachmann *et al.* In thin tubes ($d_w \leq 13$ nm) the reversal of magnetization is achieved by the propagation of a vortex domain wall, while in thick tubes ($d_w \geq 13$ nm) the reversal is driven by the propagation of a transverse domain wall. The effect of the stray

field originating from the agnetostatic interactions between the tubes of the array must be included to obtain a quantitative agreement between experimental and theoretical results. Because of its long range, the magnetostatic interaction strongly influences the coercivity of the array. We predict that the crossover between the vortex and transverse modes of magnetization reversal is a general phenomenon on the length scale considered.

2 - 28 – Tunneling magnetoresistance in $La_{0.75}Sr_{0.25}MnO_3$/ $CaMnO_3$ trilayers.

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Magnetic tunnel junctions are systems of much interest due to their potential technological applications. The tunneling magnetoresistance (TMR) is enhanced by high spin-polarized ferromagnetic electrodes. The nearly half-metallicity of the ferromagnetic manganites therefore makes these materiales very good candidates for developing TMR devices. There are different kinds of insulating oxides that can be used as a barrier, and the transport properties of the junctions depend strongly on the properties of the spacer material [1]. We have studied magnetic tunnel junctions composed of $La_{0.75}Sr_{0.25}MnO_3$ (LSMO) electrodes and $CaMnO_3$ (CMO) spacers. LSMO films are ferromagnetic and metallic below room temperature and CMO is an antiferromagnetic insulator, presenting weak-ferromagnetism below T_N ∼120 K in bulk. The trilayers were deposited by dc sputtering on $SrTiO_3$ substrates, and X-ray diffraction patterns indicate that the samples grow textured on the substrate´s (001) direction [2]. The junctions were fabricated by optical lithography combined with ion-etching. In this work, we present a study of the magneto-transport properties of μm diameter junctions. The samples present an insulating behavior over all the temperature range, indicating that the barriers have no pinholes along the cross-section of the junctions. We have measured TMR at low temperature and characterized the behavior of the barrier at different temperatures by analyzing I-V curves.

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2 - 29 – Exchange Bias-like behavior in $La_{0.75}Sr_{0.25}MnO_3/LaNiO_3$ multilayers.

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Magnetoresistive systems have been widely studied due to their potential application in spintronics devices. In particular, the development of oxides-based devices has attracted much interest lately. In a previous work, we have shown that trilayers composed of $La_{0.75}Sr_{0.25}MnO_3$ (LSMO) ferromagnetic electrodes and $LaNiO_3$ (LNO) spacers present a giant magnetoresistance effect [1]. These interesting results appear to indicate that this system is promising for magnetoelectronic devices. In this work we will show that the magnetic properties of these structures present an unexpected behaviour that makes them very interesting from a fundamental point of view also. A detailed study of the magnetism of LSMO/LNO structures reveals that these multilayers exhibit an exchange-bias (EB) anisotropy in spite of the fact that the LNO is a Pauli paramagnet. Bilayers and multilayers with different LNO thickness have been grown by magnetron dc sputtering on crystalline (001) $SrTiO_3$ substrates. X-ray diffraction measurements indicate that the samples grow highly textured in the (001) direction [2]. The comparison of magnetization loops measured at T=5K with different cooling conditions proof that our samples present exchange bias. A difference of the coercive field in the curves measured in zero field cooling (ZFC) and field cooling (FC) experiments is observed. The FC experiments were carried out after cooling the samples from 250K to 5K with different applied fields (1 kOe $\leq H \leq$ 4 kOe). The temperature dependence of the exchange bias effect has been also studied. Preliminary magneto-transport measurements, performed in the same experimental conditions, will be also shown.

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J.C. Rojas Sánchez and M. Granada acknowledge a fellowship from CONICET. L.B. Steren is a member of CONICET.

2 - 30 – Interaction of Single-stranded DNA Homopolymers with Single Wall Carbon Nanotubes

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DNA polymers can self-organize around the tubular carbon nanotube (CNT) structure in a very stable helical wrapping [1]. This strong interaction makes the DNA/CNT hybrids very promising candidates for a new generation of nanoelectronic devices, nanoscale sensors and for biomedical applications. In addition, DNA wrapping renders CNTs dispersable in water and allows their separation by type [2]. We have carried a systematic study on the interaction of DNA with carbon nanotubes. The results indicate very strong DNA conformational change induced by the carbon nanotube surface. In order to gain a deeper understanding of this system, in this work we investigated the influence of 20-mer oligonucleotides of dA, dC, dG, dT and the duplex (dA)20:(dT)20 on dispersion efficiency of HiPco single-walled carbon nanotubes (SWNT) at pH = 7.4 and 8.6. The results were compared to that obtained with (dGT)n oligonucleotides, which are commonly used in DNA/carbon nanotubes studies. The dispersion efficiency was estimated by a methodology based on optical absorption measurements developed in our group. We found that the highest dispersion efficiency was achieved at pH=8.6, under low NaCl concentration. In this condition, (dA) dispersed the SWNT the most efficiently. At pH=7.4 and 0.1M Na^+, we found that (dT)20 has the highest dispersion efficiency in agreement with previous work [1]. Circular dichroism (CD) measurements clearly showed that, while (dA)20 and (dC)20 underwent pronounced conformation improvement of their right-handed single-stranded helices upon hybridizing with SWNT at pH=8.6, (dT)20 oligonucleotide does not appear to have its helix structure significantly affected by the presence of carbon nanotubes.

Work supported by the Brazilian Agencies CNPq, FAPEMIG and AEB, and by the Brazilian Institute of Nanotechnology and the Brazilian Network on Carbon Nanotube Research.

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2 - 31 – Structural and transport properties characterisation of multilayered AFM/FM films for spintronic devices grown by pulsed laser ablation

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In this work, we show experimental transport properties of multilayered thin films, growth by pulsed laser ablation techniques (PLD). The selected system was AFM/FM/NM/FM multilayered films (AFM and FM=anti and ferromagnetic, NM= non-magnetic) . As the AFM layer we used $CoFe_2O_4$, while for the FM films we deposited Fe, NiFe and $CoFe_2$. For the NM layer, we selected Al and some oxides like TiO_2 and ZnO. Microscopies like atomic and scanning, revealed good quality interfaces with low roughness. The multilayers are magnetorresistive with good repetitiveness, in both, field and temperature dependence. I-V curves of $CoFe_2O_4$/Fe/Al/Fe multilayers show some interesting hysteretic behaviour for applications as non volatile memories.

2 - 32 – Transport through interacting Aharonov-Bohm ladder rings

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We study the conductance through Aharonov-Bohm finite ladder rings with strongly interacting electrons, modelled by the prototypical t-J model. For a wide range of parameters we observe characteristic dips in the conductance as a function of magnetic flux, predicted so far only in chains which are a signature of spin and charge separation. These results open the possibility of observing this peculiar many-body phenomenon in anisotropic ladder systems and in real nanoscopic devices.

2 - 33 − Analyses of intrinsic heterogeneities and metal segregation in Ag-Ge-Se glasses

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$Ge_ySe_{(1-y)}$ glasses are semiconductors but when Ag is added above certain threshold concentration, $Ag_x[Ge_ySe_{(1-y)}]_{(100-x)}$ glasses behave as fast ionic conductors [1]. This peculiar behaviour may be attributed to the intrinsically inhomogeneous nature of these glasses where zones rich in metals coexist with zones of the host material. The conductivity transformation may be ascribed to the percolation of the Ag rich phase [2]. $Ag_x[Ge_ySe_{(1-y)}]_{(100-x)}$ glasses either massive or as films were obtained by melt quenching and pulsed laser deposition respectively in compositions belonging to the Se rich corner of the ternary phase diagram. Their amorphous nature and intermediate range order was checked employing X-ray diffractometry, the short range order was characterized by Extended X-ray Absorption Fine Structure (Ge and Se K absorption border), and their microstructure was characterized by Scanning Electron Microscopy and Small Angle X-ray Scattering. SEM studies of bulk glasses showed these inhomogeneities for $7 \leq x \leq 20$. The inhomogeneity could not be confirmed for x=25 whereas bulk samples with $x < 7$ look homogeneous in this scale. On the other hand films look homogeneous but their surface is covered by tiny bright spheres in the nanometer scale. SAXS characterization shows that $I(q)$ depends on q as q^{-m} in all q range and present two different power law regimes. For low q values, the dependence corresponds to structures with smooth interfaces; this can be associated to the inhomogeneous nature of these glasses. The final slope of the scattered intensity change to lower absolute values that may be associated to a mass fractal structure of dimension $D_m = m$. This fact may be correlated to the lack of coherence of the interface, with compositional fluctuation on a small scale. On the other hand, the scattering intensity of film samples may be attributed to the presence of arrays of spheres. The $I(q) \propto q^{-3}$ dependence exhibited for large q values may be associated to a surface fractal structure.

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2 - 34 − Thermal treatment of the carbon nanotubes and its functionalization with styrene

DeFalco, A.,[1] Fascio, M.L.,[2] Lamanna, M.L.,[2] Corcuera, M.A.,[3] Mondragon, I.,[3] Rubiolo, G.H.,[4] D´Accorso, N.B.,[2] and Goyanes, S.N.[1]

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It is well-know that the properties of a composite material depends on each component properties and on its interface. In the case of nanocomposites, this interface is the most important parameter due to its great size, being the effectivity of the stress transfer between the matrix and the reinforcement of critical importance to obtain good mechanical properties. Carbon nanotubes are an ideal reinforcement if we take into account their mechanical properties and their great superficial area. However, to achieve an efficient reinforcement, it is mandatory that the carbon nanotubes do not agglomerate to propitiate a good adhesion between them and the matrix. The functionalization with monomer carry out to new nanofiller with good chemical affinity with the matrix, resolving dispersion and adhesion problems. In this work, we studied the functionalization of commercially available multi walled carbon nanotubes (MWCNT) (Nanocyl 3100) with styrene. The method employed was the so called "graft from". The nanotubes were used as received and oxidized in air at 400 °C. The functionalization was achieved using thionyl chloride under reflux, followed by a reaction with ethylene glycol which allows the inclusion of hydroxyl groups. The reaction of those with 2-chloropropionyl chloride leads to the generation of the polymerization initiator. Last, the radical polymerization of the functionalized nanotubes, using styrene as the monomer, led to new materials which were studied with thermogravimetric analysis (TGA), fourier transform infrared spectroscopy (FTIR), UV-Vis spectroscopy, Scanning electron microscopy (SEM) and Transmission electron microscopy (TEM).

2 - 35 – Effect of Multi walled carbon nanotubes in the UV-Vis absorption spectrum of Disperse Orange 3

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As produced, carbon nanotubes tend to bundle together and it is not easy to find an effective method to isolate them. We show in this work that the addition of dyes could improve this isolation. To study this effect we analyze the UV-Vis absorption spectrum of Multi walled carbon nanotubes (MWNT) in solutions of Disperse Orange 3 (DO3) in tetrahydrofuran with different concentrations. In our case, we use the same concentration of MWNT in all samples while the concentration of DO3 was varied from 1 μg/ml to 20 μg/ml. For weight relations DO3/MWNT up to 1, the UV-Vis absorption spectrum of DO3 shows a new absorption peak around 330 nm. This would suggest that only for these proportions of MWNT and DO3 n-π^* electronic transitions are enhanced while for higher DO3/MWNT weight relations this transition does not occur. When this happens, the self interaction of the dye will be predominant over the DO3-MWNT interaction. It should be mentioned that the appearance of this absorption peak around 330 nm indicates an interaction dye-MWNT which at the same time suggests that the DO3 would act as an efficient dispersant for carbon nanotubes. In addition, we analyze the photoisomerization process for the solutions when ratios DO3/MWNT are varied.

2 - 36 – Solvent influence on nanocomposites silica aerogel/maghemite magnetic structure

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The aim of this work is to investigate the interrelation between porosity and magnetic nanostructure in silica aerogel/maghemite nanocomposites. This material is obtained in a Sol∼Gel process followed by hypercritical drying. The so-derived nanostructured materials exhibit an accessible internal porous structure, both in the meso and in the micro scale, in which the magnetic nanoparticles are hosted. In a previous work we proposed that the resulting mean oxide particle size is strongly influenced by the alcohol used as the solvent during the synthesis step [1]. The nanocomposites were synthesized from thetraethylorthosilicate (TEOS) and iron nitrate following the procedure outlined in [2], the molar ratios m_{Fe}/m_{Si} = 0.15 alcohol/TEOS= 2.3 and H_2O/TEOS= 1.8 were holded fixed. We prepared several samples using mixtures of ethyl and methyl alcohols in various proportions ranging from 0 to 100% of MeOH. Larger amount of MeOH results in a shorter gelation time and in a smaller mean oxide particle size. The nanoparticles ensamble behaves as a superparamagnet. The dynamical properties of the nanocomposites are described in terms of the magnetic moments mean relaxation time dependence on temperature, particle size distribution, effective anisotropy, and surface effects. Various techniques covering a wide range of observation times: static magnetometry, ac susceptometry and Mössbauer effect spectroscopy were used. Structural properties are directly obtained form high resolution electron microscopy and inferred form ac susceptometry.

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2 - 37 – Effect of catalyst preparation on the yield of carbon nanotube growth

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Multi-wall carbon nanotubes (MWCNTs) were synthesized by catalytic chemical vapour deposition (CVD) on iron nanoparticles dispersed in a silica matrix as catalyst, prepared by sol gel method. In this contribution, variation of gelation condition on catalyst structure and its influence on the yield of carbon nanotubos growth was studied. The precursor utilized were tetraethyl-orthosilicate and iron nitrate. The sol were gelated at two different temperatures, 25°C (RT) and 80°C, in air and then treated at 450°C for 10 h. The xerogel were introduced into the chamber and reduced in a hydrogen/nitrogen (10%) atmosphere at 600°C. MWCNTs were formed by deposition of carbon atoms from decomposition of acetylene at 700°C. The system gelated at RT shows a yield of 100% respect to initial catalyst mass whereas the yield of gelated at 80°C was lower than 10%. Different crystalline phases are observed for both catalysts in each step of the process. Moreover, TPR analysis shows that iron oxide can be reduced to metallic iron only in the system gelated at room temperature. Carbon nanotubes obtained have a diameter about 25-40nm and several micron length. The growth mechanism of MWCNTs is tip growth mode for both catalysts.

2 - 38 − Thermal transport in one-dimensional spin heterostructures

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We analyze the thermal transport in a spin chain heterostructure in contact to reservoirs at different temperatures. By recourse to a Jordan-Wigner transformation we map the problem to a "Landauer" like setup and we solve it with non-equilibrium Green's functions. We show that due to a mechanism reminiscent of Andreev reflections in superconductors, this device could act as a thermal diode.

2 - 39 − Quantum entanglement in elliptical corrals with magnetic impurities

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Quantum corrals present interesting properties due to the combination of confinement and, in the case of elliptical corrals, to their focalizing properties. We study the case when two magnetic impurities are added to the non-interacting corral, where they interact via a superexchange AF interaction J with the surface electrons in the ellipse. Previous results showed that, when both impurities are located at the foci of the system, they experience an enhanced magnetic interaction, as compared to the one they would have in an open surface. For small J they are locked in a singlet state, which weakens for larger values of this parameter. When J is much larger than the hopping parameter of the electrons in the ellipse, both spins decorrelate while forming a local singlet with the electrons of the ellipse, thus presenting a confined RKKY-Kondo transition.

We interpret this behaviour by means of the von Neumann entropy between the localized impurities and the itinerant electrons of the ellipse: for small J the entropy is nearly zero while for large J it is maximum. In addition, the local density of states provides us with a concrete experimental tool for detecting the Kondo regime. We will also analyze alternative ways to distinguish between both regimes.

2 - 40 − Theory of the optical absorption of light carrying orbital angular momentum by semiconductors

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We develop a free-carrier theory of the optical absorption of light carrying orbital angular momentum (twisted light) by bulk semiconductors. We obtain the optical transition matrix elements for Bessel-mode twisted light and use them to calculate the wave function of photo-excited electrons to first-order in the vector potential of the laser. The associated net electric currents of first and second-order on the field are obtained. It is shown that the magnetic field produced at the center of the beam for the $l = 1$ mode is of the order of a millitesla, and could therefore be detected experimentally using, for example, the technique of time-resolved Faraday rotation.

2 - 41 − Substrate effect on the ground state magnetic configuration of 3d transition metal chains

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We investigate electronic and magnetic structures of linear chains of $3d$ atoms supported on a monolayer of copper nitride on Cu(100) using first principle LSDA calculations. Based on these results, we also calculate the intrachain magnetic coupling by means of an effective Heisenberg model. We obtain that chemical environment and lattice relaxation are important for an accurate description of the magnetic properties of the investigated nanochains.