PROGRAM AND ABSTRACT BOOKLET

MAP-FIS PhD RESEARCH CONFERENCE 2012/2013

Anfiteatro Manuel Fernandes Thomaz, Universidade de Aveiro, January 18, 2013.

The Conference

MAP-fis is the joint doctoral programme in Physics of Univer- sidade do Minho, Universidade de Aveiro and Universidade do Porto (MAP).

One of the main objectives of the MAP-Fis program is to create new links and strengthen existing collaborations between researchers at the MAP Universities (Minho, Aveiro and Porto), the associated National Laboratories and Research Centres. The Scientific Committee of MAP-Fis feels that one important step towards increasing scientific interactions between investigators at these organisations is the presentation of current PhD research results during an informal conference.
The fifth MAP-Fis PhD research conference will be held in at the Universidade de Aveiro in Aveiro, on Friday, January 18, 2013.

The conference will have one session which will cover the following general research topics:

- Gravitation, Cosmology & Particle Physics
- Condensed Matter & Advanced Materials
- Statistical Physics & Complex Networks
- Meteorology & Oceanography
- Optics & Photonics

There will be a poster session also organized in terms of the above general topics.

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Program

9:30 Opening session: Welcome

Optics and Photonics

09:45 – José Luis Santos (UP) "New Paths in Optical Sensing"

10:15 – C. S. Gonçalves "Study of the demagnetization dynamic in magnetic films using pump-probe with temporal resolution in the 6 femtosecond range"

10:30 – Miguel N Canhota "Progress in the simulation and experimental realization of ultrashort light pulse generation by cascaded four-wave mixing"

10:45 – Poster session (Coffee Break)

Meteorology & Oceanography

11:30 – Alfredo Rocha (UA) "Numerical simulation of weather and climate"

12:00 – Ana Picado "Upwelling and rivers discharge effects on chloriphyll production along the NW coast of the Iberian Peninsula"

Gravitation, Cosmology & Particle Physics

12:15 – Orfeu Bertolami (UP) "On the road and some scalar field avenues"

12:45 – Lunch

Statistical Physics & Complex Networks

14:30 – Sergey Dorogovtsev (UA) "The complex networks quest"

15:00 – M. A. Lopes "Emergence of brain waves as a dynamical phase transition"

15:15 – J M G Sousa "Monte Carlo study of the phase diagram of C60"

15:30 – R A da Costa "A toy-model for flow optimization"

15:45 – Posters (Coffee Break)

Condensed Matter & Advanced Materials

16:30 – Mikhail Vasilevskiy (UM) “Collective effects in absorption and emission of light in ensembles of nanocrystal quantum dots”

17:00 – J Nunes-Pereira “Porous composite membranes based on poly(vinylidene fluoride-trifluoroethylene) for Li-ion battery applications”

17:15 – P Martins “Advancements in PVDF based magnetoelectric nanocomposites”

17:30 – J G Barbosa “Electrophoretic Deposition of $CoFe_2O_4$ nanograins dispersed in a $BaTiO_3$ matrix

17:45 – D J Silva “Influence of the doping on the preferred sites of Fe and Ni in silicon”

18:00 – J N B Rodrigues “Scattering by periodic defect lines in graphene”

18:15 – Final Remarks

POSTERS

Poster Session

P1 - Ana Luísa Silva
Aveiro
X-ray imaging detector based on a 2D sensitive THCOBRA with resistive line readout

P2 - Angela Costa
Porto
A Bulk Optical Current Sensor For Metering And Protection Applications In High Voltage Line

P3 - António José De Almeida
Aveiro
Ferromagnetic resonance of intrinsic CdSe quantum dots

P4 - Arlete Apolinario
Porto
Anodic fast-growth of highly ordered hexagonal arrays of TiO_2 *nanotubes by a single anodization step*

P5 - Armando Ferreira
Minho
Electromechanical response of carbon nanotube / poly(vinylidene fluoride) composites and its application to the limb/prosthesis pressure mapping

P6 - Carina Lopes
Aveiro
Influence Of Morphological Changes In A Lagoon Flooding Extension: Case Study Of Ria De Aveiro (Portugal)

P7 - Carlos Gouveia
Porto
Optical Sensors For Dissolved Co2 Determation In Aquaculture Applications

P8 - Clarisse Ribeiro
Minho
PVDF And PLLA Membranes For Tissue Engineering Applications

P9 - Daniel Mota
Porto
Order parameter coupling in $La_{0.7}Sr_{0.3}MnO_3$ *thin films epitaxially grown on* $SrTiO_3$

P10 - Gonçalo Oliveira
Porto
Dynamic off-centering of Cr3+ ions and short-range magneto-electric clusters in $CdCr_2S_4$.

P11 - Hugo Martins
Porto
Sensor De Vibrações Usando Laser De Raman E Redes De Bragg Em Fibra Interrogado Em Potência

P12 - Isabel Gomes
Minho
$Pr_{0.5}Ca_{0.5}MnO_3$ thin films on $LinNbO_3$ substrates

P13 - Ivo Nascimento
Porto
Theoretical Analysis Of Magneto Optical Current Sensors For Hipower Systems

P14 - J P Araque
Minho
Search for vector-like quark production with the ATLAS detector.

P15 - Luís Guerra
Porto
Nonvolatile Resistive Switching In Ta-TaOx-Ta Memristive Devices

P16 - Marcelo Barbosa
Porto
The Study Of Thin Films And Nanostructures At Atomic Scale Using Exotic Nuclear Methods

P17 - Marta Ferreira
Porto
Interferómetros Em Fibra Óptica

P18 - Mengjie Wang
Aveiro
Hawking radiation for a charged Proca field

P19 - Raquel Querós
Porto
A Label-Free DNA Aptamer-Based Lpg Biosensor For The Detection Of E. Coli Outer Membrane Proteins

P20 - Ricardo André
Porto
High-Birefringence Sagnac Interferometer Based On Suspended Core Fiber

P21 - Rita Ribeiro
Porto
Fiber Optical Tweezers: Computational Models

P22 - Rita Rodrigues
Minho
Magnetoliposomes Based On Nickel/Silica Core/Shell Nanoparticles

P23 - Sandra Correia
Aveiro
Organic-inorganic hybrid materials for luminescent solar concentrators

P24 - Vanessa Fernandes Cardoso
Minho
Efficiency Improvement Of Microfluidic System Using Acoustic Streaming Phenomenon Based On Piezoelectric P(Vdf-Trfe) Copolymer

P25 - Vânia Freitas
Aveiro
Luminescent Urea Cross-Linked Tripodal Siloxane-Based Hybrids

Abstracts

Oral presentations

STUDY OF THE DEMAGNETIZATION DYNAMIC IN MAGNETIC FILMS USING PUMP-PROBE WITH TEMPORAL RESOLUTION IN THE 6 FEMTOSECOND RANGE

C. S. Gonçalves[1], Helder Crespo[2], David Schmool[3]

Department of Physics and Astronomy, Faculty of Sciences,University of Porto.
[1] cledson.s.l@gmail,[2] hcrespo@fc.up.pt, [3] dschmool@fc.up.pt,

In recent decades, one of the aims of using magneto-optical techniques has been to measure and more recently to control the magnetization of materials via the interaction with light. Additionally, pulsed light methods have also been applied as tools to obtain information about physical phenomena that occur at timescales of around the tens of femtoseconds (1 fs = 10^{-15} seconds). Effects at this scale contain important information about the energy in magnetic systems [1], such as magnetic anisotropy, spin-orbit interaction and exchange interaction. The so-called "pump-probe" spectroscopic technique is extremely powerful as a visualization tool at timescales that cannot be otherwise accessed. This method has shown great success in the characterization and observation of fundamental physical properties such as molecular dynamics and magnetization processes [2-4]. A key element in our study is the development of a femtosecond pump-probe spectroscopy set-up as well as the detection and data acquisition systems. Our experimental set-up will be used to perform dynamic studies with unprecedented timescales on magnetic materials and nanostructures and on the order of 6 femtoseconds. This will allow us to do state-of-art studies of the ultrafast demagnetization mechanisms and fundamental processes in a variety of magnetic materials and structures. In this presentation we will start with a brief theoretical approach to the fundamentals of the technique as well as a description of the set-up components. Finally, using the system in its preliminary stages, we have measured magnetic hysteresis loops for different time delays between the pump and the probe beams. This shows that we can achieve ultrafast demagnetization, where we have used pulses with 25 fs duration.

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PROGRESS IN THE SIMULATION AND EXPERIMENTAL REALIZATION OF ULTRASHORT LIGHT PULSE GENERATION BY CASCADED FOUR-WAVE MIXING

Miguel N. Canhota[1], Helder Crespo[1], Rosa Weigand[2]

[1]IFIMUP-IN and Departamento de Física e Astronomia, Faculdade de Ciências, Universidade do Porto, R. do Campo Alegre 687, 4169-007 Porto, Portugal.
[2]Departamento de Óptica, Facultad de Ciencias Físicas, Universidad Complutense de Madrid, Avda. Complutense s/n 28040 Madrid, Spain
[1] mmacau@gmail.com

Nonlinear and ultrafast optics encompasses the creation, manipulation and measurement of ultrashort laser pulses. Ultrashort pulses are important in the study of phenomena that occur at very small time scales, on the order of 10^{-15} seconds or even less. With this high temporal resolution it is possible to - literally -shed new light in areas such as chemistry and biology [1]. This project aims to numerically simulate, and to experimentally generate and characterize ultrashort pulses with wavelengths in the region of the electromagnetic spectrum known as vacuum ultraviolet (VUV) through the nonlinear optical process of cascaded four-wave mixing (CFWM) [2]. In our case, this involves the interaction of two non-collinear pulses with different central wavelengths, (such as 800nm and 400nm), in fused silica and in other uv-transparent materials, resulting in several, angularly separated beams with wavelengths ranging from the infrared to the ultraviolet and beyond. Of the wavelengths mentioned above we are mostly interested in those lying in the ultraviolet region. The numerical work involves the modification and improvement of a code designed by Dr.João Silva as part of its doctoral thesiswork [3,4] which allows simulating CFWM for noncollinear interaction geometries. In this presentation I am going to (re)introduce some basic topics and talk about recent improvements made to the code as well as modifications yet to be made, such as the inclusion of pump pulse shaping and two-photon absorption processes. Experimentally, we expect to observe generated pulses at 266nm or lower, suitably compressed in the time domain. We would also like to verify that the carrier-envelope phase (CEP) of the pulses is preserved throughout the nonlinear process.

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UPWELLING AND RIVERS DISCHARGE EFFECTS ON CHLORIPHYLL PRODUCTION ALONG THE NW COAST OF THE IBERIAN PENINSULA

Picado, A. [1], Alvarez, I.[1,2], Vaz, N.[1], Dias, J.M.[1]

[1] *NMEC, CESAM, Physics Department, University of Aveiro, Aveiro 3810-193 Portugal*
ana.picado@ua.pt, nuno.vaz@ua.pt, joao.dias@ua.pt
[2] *EPhysLab, University of Vigo 32004, As Lagoas, Ourense, Spain*
ialvarez@uvigo.es

The knowledge of oceanic physical processes at global or regional scales is fundamental to study the biogeochemical processes in the ocean, particularly those linked to primary production. Climate change can affect these processes once primary production and chlorophyll-*a* (Chl-*a*) levels are highly sensitive to sea surface temperature (SST) and wind patterns. Several studies, carried out during the last decades analyzed the oceanic temperature worldwide, revealing a global warming trend in the ocean [1-3]. Additionally, strongest winds were observed [4] accelerating coastal upwelling circulation [5]. Sea surface global warming can have a negative impact on marine ecosystems, being its effect commonly associated to the latitudinal displacements of populations, specially phytoplankton [6] and zooplankton [7]. Therefore, the spatial and temporal patterns of temperature, Chl-*a* and wind are important oceanographic characteristics with important implications for sustainable management of fisheries and aquaculture.

The use of remote sensing imagery constitutes an efficient way to improve the knowledge of the environmental conditions of an ecosystem, being used to characterize the behavior of primary production over vast areas.

The northwestern coast of the Iberian Peninsula (IP) is the northernmost limit of the Eastern North Upwelling System [8], being a region characterized by significant hydrologic and biogeochemical activity. Coastal upwelling has important biological implications since primary production is controlled by this phenomenon [9]. Also, a significant volume of freshwater is discharged every year along the northwestern IP by a considerable number of rivers, which stands out as being most important the Mondego, Douro and Minho Rivers. The freshwater input is more intense during the winter, but low salinity values persist during all year as a buoyant plume.

Thus, the aim of this work is to investigate the relationship between the atmosphere-ocean-land conditions and chlorophyll *a* (Chl-*a*) formation along the northwestern coast of the IP. Spatial and temporal distribution of Chl-*a* concentration, sea surface temperature, surface winds and rivers discharge were analyzed from 1998 to 2007, using remote sensing data.

Generally, the Chl-*a* concentrations are higher near the coast showing a seasonal variability. In fact, along the coast there are higher Chl-*a* concentrations during the dry season (April to September) which can be associated to the upwelling favorable conditions (southward winds). These favorable conditions are related to the presence of cold nutrient-rich water which were upwelled towards the surface layers enhancing the primary production. During winter months, the wind pattern is usually upwelling unfavorable (northward winds); however high Chl-*a* concentration also occurs near the coast. These high values could be related to inland nutrients input through rivers discharge and winter upwelling events. Afterwards, correlation coefficients were computed between Chl-*a* and upwelling index, SST and rivers discharges. During dry season chlorophyll and upwelling index are positively correlated, increasing southward (0.54 southward of the study area). During wet season, the correlation coefficient between chlorophyll and rivers discharge is 0.70 in the northern region of the study area. Therefore, during spring-summer months the chlorophyll variations could be explained mainly by the frequent upwelling events, whereas during autumn-winter months, high chlorophyll concentration near coast depends on rivers discharges.

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EMERGENCE OF BRAIN WAVES AS A DYNAMICAL PHASE TRANSITION

M. A. Lopes[1], **A. V. Goltsev**[1,2], **J. F. F. Mendes**[1]

[1] Departamento de Física & I3N, Universidade de Aveiro, 3810-193 Aveiro, Portugal.
[2] Ioffe Physico-Technical Institute, 194021, St. Petersburg, Russia.
mal@ua.pt

ABSTRACT

Many physical systems undergo second-order phase transitions which are accompanied by critical phenomena such as divergence of response function, critical fluctuations and critical slowing down of relaxation. Using a stochastic model, we investigate analytically and numerically dynamics of neural networks. We demonstrate that spontaneous emergence of network oscillations is a dynamical phase transition. When the system approaches a critical point similar critical phenomena are present and signal the second order phase transition. Remarkably, these phenomena give rise to resonance phenomena such as stochastic resonance and band-pass filter behavior, which were observed in mammalian brain.

MONTE CARLO STUDY OF THE PHASE DIAGRAM OF C_{60}

J.M.G. Sousa[1], **A.L. Ferreira**[1], **M.C. Mira**[1]

[1] Departamento de Física & I3N, Universidade de Aveiro, Campus Universitário de Santiago, 3810 – 193, Aveiro
j.sousa@ua.pt

RESUMO

We study the phase behavior of the fullerene-C_{60} using interaction potentials that deal with each carbon atom explicitly. While computationally very expensive this provides a better physical description of the system than considering the C_{60} as a unique interaction center with some orientation dependence. An interesting class of empirical potentials for carbon systems, known as bond-order potentials, have been developed in the last decade. They are able to describe the energies and forces in each atom as a function of the local coordination, environment and type of bond. They are ideal to study the high pressure polymerization effects of C_{60}.

A TOY-MODEL FOR FLOW OPTIMIZATION

R. A. da Costa [1], S. N. Dorogovtsev[1,2], J. F. F. Mendes[1]

[1] *Departamento de Física da Universidade de Aveiro, 3810-193 Aveiro, Portugal*
[2] *A. F. Ioffe Physico-Technical Institute, 194021 St. Petersburg, Russia*
americo.costa@ua.pt

In many real systems - such as electrical circuits, hydraulic systems, transport optimization systems, information networks, etc - the amount of current flowing through some particular channel is determined by properties of the channel itself and properties of the alternative channels.
The studied complex system configures a toy-model for flow optimization problems. The system is fed at each channel of the layer $t = 0$ with current j, given by some arbitrary initial probability density distribution $P(j,t = 0)$. Then these currents are merged and split alternately throughout the successively layers of nodes and links or channels. At the distance of t layers from the top, the probability density distribution of currents j on links, $P(j,t)$, will depend on t and on initial distribution $P(j, 0)$. Nevertheless, when $t \to \infty$ the distribution becomes stationary, $P(j,t) = P(j)$, and independent of the specific form of the initial distribution. In fact, $P(j)$ only depends of the first moment of the initial distribution, the average current per link $\langle j \rangle$, which, on this model, is conserved through the layers, and can be regarded as the only independent parameter of this problem.
By taking a mean-field approach we are able to write compact iterative equations that describe exactly the evolution of $P(j,t)$ for the mean-field version of the model. Analysis of those equations allows for exact determination of the stationary form of $P(j,t)$ in the limit of high currents, $\langle j \rangle \to \infty$. Out of this limit exact solution is elusive and standard methods fail, namely the Laplace Transform Technique. Yet that does not impede the discovery of the special properties exhibited by the distribution $P(j,t)$, when the average current is small, in particular $\langle j \rangle < 0.25$.

POROUS COMPOSITE MEMBRANES BASED ON POLY(VINYLIDENE FLUORIDE-TRIFLUOROETHYLENE) FOR LI-ION BATTERY APPLICATIONS

J. Nunes-Pereira[1], A.C. Lopes[1], C.M. Costa[1], L.C. Rodrigues[2], R. Leones[2], M.M. Silva[2] and S. Lanceros-Méndez[1,3]

[1] *Centro/Departamento de Física, Universidade do Minho, 4710-057 Braga, Portugal.*
[2] *Centro/Departamento de Química, Universidade do Minho, 4710-057 Braga, Portugal.*
[3]*INL- International Iberian Nanotechnology Laboratory, 4715-330 Braga, Portugal.*

*lanceros@fisica.uminho.pt

A solid polymer electrolyte (SPE) is the membrane separator between cathode and anode in lithium-ion battery applications. The SPE in comparison with other electrolytes exhibits high flexibility, electrochemical and thermal stability and lithium selective transference. SPEs are intensively investigated in order to improve battery performance, among other ways, by the incorporation of suitable fillers (oxide ceramic, zeolites, ferroelectric material, carbon nanotubes, etc) into the host polymer for tailored mechanical strength, thermal stability and ionic conductivities [1-3].

In the present work, P(VDF-TrFE) membranes, a co-polymer of PVDF was prepared by solvent casting with specific porosity and incorporating various fillers, such as clays, zeolites, carbon nanotubes and ferroelectric ceramics.

The influence of the filler type and content in the performance of the battery separator membranes with and without electrolyte solution (1M $LiClO_4.3H_2O$-PC) was evaluated.

The inclusion of fillers in generally affects the membrane average pore size and can modify the porosity and electrolyte uptake. The overall mechanical and thermomechanical properties are enhanced by the presence of fillers, as well the electrical and electrochemical properties, namely the thermal stability of the conductivity and the ionic conductivity which increases with inclusion of fillers.

Acknowledgments

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References

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ADVANCMENTS IN PVDF BASED MAGNETOELECTRIC NANOCOMPOSITES

P. Martins[1,2] and S. Lanceros-Mendez[1,2]

[1]*Centro/Departamento de Física, Universidade do Minho, 4710-057 Braga, Portugal*
[2] *International Iberian Nanotechnology Laboratory, 4715-330 Braga, Portugal*

The magnetoelectric (ME) effect is a physical phenomenon with a wide range of device applications such as computer memories, smart sensors, actuators and high frequency microelectronic devices [1]. There are few single-phase ME materials and most of them show weak ME coupling at room temperature. In order overcome this limitation, composite materials with increased ME effect are being developed [2]. Most of the ME investigations have used as piezoelectric matrix ceramic materials, but ceramic composites may become fragile and are limited by deleterious reactions at the interface regions leading to low electrical resistivities and high dielectric losses, making those ceramic composites not attractive for applications [3]. In this way, new multifunctional Poly(vinylidene fluoride) (PVDF) and copolymers based nanocomposites were produced with magnetostrictive $NiFe_2O_4$, $CoFe_2O_4$ and $Ni_{0.5}Zn_{0.5}Fe_2O_4$ nanoparticles. PVDF and copolymers were used due to their flexibility and high piezoelectric coefficient and ferrite nanoparticles due to their good magnetostrictive properties and distinct magnetic response [3-4].
The piezoelectric, dielectric, ferroelectric, magnetic and ME properties of the resulting nanocomposites were determined and discussed.
It was found that the dispersed ferrite nanoparticles strongly enhanced the nucleation of the β-phase of the PVDF matrix, essential for the ME response. The origin of such β-phase nucleation was attributed to the electrostatic interactions resulting from the presence of negative nanoparticle surfaces that interact with the polymeric CH_2 groups that have positive charge density.
It was also verified that macroscopic magnetic and dielectric responses of the composites strongly depend on the ferrite nanoparticle content, with both magnetization and dielectric constant increasing for increasing filler content. The β-relaxation in the composite samples was similar to the one observed for β-PVDF obtained by stretching. A superparamagnetic behaviour was observed for PVDF/$NiFe_2O_4$ composites, whereas PVDF/$CoFe_2O_4$ samples show a magnetic hysteresis cycle with coercivity of 0.3 T.
Ferroelectric and piezoelectric properties were improved when small amount of $CoFe_2O_4$ nanoparticles (up to 7% in weight percent (wt.%)) were added to the P(VDF-TrFE) matrix. The highest ME response of 41.3 mV/cm.Oe was found in the P(VDF-TrFE)/$CoFe_2O_4$ (28/72 wt.%) composite when a H_{DC}=0.25T was transversely applied to the sample surface and a ME voltage coefficient of ≈5mV/cm.Oe was obtained at a H_{DC}=0.5T for the PVDF/$CoFe_2O_4$ (93/7 wt.%) sample. This ME response for the PVDF based composites was possible after stretching of the samples, which also led to the formation of voids.
Direct ME effects up to 1.35 mV/cm.Oe were obtained in a H_{DC} =0,5T, for the P(VDF-TrFE)/$Ni_{0.5}Zn_{0.5}Fe_2O_4$ (15/85 wt.%). P(VDF-TrFE)/$Ni_{0.5}Zn_{0.5}Fe_2O_4$ nanocomposites show, as compared to P(VDF-TrFE)/$CoFe_2O_4$ nanocomposites, linear and non-hysteretic direct magnetoelectric responses up to 0.5 T.
It is in this way, novel polymer based ME composites were produced and characterized in such way that it was demonstrated their suitability for sensor applications [5].

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ELECTROPHORETIC DEPOSITION OF $CoFe_2O_4$ NANOGRAINS DISPERSED IN A $BaTiO_3$ MATRIX

J.G. Barbosa[1], C.Moura[1], M.R. Pereira[1], I.T.Gomes[1], J.A.Mendes[1], B.G.Almeida[1]

[1]*Centro de Física, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal*
jbarbosa@fisica.uminho.pt

Nanostructured materials presenting a coupling between the electric and magnetic degrees of freedom have been attracting much scientific and technological interest. By combining a piezoelectric ceramic and a magnetostrictive material, the elastic interactions between the phases provide the coupling mechanism inducing a magnetoelectric behavior.

In electrophoretic deposition (EPD), an electric field is applied on a suspension of charged particles that move towards an electrode and are deposited on it. Due to this, very small nanoscopic particles can be deposited by EPD. As such, a nanostructure can be built where dispersed grains of the magnetostrictive phase are covered with a piezoelectric film that fills the voids between them. The final structure can be considered as a bilayer composite film, where the interface area between the phases is increased relative to typical bilayers films. Here, composites of electrophoretic deposited cobalt ferrite ($CoFe_2O_4$-magnetostrictive) nanograins were dispersed in a laser ablated barium titanate ($BaTiO_3$-piezoelectric).

Evidence of stress mediated coupling between the two phases, was found by magnetic field dependent Raman spectroscopy. In the presence of a magnetic field, changes on $CoFe_2O_4$ T-site and $BaTiO_3$ E(TO)+ A1(TO) modes positions were observed and ascribed to magnetic field induced stresses.

INFLUENCE OF THE DOPING ON THE PREFERRED SITES OF FE AND NI IN SILICON

D.J. Silva [1], U. Wahl [2], J.G. Correia [2], L.M.C. Pereira [3], L. Amorim [3], M. Ribeiro da Silva [4], and J.P. Araújo [1];

[1] *Universidade do Porto, Portugal*
[2] *IST/ITN, Sacavém, Portugal*
[3] *IKS, KU Leuven, Belgium*
[4] *IST, Lisbon, Portugal*
djsilva99@gmail.com

The behavior of transition metals (TMs) in silicon has been an important subject on Si manufacturing due to the fact that TMs are unwanted contaminants in Si, being responsible for the creation of deep levels and therefore act as "lifetime killers" for minority carriers. These deep levels depends not only on the isolated form of the TM but also on its complexes with other impurities or defects, and thus on its occupied lattice sites. Although being extensively studied for the last four decades, the understanding of its occupied lattice sites is still poor. One unique technique to investigate the positions of impurities is emission channeling (EC) which relies on implanting single crystals with radioactive probe atoms that decay by the emission of beta particles, which, on their way out of the crystal, experience channeling effects along crystallographic directions. These channeling effects depend on the lattice site occupied by the probe atom.

We have studied the lattice location of the transition metals ^{59}Fe (t/2=44.6 d) and ^{65}Ni (t/2=2.5 h) in Si single crystals of various doping types [(n^+ and p^+) for Fe and (i, n^+, p^+) for Ni] by means of off-line and on-line experiments. These exotic isotopes were produced at the on-line isotope mass separator (ISOLDE) facility at CERN. Our results show Fe [1] and Ni in three different lattice sites: ideal substitutional (S), displaced bond-center (near-BC) and displaced tetrahedral interstitial sites (near-T). While in p^+-Si Fe prefers near-T sites, in n^+-Si Fe prefers to stay in near-BC and ideal S sites. Unlike Fe, Ni does not show significant differences with the doping, preferring to stay in near-BC sites. The origin of these lattice sites should be related with the vacancies produced during the implantation. FeB pairs are also a possibility for the observed near-T sites in p^+-Si. In this presentation one will present the technique and discuss the obtained results.

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SCATTERING BY PERIODIC DEFECT LINES IN GRAPHENE

J. N. B. Rodrigues[1], N. M. R. Peres[2], J. M. B. Lopes dos Santos[1]

[1] *Centro de Física do Porto and Departamento de Física, Faculdade de Ciências da Universidade do Porto.*

[2] *Centro de Física and Departamento de Física, Universidade do Minho.*

joaonbrod@gmail.com

Recently, Tsen et al. [1] demonstrated how one can probe the electric properties of a single grain boundary in graphene. Following this remarkable possibility, we study, from a theoretical point of view, the electronic transport across periodic defect lines in graphene. In the continuum low-energy limit, such defects act as infinitesimally thin stripes separating two regions where the Dirac Hamiltonian governs the low-energy phenomena. The behavior of these systems is determined by the boundary condition imposed by the defect on the massless Dirac fermions. We demonstrate how this low-energy boundary condition can be computed from the tight-binding model of the defect line. We illustrate this procedure by considering a simple zigzag oriented defect line solely composed by pentagons: the pentagon-only defect line. The recently observed zz(558) defect line [2], as well as the zz(5757) defect line will also be considered [3,4].

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Abstracts

Posters

X-ray imaging detector based on a 2D sensitive THCOBRA with resistive line readout

A.L.M.Silva[1], C.D.R. Azevedo[1], L. Carramate[1], T. Lopes[1], R. de Oliveira[2], J.F.C. Veloso[1]

[1]I3N, Physics Department, University of Aveiro, 3810-193 Aveiro, Portugal
[2] TS Division, CERN, CH-1211 Geneva 23, Switzerland

A new x-ray imaging detector based on a THCOBRA using a simple position readout is proposed.
It consists on a hybrid device that combines the properties of a THGEM and a MHSP in one single structure. It has two multiplication stages allowing to reach the high gains needed to use resistive line readout methods. The new THCOBRA structure has an 10x10 cm^2 sensitive area and uses two orthogonal resistive lines located at the end of the electrodes in both sides of the structure for position sensitivity. The charge is collected in the edges of each resistive line and then the resulting four signals amplitude are digitized and processed. Therefore, from the amplitude of each pair of signals it is possible to determine the centroid of the electron avalanche distribution. The detector uses a preamplifier stage performed by a THGEM, followed by the THCOBRA. The system is operating at atmospheric pressure filled with Ne/5%CH_4 or with pure Ar.
A system characterization in terms of spatial and energy resolution will be presented together with the image capability to infer its performance in X-ray imaging applications.

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A BULK OPTICAL CURRENT SENSOR FOR METERING AND PROTECTION APPLICATIONS IN HIGH VOLTAGE LINE

A.C.S.Brígida[1*], J.C.W.A.Costa[1], P.A.S. Jorge[2], I.M.Nascimento[2,3], J.M.Baptista[2,4], M.AG.Martinez[5],

[1] *Universidade Federal do Pará, Belém, Brazil*

[2] *INESC Porto, Porto, Portugal.*

[3] *Faculdade de Ciências, Universidade do Porto, Portugal.*

[4] *Centro de Competências de Ciências Exactas e de Engenharia, Universidade da Madeira, Funchal, Portugal.*

[5] *Centro Federal de Educação Tecnológica Celso Suckow da Fonseca, Rio de Janeiro, Brazil*

e- mail: acsbrigida@ufpa.br

A magneto-optical optical bulk current sensor, using a dual quadrature polarimetric processing scheme, is evaluated for current metering and protection applications in high voltage lines. The measurement of electric current through optical methods is interesting for applications in high power systems because it has several advantages over traditional methods, such as high bandwidth, high electrical insulation, immunity to electromagnetic interference, they can de lighter, compact, simpler and cheaper [1]. The sensor is based on the Faraday effect [2] in a polarimetric arrangement [3]. Sensor calibration and resolution are obtained in different operational conditions. The best configuration for implementation of a prototype was evaluated using optical sources in the 1550 nm spectral region. The use of a sources operating telecom wavelength indicate the feasibility of interrogating such sensor via the OPGW link installed in standard high power grids.

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Ferromagnetic Resonance of Intrinsic CdSe Quantum Dots

A. J. Almeida[1], R. N. Pereira[1], A. Sahu[2], D. J. Norris[2], M. S. Brandt[3]

[1]*Department of Physics and I3N, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal*
[2]*Optical Materials Engineering Laboratory, ETH Zurich, 8092 Zurich, Switzerland*
[3]*Walter Schottky Institut, Technische Universität München, Am Coulombwall 4, 85748 Garching, Germany*

Ferromagnetic semiconductors are promising for the manipulation of both spin and charge, making these materials highly desirable for future technological applications, in particular spintronics. While most studies have focused on diluted magnetic semiconductors (DMS), in which the magnetic moments origin in the introduction of a few percent of transition-metal ions with partially filled *d* or *f* bands in semiconductors, an increasing number of reports has provided evidence for ferromagnetic behavior in semiconductor quantum dots (QDs) devoid of magnetic ions. In some studies, this unexpected ferromagnetism was associated to charge transfer between the QDs surface and their ligands [1,2], which is enhanced in QDs due to their very high surface-to-volume ratio. Here, we investigate intrinsic CdSe QDs using temperature-dependent magnetic resonance (MR) spectroscopy. The MR spectra of our QDs display a broad signal with angular dependent zero-crossing magnetic field. We show that this signal can be rationalized with the theoretical framework of ferromagnetic resonance, assuming an effective shape anisotropy. The temperature dependence of this signal indicates that the ferromagnetism of our CdSe QDs quenches at temperatures below 80 K. We suggest that the observed quenching of the QDs ferromagnetism results from the thermal activation of charge transfer between Cd atoms at the QDs surface and their attached organic ligands.

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ANODIC FAST-GROWTH OF HIGHLY ORDERED HEXAGONAL ARRAYS OF TiO_2 NANOTUBES BY A SINGLE ANODIZATION STEP

A. Apolinário[1], C.T. Sousa[1], J. Ventura[1], J.D. Costa[1], D.C. Leitão[1,2], J.M. Moreira[1], J. B. Sousa[1] A.M. Mendes[3] and J. P Araújo[1]

[1]IFIMUP-IN and Departamento de Física e Astronomia, Rua do Campo Alegre 687, 4169-007 Porto, Portugal.

[2] INESC-MN and IN, Rua Alves Redol 9, 1000-029 Lisboa, Portugal

[3]LEPAE- Dep. Engenharia Química-Faculdade de Engenharia, R. Dr. Roberto Frias, 4200-465 Porto, Portugal

arlete.apolinario@fc.up.pt

Highly-ordered TiO_2 nanotubes (NTs) have gained much importance for application in hydrogen production by water splitting (photoelectrochemical cells) and the dye-sensitized solar cells (DSCs) [1,2]. The TiO_2 NTs can be synthesized using a titanium foil in fluoride containing electrolytes via electrochemical anodization method. The NTs geometry depends on different anodizing parameters (electrolyte type and concentration, pH, time, applied potential) that determine the tube features (length, pore diameter, wall thickness, etc.).We synthesized TiO_2 NTs arrays by an electrochemical anodization of a Ti foil (two-electrode cell) with an anodization potential of 60 V for 17 h, in an ethylene glycol solution containing NH_4F (0.3 wt%) and H_2O (2 wt%) at room temperature [3]. We implemented, prior to the anodization, three different pre-treatments on the Ti foil: a chemical etching with 4% HF solution, a mechanical polishing and an electropolishing in a H_2SO_4/HF solution, with an applied potential of 10V during 4 min. In this work, we describe the impact that a simple pre-treatment has to the template growth and final thickness after a single anodization step, as well as on the template quality (NTs organization and domain size). For this purpose, the topography of the Ti surface (prior to the anodization) with these 3 pre-treatments and an as-rolled Ti sample was investigated by Atomic Force Microscopy. Roughness studies were compared with the NTs template thickness and organization quality. We obtained highly self-ordered arrays of TiO_2 NTs, and found that pre-treatments that decrease the Ti surface roughness are a crucial step in the TiO_2 NTs electrochemical anodization syntheses for obtaining: a fast NTs growth attaining a highest final template thickness; an enhancement in the NTs organization quality reaching highly ordered hexagonal NTs arrays in larger areas.

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ELECTROMECHANICAL RESPONSE OF CARBON NANOTUBE / POLY(VINYLIDENE FLUORIDE) COMPOSITES AND ITS APPLICATION TO THE LIMB/PROSTHESIS PRESSURE MAPPING

A. Ferreira[1], F. Vaz[1], S. Lanceros-Mendez[1,2]

[1]*Center/Department of Physics, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal.*
[2]*INL – International Iberian Nanotechnology Laboratory, 4715-330 Braga, Portugal.*

E-mail de contacto: armando.f@fisica.uminho.pt

When poly(vinylidene fluoride), PVDF, is in its α-phase, it is also an interesting material for several types of applications due, in particular, to its superior dielectric constant, chemical inertness, thermal stability and mechanical properties, when compared to other polymer materials [1]. So, it seems reasonable to include PVDF and its co-polymers in the research of smart sensors [2] in each of its different phases [1]. This work reports on the piezoresistive response of carbon nanotube/poly(vinylidene fluoride), CNT/PVDF, composites prepared with different CNT types with and without functionalization, via in situ-generated diazonium compounds. The results show that for a CNT concentration close to the percolation threshold, tunneling is the main mechanism responsible for the electrical response, leading also to a significant increase of the piezoresistance of the composites. Interestingly, this fact is independent of the CNT type or functionalization, as well as of the percolation threshold concentration. In this way, a close relationship between the percolation threshold and the piezoresistive response was demonstrated. The electromechanical response, as characterized by the gauge factor, reach values up to 3.9, being among the largest obtained for thermoplastic composites and demonstrating the suitability of these materials for sensor applications.
The developed sensors, with suitable readout and transmission electronics, have been implemented in the development of smart-prosthesis.

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INFLUENCE OF MORPHOLOGICAL CHANGES IN A LAGOON FLOODING EXTENSION: CASE STUDY OF RIA DE AVEIRO (PORTUGAL)

C.L. Lopes[1], P.A. Silva[2], J.M. Dias[1]

[1] *NMEC, CESAM, Departamento de Física da Universidade de Aveiro*
[2] *CESAM, Departamento de Física da Universidade de Aveiro*
carinalopes@ua.pt

Coastal lagoons are interface zones where land, water and atmosphere interact in a dynamic balance that is constantly being changed by natural and human influence. It is expected that the present natural pressures will future intensify as result of climate change effects. Coastal lagoons continuously adapt to these changes modifying its hydrodynamics and morphology. The effects of lagoons geomorphology on its hydrodynamics has been studied in several lagoons worldwide [1-3]. These studies demonstrate that tidal propagation is strongly dependent on the bathymetric configuration. The present study aims to assess the changes that local morphological modifications induce in flooding extension of Ria de Aveiro as well as in the tidal prism. A flooding assessment of the lagoon margins was performed applying the hydrodynamic model ELCIRC under different morphological conditions. The ELCIRC model configuration applied in this study was previously calibrated for Ria de Aveiro lagoon [2]. Four different numerical bathymetries were constructed based on over time topo-hydrographic surveys: the first corresponding to a general survey carried out in 1987/88; in 2001 was performed an update of the inlet bathymetry; in 2011 the update of the majority of the lagoon channels and in 2012 a final update restricted to the inlet. These data show that the inlet evolving region had experienced mostly erosion. Furthermore, between 1987/88 and 2011, a deepening of the lagoon main channels was observed. The numerical results suggest that the lagoon flooded area had increased about 16% between 1987/88 and 2012 for spring tide due to the lagoon morphological changes. The new regions flooded correspond to the margins of S.Jacinto channel head and lagoon central areas. The tidal prism results evidence that between 1987 and 2012 there was a redistribution of the water volume flowing into the lagoon among their main channels in consequence of the morphological modifications.

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OPTICAL SENSORS FOR DISSOLVED CO_2 DETERMATION IN AQUACULTURE APPLICATIONS

K.Balogh[1,6], João M. Jesus[2,4], C. Gouveia[1,3], Jorge O. Domingues[2,4], A. Markovics[6], J.M. Baptista[1,3], B. Kovacs[6], Carlos Pereira[2,5], Maria-Teresa Borges[2,4], P. A. S. Jorge[1]

[1] *INESC Porto, Porto Portugal*

[2] *Faculty of Sciences, University of Porto, Porto, Portugal*

[3] *CCEE, Madeira University, Funchal, Portugal*

[4]*Department of General and Physical Chemistry, University of Pécs, Pécs, Hungay*

pjorge@inescporto.pt

The aquaculture industry is increasily shifting into new intensification culture techniques, which provide increased production and better resource management. However, the increase in fish density and decrease in water renewal, concentrate metabolites to dangerous levels, resulting in the need for more adequate monitoring. In these systems, dissolved CO_2 (dCO_2) can now accumulate and have harmful effects on fish. Considering the current needs, monitoring techniques for dCO_2 in aquaculture are underdeveloped. Standard laboratorial procedures for the measurement of dCO_2 do not provide on-line and *in-situ* data and many of the existing dCO_2 sensors are inadequate due to high sensitivity to metabolites and salinity [1]. In this work a comparison between a commercial solution and a novel fiber optic sensor based on a specially designed polymer membrane is presented. A commercially available option for direct measurement of dCO_2, with datalogging, recommended for aquaculture applications, is the OxyGuard Portable CO_2 Analyzer™.It is based in infrared gas absorption and uses a CO_2 gas pressure sensitive probe. The sensor was tested with deionized water and artificial and fishfarm seawater, for both low and high dCO_2 concentrations. Despite good performance and datalogging capabilities, the analyzer presented a set of significant limitations for its application in long-term monitoring for the aquaculture industry. Namely the large response time, lack of multi-point monitoring as well as probe large size and high price, which imply an elevated cost for multi-point measurements, as it would be needed one probe per sampling point. On the other hand, fiber optic sensors, represents an interesting solution due to their high sensitivity, small size, and capability for in-situ, real-time, remote, and multi-point sensing [2]. The novel optical-fiber sensor was used for measuring gaseous and dCO_2, where the measurements are based either on the color or refractive index changes. The colorimetric measurements allow us to conclude that the sensor works for the full range of CO_2 concentrations (0-100%). The reversibility of the response is also clear. The response and recovery time were measured, being 20s and 46s respectively. The resolution of 0.15% v/v was also estimated. The most sensitive range is from 0-20% which is the most important for most industrial, environmental and biomedical applications. Evaluation of the change of the layer refractive index with CO_2 also showed that such mechanism can be used for sensor implementation enabling multiplexing using standard optoelectronics.

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PVDF AND PLLA MEMBRANES FOR TISSUE ENGINEERING APPLICATIONS

C. Ribeiro[1,2], V. Sencadas[1,2,3], J. L. Gómez-Ribelles[4,5] and S. Lanceros-Mendez[1,2]

[1] *Centro/Departamento de Física, Universidade do Minho, Campus de Gualtar, 4710-058 Braga, Portugal*

[2] *INL - International Iberian Nanotechnology Laboratory, 4715-330, Braga, Portugal*

[3] *Instituto Politécnico do Cavádo e do Ave, Campus do IPCA, 4750-810,Barcelos, Portugal*

[4] *Center for Biomaterials and Tissue Engineering, Universitat Politècnica de Valencia, Camino de Vera S/n, 46022 Valencia, Spain*

[5] *Networking Research Center on Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN), Valencia, Spain*

cribeiro@fisica.uminho.pt

In the last decades, the biomaterials and tissue engineering interdisciplinary research fields have been two of the most dynamic ones and have attracted increasing attention by the scientific community [1-2]. With the advancements in the tissue engineering field the necessity of study and develop a wide variety of biomaterials with different properties has emerged [3-4]. Among the different types of materials, polymers have proved to be an excellent choice, due to their simple processing, flexibility, physical properties and due to be easy to get in different shapes. In particular, piezoelectric polymers have attracted interest since they respond to electrical and mechanical solicitations, allowing to actively stimulating tissues. Further, interesting for tissue engineering are the polymer structures in the form of micro and nanofibers [5-7].

In this work, the processing and characterization of two piezoelectric polymers, poly(L-lactic acid) (PLLA) and poly(vinylidene fluoride) (PVDF), aiming tissue engineering applications was achieved. Processing was achieved both in the form of films and fibers. PLLA and PVDF electrospun fibers morphology was controlled by changing process parameters such as applied voltage, feed rate and collector system. Regarding PVDF fibers, the processing parameters allows to change the β-phase fraction between 50% and 85% and fiber diameter from a few hundreds of nanometers to micrometers. Concerning PLLA fibers, the crystallinity was tailored between 0%, i.e. amorphous fibers, and 50%, by annealing treatment. The PLLA fibers diameter was further reduced by the introduction of poly(ethylene oxide) (PEO) polymer. In this way, electrospun membranes were prepared with tailored fiber diameter from some micrometers for pure PLLA membranes to few hundreds of nanometers by electrospinning of PLLA-PEO solution.

Additionally, the biological response of PLLA and PVDF membranes was also addressed. In the case of PLLA electrospun membranes, human chondrocytes were used and it was found that proliferation of human chondrocytes cultured in the monolayer substrates is not different on aligned or non-aligned amorphous mats. However, the differentiation rate seems to be higher on the non-aligned amorphous mats. Furthermore, the crystallization of the aligned mats showed nearly suppressed proliferation and the cells had produced higher amounts of aggrecan, characteristic of the extracellular matrix of hyaline cartilage.

ORDER PARAMETER COUPLING IN $La_{0.7}Sr_{0.3}MnO_3$ THIN FILMS EPITAXIALLY GROWN ON $SrTiO_3$

D. A. Mota[1], Y. Romaguera Barcelay[1], A. Almeida[1], J. Agostinho Moreira[1]

[1] *IFIMUP and IN-Institute of Nanoscience and Nanotechnology, Departamento de Física e Astronomia da Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal*

dmota@fc.up.pt

The manganites are a unique class of materials with an extremely strong coupling between three fundamental degrees of freedom: electronic, spin and lattice order [1]. Of particular interest is $La_{0.7}Sr_{0.3}MnO_3$ (LSMO), showing both a Curie temperature of 360 K and an almost full spin polarization [2].

LSMO thin films grown coherently on cubic perovskite substrates are usually subjected to not only a biaxial strain due to lattice mismatch but also a further type of distortion, namely, angular distortion (or elastic shear). This angular distortion will also induce strain in the films and relax with increasing film thickness [3]. $SrTiO_3$ (STO) substrates may induce a biaxial strain on the growing film due to the tetragonal distortion occurring below the antiferrodistortive phase transition (T_S) at 105 K.

In this work LSMO thin films were grown on oriented STO (001) substrates by laser ablation. X-rays diffraction, atomic force microscopy and scanning electron microscopy were used to analyse film orientation and texture. Temperature dependence of the magnetizations obtained under magnetic fields parallel and perpendicular to the substrate, confirms the large anisotropy of LSMO films. Below T_S, the magnetization starts to deviate from the expected Brillouin behaviour. The relation between the excess of magnetization relative the one obtained from Brillouin fitting and the square of the order parameter of the STO phase transition is linear. This result is in favour for the existence of magnetostrictive coupling between LSMO film and STO (001) substrate. Magnetoresistance and resistivity measurements also show an anomaly at T_S.

The linearity between the magnetization difference and the square of the order parameter of the STO has a strong dependence with LSMO film thickness. Above a critical thickness (~155 nm) the M(T) curve below the T_S has an inverse behaviour. High resolution transmission electron microscopy experiments are currently running out to understand this switching mechanism. The emergence of such an “additional degree of freedom” may not only lead to a deeper understanding of interface-mediated order-parameter coupling in $La_{0.7}Sr_{0.3}MnO_3$ films but also an improvement in the spintronics field.

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Dynamic off-centering of Cr^{3+} ions and short-range magneto-electric clusters in $CdCr_2S_4$.

Gonçalo N.P. Oliveira[1,2], André M. Pereira[2], Armandina M. L. Lopes[1], João S. Amaral[2,3], António M. dos Santos[4], Tânia M. Mendonça[2], Célia T. Sousa[2], Yang Ren[5], Vitor S. Amaral[3], J. Guilherme Correia[6], João P. Araújo[2]

1 – CFNUL – Center Nuclear Physics, University of Lisbon, Av. Prof. Gama Pinto, 2, 1649-003, Lisboa, Portugal
2 – IFIMUP and IN - Institute of Nanoscience and Nanotechnology and Department of Physics and Astronomy, Faculty of Sciences, University of Porto, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal
3 - CICECO and Departament of Physics, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal
4 – Neutron Scattering Science Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA
5 - APS - Advanced Photon Source, Argonne National Laboratory, Argonne, Illinois 60439, USA
6 - ITN - Instituto Tecnológico e Nuclear, EN 10 - Apartado 21, 2686-953 Sacavém, Portugal
goliveira@fc.up.pt

The quest for improved multiferroic materials is, nowadays, a hot topic of research promising routes for the development of several technological applications based on the magneto-electric coupling [1-4]. In this respect, the most appealing multiferroic materials are those, which display a strong coupling between the magnetic and polar degrees of freedom [5-7].
Our studies provide clear-cut experimental evidence for the origin of the relaxor-like behavior on the cubic spinel $CdCr_2S_4$. Here we definitely settle that this behavior arises from Cr off-centering displacement from its coordination sphere being thus responsible for the observed colossal magneto-electrical effects. Our findings were achieved by a singular combination of local probe techniques namely Pair Distribution Function (PDF) and Perturbed Angular Correlation (PAC). We further show that the off centering of the magnetic Cr-ion gives rise to a peculiar entanglement between the polar and magnetic degrees of freedom, stabilizing in the paramagnetic phase, short range magnetic clusters. This phenomenon was unveiled by low-field high-resolution magnetization measurements, analyzed using a modified Landau theory with a linear coupling between the magnetic and polar order parameters.
Our work provides fundamental comprehension of the magneto-electric coupling, essential for opening new routes to tune these materials for suitable applications namely in the Spintronics industry. Furthermore, we point out the PDF and PAC techniques on the unveiling of the behavior presented by this system, where their local probe analyses capability was of fundamental importance.

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Sensor de vibrações usando laser de Raman e redes de Bragg em fibra interrogado em potência

H. Martins*[a,b], Manuel B. Marques[a,b] e Orlando Frazão[a]
[a]INESC Porto, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal;
[b]Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal

RESUMO

Apresentámos um sensor de vibração baseado numa cavidade laser de Raman de 1 km entre duas redes de Bragg em fibra ótica (FBG) iguais. Quando é aplicada vibração/deformação na FBG sensora, o seu comprimento de onda desloca-se, diminuindo a eficiência do laser. A vibração/deformação aplicada manifesta-se numa variação de potência de saída do laser. Evitam-se assim métodos de medição complexos (técnicas interferométricas ou espetroscópicas) permitindo uma aquisição de dados rápida e barata. O sistema desenvolvido permite medir vibrações de amplitude máxima de 10 dBVms, com uma frequência máxima de 1 kHz. As deformações medidas foram comparadas com as deformações aplicadas.

$Pr_{0.5}Ca_{0.5}MnO_3$ THIN FILMS ON $LiNbO_3$ SUBSTRATES

I. T. Gomes[1,2], B. G. Almeida[1], J. P. Araújo[2]

1 Departamento de Física, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal

2 Departamento de Física and IFIMUP-IN, Universidade do Porto, Rua do Campo Alegre 687, 4169-007 Porto, Portugal

isabelgomes@fisica.uminho.pt

The $Pr_{1-x}Ca_xMnO_3$ (PCMO) manganite exhibits a very broad composition range with charge and orbital ordering effects. A sufficiently strong static magnetic field applied to this system triggers an insulator to metal transition by which the charge- and orbital-ordered antiferromagnetic insulating ground state is melted into a conducting ferromagnetic metallic state, inducing colossal magnetoresistance [1,2]. The charge ordering transition is highly affected by pressure, electric and magnetic fields, radiation and epitaxial strain in thin films.

Lithium niobate ($LiNbO_3$) is ferroelectric up to 1210 °C and is commonly used in wave guide and integrated optics applications, due to its optical, electro-optic, piezoelectric, photorefractive, elastic and photoelastic properties [3].

Thin films of $Pr_{0.5}Ca_{0.5}MnO_3$ were deposited on z-cut $LiNbO_3$ by pulsed laser ablation using a KrF excimer laser with λ = 248 nm. The X-ray diffraction measurements have shown that the films grow highly oriented on $LiNbO_3$, with a pseudocubic (111) preferred growth direction. The thicknesses of the films, measured by low angle X-ray reflectivity, are between 13 and 140 nm. The standard four-probe-in-line technique was used to measure the electrical resistivity of the samples, and the results have shown a semiconducting behaviour in all the samples with an anomaly around 240 K, corresponding to the charge ordering transition. The temperature of the transition (T_{CO}) was estimated from the ln ρ vs. (1/T) plots. The charge ordering temperature was found to be dependent on the strain induced by the lattice mismatch on the films.

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THEORETICAL ANALYSIS OF MAGNETO OPTICAL CURRENT SENSORS FOR HIPOWER SYSTEMS

I.M. Nascimento[1,2], A.C.S. Brígida[1,3] , J.C.W.A. Costa[3], M.A.G. Martinez[4],

J. M. Baptista[1,5], P.A.S. Jorge[1]

[1] *INESC Porto, Porto, Portugal*
[2] *Faculdade de Ciências, Universidade do Porto, Portugal*
[3] *Universidade Federal do Pará, Belém, Brasil*
[4] *CEFET – Centro Federal de Educação Tecnológica Celso Sudockow da Fonseca, Rio de Janeiro, Brasil*
[5] *Centro de Competências de Ciências Exatas e de Engenharia, Universidade da Madeira, Funchal, Portugal*
imn@inescporto.pt

The accurate measurement of electric energy is a fundamental aspect in the development of sustainable energy management systems [1]. Comparing optical current sensors with conventional current transformers, they offer several advantages: large bandwidth, highly linear response over a wide frequency range, high electrical insulation, immunity to electromagnetic interferences, possibility of AC and DC measurements, absence of saturation effects, possibility of multiplexing and compatibility with fiber optic communication technology, allowing long range remote detection [2, 3].

In this paper, a polarimetric bulk optical current sensor is theoretically studied, and the effects of different sources of error considering practical deployment are evaluated. In particular, the effects of temperature induced linear birefringence and the interference from external magnetic fields in a three-phase system are analyzed. This sensor uses a dual detection scheme based on two orthogonal polarizations where the obtained signal is free from common mode noise and immune to power fluctuations [3]. In addition, Jones matrix formalism [4] is used to obtain the sensor transfer function.

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Search for vector-like quark production with the ATLAS detector.

J. P. Araque
Universidade do Minho, Portugal.

Heavy vector-like quarks might be produced in different models, such as singlet models for T and B quark, with electric charge of 2/3 and 1/3 respectively and doublet models for (X, T), (T, B) and (B,Y) quarks, where X has an electric charge of 5/3 and Y hasan electric charge of 4/3. The first step for the analysis program is to generate the required signal samples in a consistent way. The PROTOS generator is being used and validated within the ATLAS framework. The kinematic differences between models are evaluated and a strategy for the signal events generation is proposed.

Nonvolatile resistive switching in Ta-TaO_x-Ta memristive devices

L.M. Guerra[1], J. Ventura[1], J. Pereira[2], S. Freitas[2], P. P. Freitas[2]

1. IFIMUP and IN-Institute of Nanoscience and Nanotechnology, and Departamento de Fisica, Faculdade de Ciencias, Universidade do Porto, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal
2. INESC-MN and IN-Institute of Nanoscience and Nanotechnology, Rua Alves Redol, 9-1, 1000-029 Lisbon, Portugal
luismg9@hotmail.com

Abstract

In 1971 Leon Chua reasoned from symmetry arguments that there should be a fourth fundamental passive circuit element, the memristor (short for memory resistor) [1]. However, it was not until 2008 that the first physical realization of the memristor was achieved [2]. Defined more generally, memristive devices are passive circuit elements whose resistance (internal state) depends on the history of the applied voltage and current. Their fingerprint is a pinched hysteretic current-voltage (I-V) loop, whose size is frequency dependent, meaning that these devices are capable of storing and processing information. The most typical class of memristive devices are two-terminal resistance switches built from a thin-film metal-insulator-metal (MIM) stack. The fact that these structures can be scaled down to less than 10 nm and offer fast, non-volatile, low-energy electrical switching make them promising candidates for applications such as resistive random access memories (ReRAMs). Their electrical properties also have an uncanny resemblance to those of biological synapses and thus are being considered for novel neuromorphic applications [3].

Here we present a detailed I-V study on devices which illustrate key properties of these memristive systems. The fabricated devices are composed of Ta (1100 Å)/TaO_x (100 Å)/Ta (1100 Å) stacks, deposited on Si/Al_2O_3 100 nm-thick substrates, and microfabricated down to areas of 20x20 μm^2. In Fig. 1 we present successive *set* [switching from the high-resistance state (HRS) to the low-resistance state (LRS)] and *reset* (HRS to LRS) cycles. In the inset of Fig. 1 we can see that the *set* process corresponds to an abrupt increase in the electrical conductivity. A current compliance must then be used or switching becomes irreversible. The *reset* process requires a higher current value, but takes place in a narrow voltage range. One readily notes from the obtained data that these devices are nonpolar (i.e. switching depends only on the amplitude of applied voltage, contrarily to the bipolar case where it depends also on the polarity [4]). Even though the physics behind the switching mechanisms is not yet fully understood, it is generally accepted that in the nonpolar case thermal effects, namely Joule heating, are dominant [5]. Figure 2 shows a single, self-crossing, pinched hysteretic loop, here confirming that a nonpolar device can be operated in both polarities. Finally, we note that the average R_{on}/R_{off} ratio of the measured devices is of approximately 10^7, making these devices, after optimization of the set/reset voltage distributions, highly desirable for memory applications.

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Figures

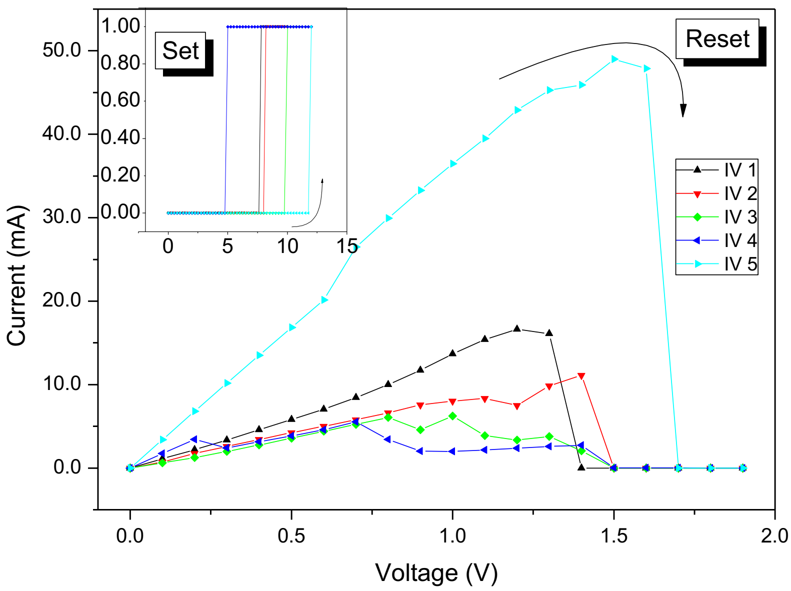

Figure 1. Measured I-V data for positive applied voltage, showing consecutive reset curves. Inset shows the corresponding set curves, also illustrating the variability of the set voltage. Data was obtained for a 20x20 μm^2 device.

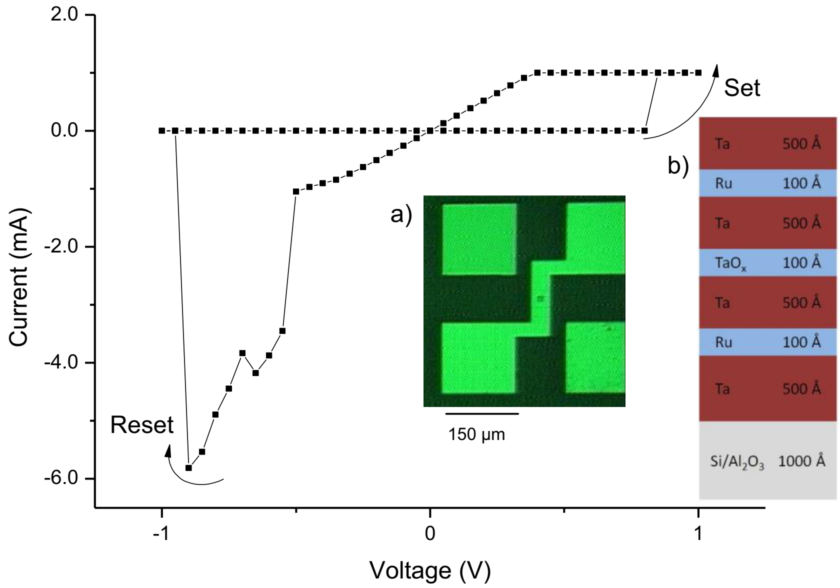

Figure 2. Measured I-V curve for both positive and applied voltages. Here we show that a nonpolar device can be operated under bias of different polarities. Inset a) shows optical microscope image of one fabricated device. We can see the bottom and top electrodes, while the stack is the small square in the middle of the image. Inset b) shows the stack structure and materials.

THE STUDY OF THIN FILMS AND NANOSTRUCTURES AT ATOMIC SCALE USING EXOTIC NUCLEAR METHODS

M. B. Barbosa[1], K. Lorenz[2,3], J. G. Correia[2,3], J. P. Araújo[1]

[1] *IFIMUP and IN – Institute of Nanoscience and Nanotechnology, Departamento de Física e Astronomia da Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre, 4169-007 Porto, Portugal.*

[2] *IST/ITN, Instituto Superior Técnico, Universidade Técnica de Lisboa, Estrada Nacional 10, 2686-953 Sacavém, Portugal.*

[3] *Centro de Física Nuclear da Universidade de Lisboa, Avenida Prof. Gama Pinto, 1649-003 Lisboa, Portugal.*

marcelo.barbosa@fc.up.pt

The study of nanomaterials has grown considerably in recent years due to its promising applications in everyday life technologies. However, its relevancy relies on both tunable properties and the large-scale integration feasibility [1]. Great advantages can be obtained by merging nanostructures with thin film technologies, where ion implantation is still envisaged as an integrated part of the processes. Still, ion implantation carries along with the benefits – universal dopant and profile tuning – intrinsic nuisances, i.e., defects and poor solubility. Therefore, in this highly integrated new world the small scale rules both new properties and new problems.

Willing to contribute to the better understanding of doping and processing by ion beams, we present here two examples of studies performed with the nanoscopic Perturbed Angular Correlation technique that probes the charge density distribution in the surroundings of chosen radioactive nuclei, thus allowing characterizing the probe's real environment at the atomic scale. We have chosen the study of ZnO and $Cd_xZn_{1-x}O$ thin films – aimed to cover luminescence wavelengths from UV to yellow [2] – with implanted $^{111m}Cd/^{111}Cd$ probe, and the technologically relevant high –K factor Ga_2O_3 nanowires and Ga_2O_3 pellets where Cd is a potential p-type dopant [3].

For each case, we show how and to which extent the local environment of the implanted Cd is reconstructed to the one of the host crystalline matrix as a function of annealing temperature. We further attempt to identity local defects with first principle simulations by DFT methods.

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INTERFERÓMETROS EM FIBRA ÓPTICA

M. S. Ferreira[1,2], J. L. Santos[1,2], O. Frazão[1]

[1] INESC Porto, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal
[2] Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal

E-mail de contacto: msaf@inescporto.pt

RESUMO

Neste trabalho apresentam-se duas configurações diferentes usando um tubo de sílica, as quais são testadas como aplicação em sensores. A primeira configuração, uma cavidade de Fabry-Pérot monitorada em reflexão, é caracterizada em temperatura, assim como para variações de pressão de azoto gasoso. Sensibilidades de 8.11 pm/ºC e 2.61 nm/MPa são obtidas para altas temperaturas e para pressão, respectivamente. A segunda configuração consiste numa pequena secção de tubo de sílica entre duas fibras SMF28. O espectro de transmissão evidencia a presença de um filtro espacial, o qual é sujeito a variações de deformação e temperatura. Neste caso, sensibilidades de 27.5 pm/ºC e 0.59 pm/με foram respectivamente obtidas.

Hawking Radiation for a charged Proca field

Mengjie Wang, Marco O. P. Sampaio, Carlos Herdeiro

Departamento de F´ısica da Universidade de Aveiro and I3N

Campus de Santiago, 3810-183 Aveiro, Portugal

E-mail: mengjie.wang@ua.pt

We generalise our recent analysis of the wave equation for a neutral Proca field in D-dimensional Schwarzschild black hole, by adding charge both to the field and the black hole, on the 3+1 dimensional Standard Model brane. A detailed numerical study is performed to obtain the transmission factors and we find superradiant modes. Then we compute the Hawking fluxes and observe an inverted charge splitting effect for small energies for two or more extra dimensions. Our work can be used to improve the balck hole event generators for phenomenological studies of TeV gravty scenarios.

A LABEL-FREE DNA APTAMER-BASED LPG BIOSENSOR FOR THE DETECTION OF *E. COLI* OUTER MEMBRANE PROTEINS

R.B. Queirós[1,2,3], C. Gouveia[1], P.V.S. Marques[1,2], J.P. Noronha[4], M.G.F. Sales[3], P. Jorge[1]

1INESC TEC (coordinated by INESC Porto), Porto, Portugal

2Faculdade de Ciências da Universidade do Porto, Portugal

3BioMark/ISEP, School of Engineering, Polytechnic Institute of Porto, Portugal

4 REQUIMTE/FCT-UNL, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, Portugal

The increasing need for devices capable of performing reliable, fast and in situ measurements in the field of biochemical detection is guiding researchers to look for new technologies [1]. Long Period Gratings (LPG) are among the most promising fibre optic-based refractive index transducers to be employed for unlabeled biochemical assays [2]. The use of LPG is cost-effective because it does not require expensive instrumentation and allow portability. They also present high sensitivity to refractive index, which can be increased and tuned by using high refractive index overlays [3]. The present work describes the use of one *E. coli* DNA aptamers (herein called ECA) for the determination of *E. coli* outer membrane proteins (EcOMP) in waters using a LPG as a refractometric platform. The ECA raised against EcOMP was immobilized using a cationic polymer - poly-L-lysine (PLL). The sensing head was characterized and tested against EcOMP and applied to spiked environmental water samples. The sensing principle of the ECA LPG biosensor relies on measuring the shift of the resonance wavelength (λ_R), due to the changes in the surrounding refractive index (SRI). The changes in λ_R are monitored in real time by a FS2200 Braggmeter unit, between 1500 and 1600 nm, in transmission mode. The functionalized ECA was bind to an optical fibre with an inscribed LPG (Λ= 395-398 μm). After, the sensing head was incubated with several varying concentrations of EcOMP ranging from 1×10^{-10} M to 3×10^{-8} M. Between all this steps the shift of the resonance was measured. In the presence of EcOMP, the ECA folds around the proteins and forms an EcOMP-ECA complex. The formation of this complex causes an increase in the effective refractive index of the cladding and consequently a decrease of the wavelength of the resonance. In figure 1 is presented the transmission spectra of the LPG reporting the wavelength shift of the resonance during the immobilization procedure and following affinity-assay for the sensing head.

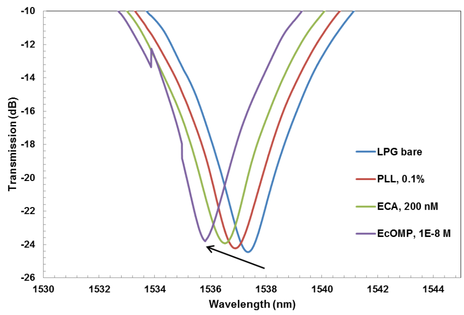

Figure 1- Transmission spectra of the LPG reporting the wavelength shift of the resonance during the immobilization procedure with PLL and following affinity-assay (ECA-EcOMP).

In general terms, the sensing head showed a concentration-dependence behaviour, with a shift of the resonant loss of about 2 nm. The sensing heads were regenerated (under low pH conditions) and the deviation of the subsequent detection was less than 0.1 %. These analytical features, as well as its fabrication easiness and operational convenience, make it a promising method for the detection of *E. coli*.

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High-Birefringence Sagnac Interferometer based on Suspended Core Fiber

Ricardo M. André[1,2*], Manuel B. Marques[1,2], Orlando Frazão[2]

[1] Departamento de Física e Astronomia da Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre 687, 4169-007 Porto, Portugal
[2] INESC Porto - Instituto de Engenharia de Sistemas e Computadores do Porto, Rua do Campo Alegre 687, 4169-007 Porto, Portugal
*E-mail de contacto: randre@inescporto.pt

ABSTRACT

In this work, we developed a Sagnac interferometer based on a fiber loop mirror with a section of suspended core fiber. The section of suspended core fiber has a suspended core with dimensions close to 1μm and a triangular format. This structure has a high birefringence and simultaneously presents intermodal interference. The intermodal interference is due to the high index difference between silica and air. The spectral response of this configuration shows the presence of three interferometers. One corresponds to the interference between light propagating in the fast and slow modes (group birefringence). The others are associated with intermodal interference. Using all three interferometers it is possible to measure the mechanical strain applied to the sensor element with high sensitivity (-2.44 pm/με).

FIBER OPTICAL TWEEZERS: COMPUTATIONAL MODELS

R. S. Rodrigues Ribeiro[1,2], P. A. S. Jorge[1], A. Guerreiro[1,2]

[1] *INESC Porto, Rua do Campo Alegre, 687. 4169-007 Porto, Portugal*
[2] *FCUP, Rua do Campo Alegre, 687. 4169-007 Porto, Portugal*
ritbeiro@gmail.com

Optical trapping of dielectric particles by a single-beam gradient force was first demonstrated by Artur Ashkin in 1986 [1]. This method has been developed as optical tweezers technology in fields of physics, biology and chemistry. Using optical trapping it is possible to capture and manipulate, for example, particles or cells in a nearly non-invasively process [2].

Usually optical tweezers are in bulky structures, which are expensive, complex and have a limited utilization in several environments. The realization of optical tweezers based on single optical fiber is capable of turning this device into a miniaturized and handy diagnostic tool, suitable for many applications, like *in vivo* biological operations [3].

This work discusses the calculation of the trapping forces in optical tweezers using a combination of the finite differences time domain (FDTD) method and the Lorentz force on electric dipoles. The results of 2D simulations of the trapping of a circular particle by a waveguide with a circular tip are presented and discussed. These results will be useful to describe real trapping situations using fiber optical tweezers.

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MAGNETOLIPOSOMES BASED ON NICKEL/SILICA CORE/SHELL NANOPARTICLES

A. Rita O. Rodrigues[1], D. Peixoto[2], M.J.R.P. Queiroz[2], B.G. Almeida[1], I.T. Gomes[1], J.P. Araújo[3], E.M.S. Castanheira[1], P.J.G. Coutinho[1]
[1] *Centro de Física (CFUM) and* [2]*Centro de Química (CQ/UM), Universidade do Minho, Campus de Gualtar, 4710-057 Braga*
[3] *IFIMUP/IN - Instituto de Nanociência e Nanotecnologia, R. Campo Alegre, 4169-007 Porto*
ritarodrigues81@hotmail.com

Liposomes entrapping magnetic nanoparticles (magnetoliposomes) are of large importance in drug delivery, as they can be guided and localized to the therapeutic site of interest by external magnetic field gradients and used in cancer treatment by hyperthermia [1-2].
In this work, systems of nanometric dimensions based on magnetoliposomes were developed, for application in the delivery of antitumor drugs, by combining lipid membranes with nickel magnetic nanoparticles, with or without a silica shell.
Nickel magnetic nanoparticles were prepared using different microheterogeneous media, which were then covered with a silica shell. The structural, spectroscopic and magnetic properties of the prepared nanoparticles were evaluated. These nanoparticles were either incorporated in liposomes or produced in the presence of a lipid or surfactant layer, thereby obtaining magnetoliposomes.
New fluorescent compounds with potential antitumor activity were incorporated in these magnetoliposomes. The compounds were previously studied by UV-vis. absorption and fluorescence spectroscopies, and exhibited a solvent sensitive emission, although they are not emissive in protic solvents [3]. The localization of the compounds in liposomes was assessed by fluorescence (steady state) anisotropy measurements. The results showed that they are mainly located in the lipid bilayer, feeling the transition between the gel phase and the liquid-crystalline phase of the lipids [3].
A preliminary study of the non-specific modes of interaction of the magnetoliposomes with cells was performed using GUVs (giant unilamellar vesicles) as models of cell membranes. The interaction was evaluated by resonance energy transfer (FRET) between the antitumoral compounds (donors) and labeled lipids included in the GUVs, containing the fluorescent marker NBD (nitrobenzodiazole, acting as acceptor) at several different positions of the lipid molecule. The results revealed the occurrence of fusion between the magnetoliposomes and the GUVs.

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ORGANIC-INORGANIC HYBRID MATERIALS FOR LUMINESCENT SOLAR CONCENTRATORS

S. Correia [1-3], P. P. Lima [1, 2], L.D. Carlos [1, 2], P. S. André [1, 3] and R. A.S. Ferreira [1, 2]

[1] *Physics Department, University of Aveiro, 3810-193 Aveiro, Portugal*

[2] *CICECO, University of Aveiro, 3810-193 Aveiro, Portugal*

[3] *Instituto de Telecomunicações - Pólo de Aveiro, 3810-193 Aveiro, Portugal*

sandracorreia@ua.pt

Research on organic-inorganic hybrid (OIH) doped with Ln^{3+} and dyes is an active field towards the development of eco-friendly and multifunctional systems with applications spanning domains as optics, environment and energy [1]. An emergent field, so-called green photonics, includes recent developments in photonics towards its sustainable use, gathering key topics like lighting, photovoltaic conversion and optical communications [2]. Ln^{3+}- and dye-doped OIH synergistically benefit from the thermal/mechanical stability of the inorganic skeleton, flexibility of the polymer and Ln^{3+}/dyes intrinsic luminescence (high brightness and quantum yields) [1]. Compared with dyes, Ln^{3+} display narrower emission (FWHM< 4 nm), higher lifetimes (μs-ms) and larger Stokes shifts. Ln^{3+}- and dye-doped OIHs can be processed as thin films with controlled thickness and refractive index with applications as luminescent solar concentrators (LSCs) and integrated optics (IO) devices.

The LSC can enhance the low efficiency (<24 %) of commercial photovoltaic (PV) cells, which is one of the limitations associated with a general usage of this technology. LSCs are made of a transparent substrate doped with fluorophores (*e.g.* dyes, quantum dots, Ln^{3+}) that successfully convert the sunlight UV and/or NIR component into visible radiation [3,4]. Through total internal reflection a large fraction of the emitted light is trapped within the plate and guided to the edges, being collected by PV cells, which results in an increased photovoltaic output [4,5].

In this we will present a LSC based on OIH (so called tri-ureasils) modified by Eu^{3+} deposited by spin-coating on a glass transparent substrate. A commercial amorphous-Si PV cell was coupled to the LSC and the optical conversion efficiency was determined.

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EFFICIENCY IMPROVEMENT OF MICROFLUIDIC SYSTEM USING ACOUSTIC STREAMING PHENOMENON BASED ON PIEZOELECTRIC P(VDF-TRFE) COPOLYMER

V. F. Cardoso[1], G. Minas[1], S. Lanceros-Méndez[2*]

[1] *Algoritmi Center, University of Minho, Campus of Azurem 4800-058 Guimaraes, Portugal*
[2] *Department/Center of Physics, University of Minho, Campus of Gualtar, 4710-057 Braga, Portugal*
*vanessa@dei.uminho.pt

Microfluidic technology has become an important tool in (bio)chemical analysis due to its intrinsic advantages [1-2]. However, the fluid mixing can become time consuming due to the laminar flow regime present in the micrometer fluidic structures. Among the different approaches to overcome this limitation, one with large interest due to its low manufacturing cost, easy processing and integration, is related to the phenomenon called acoustic streaming. The acoustic waves generated by a piezoelectric transducer placed underneath the microfluidic structure allow to accelerate the fluid mixture [3-4].
This paper is devoted to the investigation of the feasibility and performance of acoustic streaming for the mixture of fluids at the microscale, generated with a copolymer based piezoelectric transducer. The fabricated transducer comprises a 25 µm thick piezoelectric film of poly(vinylidene fluoride-trifluoroethylene) (P(VDF-TrFE)) with 85 nm thick electrodes of aluminium doped zinc oxide (AZO).
The efficiency of the acoustic streaming phenomenon of the piezoelectric P(VDF-TrFE) transducer was studied by means of two diagnostic kits based on uric acid and nitrite. The experiments were performed within a microfluidic structure in polymethylsiloxane comprising a reaction chamber with an area of 1 mm2 and a thickness of 500 µm. Regarding the tests with uric acid, the acoustic streaming reduced the mixture time by approximately 23% as compared to the mixture of the fluids by diffusion. In this case, the heating of 30ºC generated by the transducer played an important role, since the quantification of this biomolecule involves endothermic reactions. Concerning the study with nitrite, a gain of approximately 32% was obtained, being exclusively ascribed to the effect of the acoustic streaming, since the reactions involved are not affected by the heating generated by the piezoelectric transducer. In both cases, the gains correspond to the application of a sinusoidal signal to the contacts of the piezoelectric transducer, with a peak to peak voltage amplitude of 10 V and a frequency of 48 MHz.
The heating and acoustic streaming contribution can be controlled by the proper design of the transducer and the characteristics of the electrical signal. Thus, this study represents a contribution in order to raise the efficiency of the mixture of fluids to improve the overall performance of miniaturized analysis systems and to allow new application areas.

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LUMINESCENT UREA CROSS-LINKED TRIPODAL SILOXANE-BASED HYBRIDS

V. T. Freitas, P. P. Lima, R. A. S. Ferreira, L. D. Carlos [1*], E. Pecoraro [2], M. Fernandes, V. de Zea Bermudez [3]

[1] *Department of Physics, University of Aveiro, 3810-193 Aveiro, Portugal*

[2] *Instituto de Telecomunicações, University of Aveiro, 3810-193 Aveiro, Portugal*

[3] *Chemistry Department and CQ-VR, University of Trás-os-Montes and Alto Douro 5001-801 Vila Real, Portugal*

* lcarlos@ua.pt

The mild sol-gel process [1] is attractive for the nanoscale-controlled synthesis of organic–inorganic hybrid materials [2] with innovative properties, featuring potential applications in many areas [3-5]. An emergent and exciting field, so-called green photonics, includes recent developments in the domain of photonics towards its sustainable use. This work reports the synthesis of novel sol-gel derived urea cross-linked tripodal siloxane-based hybrids (tri-ureasils) modified by the addition of phenyltriethoxysilane (PTES) and diphenyldimethoxysilane (DPDMS) [6,7]. The materials were produced as transparent monoliths and thin films (thickness = 3.3–17.5 ± 0.1 μm). All the hybrids show efficient emission at room temperature in the blue spectral region with a maximum emission quantum yields of 0.10±0.01 [6]. The highest values were found for the tri-ureasils incorporating PTES and DPDMS essentially due to an increase in the absorption coefficient (from 1.4×10^3, for the pristine tri-ureasil, to 8.6×10^3 cm^{-1}, for the hybrids modified by the chromophores) [6]. Moreover, the influence of the amount of water (2.2 and 22.2 mmol) and HCl (between 4.0×10^{-5} and 8.0×10^{-2} mmol) used in the tri-ureasils synthesis was evaluated. It was established that for [HCl] within 0.01-0.1 M the emission quantum yield is maximized (0.13±0.01) [7].

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