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MAP-fis Conference 2015

Auditório da Escola de Ciências, U. Minho
26 June 2015

PD+F PROGRAMAS DE DOUTORAMENTO FCT

CONFERENCE PROGRAM

09:00	**Opening**		
09:15	A1	Sandra Filipa Henriques Correia	SCALE-UP THE COLLECTION AREA OF LUMINESCENT SOLAR CONCENTRATORS TOWARDS METER-LENGTH FLEXIBLE WAVEGUIDING PHOTOVOLTAICS
09:30	A2	Alexandre Manuel Pedroso Botas	Influence of the surface type on the light emission of crystalline silicon nanoparticles
09:45	A3	Rita Rodrigues	MAGNETIC LIPOSOMES BASED ON NICKEL FERRITE NANOPARTICLES
10:00	A4	Catarina José Loureiro da Silva Dias	Ag-BASED RESISTIVE SWITCHING NANOSTRUCTURES
10:15	A5	Anselmo Miguel Magalhães Marques	Superconductivity in Graphite Intercalation Compounds
10:30	A6	Hugo Gonçalves	UNUSUAL PHOTONIC PROPERTIES OF DOPED NANOSTRUCTURED POLYMERIC FIBERS
Coffee Break			
11:15	B1	Ricardo Melo André	Multiplexing focused ion beam milled Fabry-Perot cavities for temperature and refractive index sensing
11:30	B2	Ana Rita da Silva Rodrigues Ribeiro	OPTICAL FIBER TWEEZERS
11:45	B3	Miguel Noronha da Canhota	Self-diffraction and transient-grating dispersion-scan and their application to the measurement of sub 4 femtosecond laser pulses
12:00	B4	Sílvia Maria Gouveia Rodrigues	Modelling and simulation of nonlinear optical phenomena in microstructured optical fibres
Lunch and Posters			
15:15	C1	Hamid Hosseiny	GPU-accelerated optical coherence tomography data processing and visualization for microsurgical applications
15:30	C2	Vânia Patrícia Castro Teixeira Freitas	EU3+-BASED BRIDGED SILSESQUIOXANES FOR TRANSPARENT LUMINESCENT SOLAR CONCENTRATORS
15:45	C3	Juan Pedro Araque Espinosa	Search for new heavy vector-like quarks in the ATLAS experiment at the LHC
16:00	C4	André Gomes da Costa Guerra	ON A SMALL SATELLITE TO INTEGRATE MULTIPLE CAPABILITIES FOR OCEAN MONITORING
Coffee Break			
16:45	D1	Joao Dias Caetano Silva	OPE for All Helicity Amplitudes
17:00	D2	Helgi Freyr Rúnarsson	Kerr black holes with self-interacting scalar hair
17:15	D3	Flávio Luis Portas Pinheiro	The Universality of Peer-Influence in Social Networks

Poster Session			
14:00:15:15	P1	Rui Miguel Abreu Vilarinho da Silva	ENHANCING MAGNETOELECTRICITY IN TbMnO3 & DyMnO3 BY Fe3+ SUBSTITUTION
	P2	Filipe Oliveira	Multi-stacks of epitaxial GeSn self-assembled dots in Si: Structural analysis
	P3	Mengjie Wang	Boundary conditions for Maxwell perturbations in Kerr-Ads black holes
	P4	João Filipe Horta Belo	GD5SI1.3GE2.7 GIANT MAGNETOCALORIC THIN FILM: SYNTHESIS AND POST TREATMENTS
	P5	Marcelo Baptista Barbosa	Structural and electronic characterization of Ga2O3 samples using Perturbed Angular Correlations
	P6	Adérito Aramuge	STORM SURGE CHANGES ALONG THE COAST OF MOZAMBIQUE FOR FUTURE CLIMATE SCENARIOS
	P7	Carlos Amorim	To be announced
	P8	G. N. P. Oliveira	Hydrostatic pressure in CdCr2S4: Effect on local magnetic clusters
	P9	Marta Ferreira	OPTICAL FIBER SENSORS FOR EXTREME ENVIRONMENTS
	P10	João Carlos Almeida Monteiro Azevedo	Cuprous Oxide as a promising Solar Water Splitting Photocathode – Solving the Stability Technological Problems

A1 – SCALE-UP THE COLLECTION AREA OF LUMINESCENT SOLAR CONCENTRATORS TOWARDS METER-LENGTH FLEXIBLE WAVEGUIDING PHOTOVOLTAICS

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Luminescent solar concentrators (LSCs) are cost-effective components easily integrated in photovoltaics that can enhance solar cells performance. Moreover, the devices can promote the integration of photovoltaic architectural elements into buildings [1,2], with the unprecedented possibilities for energy harvesting in façade design [3,4], urban furnishings and wearable solar fabrics [5].
The devices' performance is dominated by the concentration factor, which is higher in cylindrical LSC compared with planar ones (with equivalent collection area and volume).
The feasibility of fabricating long-length LSCs has been poorly explored and essentially limited to optical paths of up to ten of centimeters, yielding devices with concentration factors lower than one. Here, we use a drawing optical fibers facility to easily scale-up the fabrication of large-area LSCs up to 2.5 m long based on bulk and hollow-core plastic optical fibers [6]. The optically active layers used to coat the bulk fibers or fill the hollow-core ones are Rhodamine 6G- or Eu^{3+}-doped organic-inorganic hybrids. The approach is demonstrated for the first time, with clear advantages towards an improvement in the devices lifetime due to the environmental and mechanical protection of the optically active layers inside the fibers core. Our optimized devices display effective optical conversion efficiency and concentration factor values of 3.34% and 11.75, respectively, illustrating the potential of this approach for the development of lightweight and mechanically flexible high-performance waveguiding photovoltaics.

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A2 – INFLUENCE OF THE SURFACE TYPE ON THE LIGHT EMISSION OF CRYSTALLINE SILICON NANOPARTICLES

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Crystalline silicon nanoparticles (SiNPs) have gathered much interest as they combine the unique features of Si at the nanoscale (e.g. wavelength tunable light emission[1-2]) with the versatile and inexpensive device fabrication associated with nanoparticle processing.[3] Their small dimensions and the large surface area, species chemically/physically attached to the SiNPs, and interface- and surface-related phenomena will eventually dominate the optical response of SiNPs.

In this work the light emission properties of SiNPs have been investigated using steady-state and time-resolved photoluminescence measurements carried out at 12 K and at room temperature. To enable a comparative study of the role of surface terminal groups on the optical properties, we investigated SiNPs ensembles with different surface termination, namely organic-termination with 1-dodecene (SiNPs-C12) and H-termination (SiNPs-H). We show that although the spectral dependence of the light emission is rather unaffected by surface termination, characterized by a single broad band peaking at ~1.64 eV, both the exciton recombination lifetimes and quantum yields display a pronounced dependence on the type of surface termination. Exciton lifetimes and quantum yields are found to be significantly lower in SiNPs-H compared to SiNPs-C12. This difference is due to a difference in non-radiative recombination resulting from inter-NP exciton migration, which in SiNPs-C12 is inhibited by the energy barriers imposed by the bulky surface groups. From comparison between the dynamics of exciton recombination at low and room temperatures, we demonstrate that the room temperature light emission efficiency is limited by thermally-activated non-radiative recombination processes, possibly associated with thermally-induced inter-NP exciton transfer.

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A3 – MAGNETIC LIPOSOMES BASED ON NICKEL FERRITE NANOPARTICLES

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Magnetic liposomes (liposomes entrapping magnetic nanoparticles) are of large importance in drug delivery, as they can be guided and localized into the therapeutic site of interest by external magnetic field gradients and used in cancer treatment by hyperthermia [1,2]. The magnetic nanoparticles can be either covered with a lipid bilayer, forming dry magnetoliposomes (DMLs), or entrapped in liposomes, originating aqueous magnetoliposomes (AMLs).

Recently, AMLs and DMLs based on nickel/silica core/shell nanoparticles were successfully prepared and characterized [3]. Pursuing better magnetic properties and higher biocompatibility, nickel ferrite nanoparticles (NPs) were synthesized by coprecipitation method and characterized by TEM, DLS, XRD and EDS. The magnetic properties measured by SQUID revealed superparamagnetic nanoparticles at room temperature (with coercive fields of 12 Oe), suitable for biomedical applications [4].

A new method for the synthesis of DMLs that can be used with calcinated nanoparticles is described. DMLs structure was confirmed by FRET (Förster Resonance Energy Transfer) measurements between the fluorescent-labeled lipids NBD-C_{12}-HPC (NBD acting as donor) included in the second lipid layer and rhodamine B DOPE (acceptor) in the first lipid layer. A FRET efficiency of 23% was calculated, with a corresponding donor-acceptor distance of 3.1 nm, confirming DMLs structure [4]. Assays of the non-specific interactions of AMLs and DMLs with biological membranes (modeled using giant unilamellar vesicles, GUVs) were performed. Membrane fusion between the magnetoliposomes and GUVs was confirmed by FRET between the labeled lipid NBD-C_{12}-HPC (donor) and the hydrophobic dye Nile Red (acceptor). A new potential antitumor drug [5] was successfully incorporated into the lipid bilayer of both AMLs and DMLs containing $NiFe_2O_4$ NPs, pointing to the promising use of these nanosystems in dual cancer therapy, exploiting the synergistic effect between chemotherapy and magnetic hyperthermia.

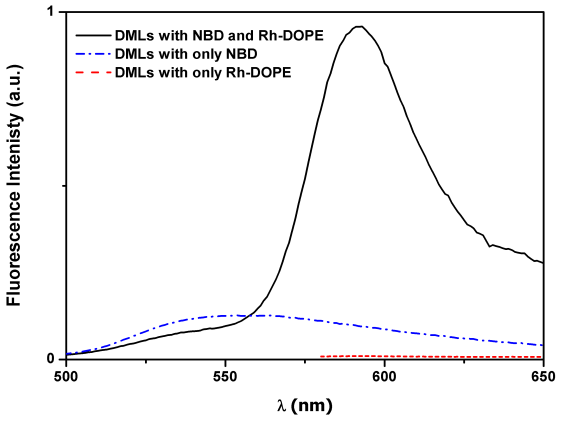

Figure 1. Fluorescence spectra (λ_{exc}=470 nm) of DMLs covered with DOPG labeled with only NBD-C_{12}-HPC; DMLs labeled with only Rhodamine B-DOPE and DMLs labeled with NBD-C_{12}-HPC and Rhodamine B-DOPE.

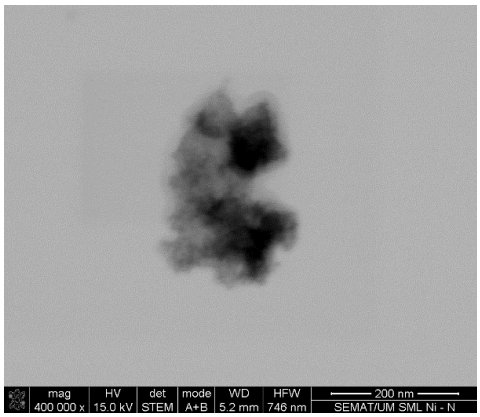

Figure 2. SEM images (with negative staining) of the synthesized DMLs based on $NiFe_2O_4$ NPs.

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A4 – Ag-BASED RESISTIVE SWITCHING NANOSTRUCTURES

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Present computer processing capabilities are becoming a restriction to meet modern technological needs. Therefore, approaches beyond the von Neumann architecture are imperative and the brain's operation and structure are truly attractive models [1]. Memristors are characterized by a nonlinear relationship between current history and voltage (resistive switching phenomenon) [2] and were shown to present properties resembling those of neural synapses. They can thus be used in networks capable of mimicking the learning and adaptation characteristics of human brains [3].
We studied the resistive switching in nanostructures with an electrolyte (here Ag_2S) and one active electrode, and others with a gradient of Ag in a Si layer. The phenomenon was attributed in both structures to the formation and rupture of metallic filaments due to ionic diffusion inside the active layer [4]. We also observed activity-dependent modifications when applying successive voltage, thus making a parallel with biological synaptic plasticity.
The study of the impact of non-ideal devices or device faults in the performance of memory networks was performed by numerically evaluating a memristor-based Willshaw associative memory network [5,6]. Adopting a binary operation, the capacity and robustness to noise of the network were evaluated as a function of defects probability and device parameter variations.
Is summary, Ag-based devices may present continuous conduction changes, a behavior analogous to biological synapses, due to Ag filaments formation and rupture. Furthermore, in a memristor-based artificial neural network, defects and variability do not imply (to some extent) the catastrophic operation failure.

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A5 – SUPERCONDUCTIVITY IN GRAPHITE INTERCALATION COMPOUNDS

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We present a study of metastability regions in the in-plane magnetic field *versus* temperature phase diagram of superconducting graphene and intercalated graphite superconductors. Due to the vanishing density of states at the Dirac point, undoped graphene requires a finite BCS interaction to become superconducting, but any finite doping drives this critical interaction value to zero [1]. Above the critical interaction value, in common with conventional quasi-2D superconductors, superconducting graphene under in-plane magnetic fields displays a low temperature first-order transition to the normal phase, but, in contrast, the width of the associated metastability region (normalized to the zero temperature critical field) shows a strong dependence on doping, achieving the maximum width when the doping shifts the Fermi energy to the van Hove singularity [2]. In the case of intercalated graphite superconductors, modeled as a two-dimensional two-band superconductor (a graphene-like band and a metallic interlayer band), a critical intraband interaction for the graphene-like band is required in order for the appearance of a second metastability region, within the superconducting phase of the phase diagram. The width of this metastability region also goes to zero as the graphene intraband interaction approaches its critical value from above, and the metastability region vanishes at the zero temperature supercooling field associated with the metallic interlayer band. For intermediate values of the graphene intraband interaction above this critical value, a low-temperature first-order transition line bifurcates at intermediate temperature into a first-order transition between superconducting phases and a second-order transition line between the normal and the superconducting phase [3].

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A6 – UNUSUAL PHOTONIC PROPERTIES OF DOPED NANOSTRUCTURED POLYMERIC FIBERS

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Organic electronics are beginning to make significant inroads into the commercial world. Many of these emerging applications require materials with well-characterized and optimized nonlinear optical properties. The most common strategy to achieve enhanced nonlinear optical responses in organic molecules is to link donor and acceptor moieties on opposite ends of a π-conjugated aromatic spacer. This configuration promotes spatial charge transfer and a strong difference in dipole moments between the ground and excited electronic states. This individual tailor made organic molecules can often exhibit enormous intrinsic nonlinear optical properties, but the translation to a macroscopic electro-optic activity is often extremely difficult. Roughly more than 80% of all π-conjugated organic molecules crystallize in centrosymmetric space groups producing materials with no second order bulk susceptibility. To overcome this restriction we embedded organic molecules which normally crystallize in centrosymmetric structures into nano-structured environments which promote highly oriented meso-crystalline structures. Polymeric nanofibers, one-dimensional nanostructures, have unique optical interactions that arise from their sub wavelength size [1], are used to greatly enhance the nonlinearities of nominally weak nonlinear materials. Introducing specific species in the nanofibers and creating in this way a hybrid material, it is possible observe an enhancement of nonlinear effects of the doped species [2,3]. Using ultrafast Second-Harmonic Generation Microscopy significant second harmonic light is observed, even at naked eye, from nanofibers of poly(L-lactic acid) (PLLA) doped with Para-nitroaniline ($C_6H_6N_2O_2$) produced by electrospinning.

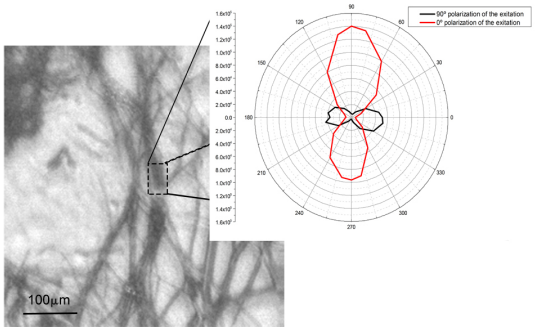

Figure 1 – Polarized light of the second harmonic generation of a nanofiber of PLLA doped with para-nitroaniline. The red curve correspond to excitation using a polarization parallel to the fibres, the black curve correspond a normal polarization excitation.

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B1 – MULTIPLEXING FOCUSED ION BEAM MILLED FABRY PEROT CAVITIES FOR TEMPERATURE AND REFRACTIVE INDEX SENSING

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Different configurations of Fabry-Perot microcavities are created on tapered fiber tips by focused ion beam milling and further analysed. Cavities in silica and cavities in air have radically different temperature sensitivities. The silica cavities have the expected sensitivity to temperature of ca. 18 pm/K, while the air cavity is effectively temperature insensitive. By multiplexing a silica cavity and an air-gap cavity on the same tapered fiber tip, a dual-cavity structure sensitive to temperature and refractive index is demonstrated. Fast Fourier transforms are applied to the structure's spectra and show independent peaks for both cavities resulting in truly independent cavities.

B2 – OPTICAL FIBER TWEEZERS, TOOLBOXES FOR PARTICLE MANIPULATION

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Currently optical tweezers are non-evasive versatile tools for precise cell/particle immobilization and manipulation. The use of optical fibres for cell/particle immobilization and manipulation have been increasing over the last decades, resulting in low cost and handy tools. However, microfabrication techniques have to be employed in order to restructure the fibres into operational optical tweezers.
In this work we aim to demonstrate the use of distinct optical fiber tweezers (OFT) for cell immobilization and manipulation. The fibre probes presented in this work are fabricated using several different methods, such as: chemical etching, photo-polymerization and focused ion beam milling. This results in a myriad of distinct probes designs: axicones, spherical lenses, Fresnel zone plates, spiral phase plates, among others. With these OFTs numerous manipulations aspects can be addressed and explored. The designs and respective trapping outputs are analysed using finite difference time domain (FDTD) simulations of the full vectorial optical propagation through the designed structures.

B3 – SELF-DIFFRACTION AND TRANSIENT-GRATING DISPERSION-SCAN AND THEIR APPLICATION TO THE MEASUREMENT OF SUB 4 FEMTOSECOND LASER PULSES

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Ultrashort laser pulses are a unique tool enabling many exciting new techniques and applications in science and technology. Measuring such short events is often as challenging as generating them. To fully characterize these pulses, i.e., their electric field, we need both amplitude and phase information. In this work we present new ultrashort pulse measurement schemes based on the newly established dispersion scan (d-scan) technique [1], invented in our group in collaboration with Lund University, Sweden. D-scan is a method for ultrashort pulse characterization based on the variation of the total dispersion (controlled by a scalar parameter such as glass wedge insertion within a pulse compressor) incurred by the pulse while propagating through the system. As the wedge insertion is varied, the spectra of a nonlinear optical signal generated by the input pulse (which is sensitive to the spectral phase of the pulse) is recorded, resulting in a 2D trace containing information on the temporal profile and spectral content of the pulse to be measured. From this trace, and the measurement of the fundamental pulse spectrum, we can apply numerical algorithms to retrieve the spectral phase and hence the pulse is reconstructed. In this work, the pulses are generated by self-phase modulation of 0.8 mJ, 27 fs laser pulses @ 800 nm in a hollow-core fiber filled with a noble gas (Ar), with a duration of 3.8 fs after compression, i.e., in the sub-two-cycle regime [2]. Unlike the first variant of d-scan, which is based on second-harmonic generation (SHG) in a nonlinear crystal, these new schemes are based on third-order optical nonlinearities, namely self-diffraction (SD) and transient-grating (TG) phenomena. Unlike SHG, the signals generated by these processes share the same range of wavelengths as the input pulses. Measurements obtained from SD d-scan and TG d-scan configurations are compared with results from SHG d-scan, yielding sub-4-fs pulse durations and a good agreement. The d-scan ability to simultaneously measure and compress few-cycle laser pulses with high-performance makes it suitable for attosecond pulse generation [3] as well as ultrahigh-resolution spectroscopy. With the SD d-scan and TG d-scan, we hope to extend the applicability of the d-scan method to the deep ultraviolet (DUV) range of wavelengths, where SHG crystals are unavailable.

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B4 – MODELLING AND SIMULATION OF NONLINEAR OPTICAL PHENOMENA IN MICROSTRUCTURED OPTICAL FIBRES

Sílvia M.G. Rodrigues[1]

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The microstructured optical fibres (MOFs) offer the possibility to guide light and observe optical phenomena in a diversity of conditions not achievable before [1-2]. We can divide these fibres into two groups: the solid-core MOFs and the hollow-core MOFs; in the 1st group the main light guidance mechanism is the modified total internal reflection, whereas in the 2nd group the main light guidance mechanisms are the photonic bandgap effect and the low density of states in the fiber's cladding.

In this presentation we will start by explaining the light guidance mechanisms occurring on those fibres, and after that we will show some examples of our simulations results that describe the dispersive and nonlinear properties of some SC-MOFs and HC-MOFs. We are interested, in particular, in a geometry that has been reported to have the highest recorded nonlinear parameter in numerical simulations for solid-core MOFs, the so called layered spiral SC-MOF [3].

In addition, we are going to present some results concerning the development of the light propagation in distinct MOFs, in which the nonlinear effects take an important role. We will study the generation of ultra-violet light and supercontinuum.

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C1 – GPU-ACCELERATED OPTICAL COHERENCE TOMOGRAPHY DATA PROCESSING AND VISUALIZATION FOR MICROSURGICAL APPLICATIONS

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Real-time optical coherence tomography (OCT) data processing and visualization is of paramount importance for live surgical guidance. Nowadays OCT data computation has shifted from central processing unit (CPU) based to graphics processing unit (GPU) based methods to significantly shorten the processing time and achieve real-time processing and 2- and 3-dimensional displays of the acquired OCT volumetric data [1, 2]. This study proposes an optimized signal processing scheme implemented by a single and dual GPUs using the compute unified device architecture (CUDA) to program the GPU(s). The strategies to reduce the time-consuming data transfers and processing time were described. Live processing and visualization were achieved by developing customized software employing an NVIDIA GTX TITAN Z GPU card consisting of dual GPUs. The recent studies on GPU-based data processing approaches have demonstrated data processing of small OCT volumes because of GPU memory and resource limitations[1-3]. However, the proposed approach shows the feasibility of real-time processing and 2D/3D visualization of large OCT data volumes by using a single GPU. The volume with the size of 1024 (Ascans) × 928 (Samples per Ascan) × 1024 (Bscans) was processed and visualized in real-time. All challenges to obtain high performance results were discussed in detail and the solutions were given. The highly optimized algorithms to extract the cross-section, *en-face* and longitudinal images were explained. Ray tracing method was implemented to render and show 3D volumetric OCT data in real-time. The temporal performance of the processing module and each aforementioned visualization unit for different data set sizes were reported. A retinal motion was presented by rendering 18 captured volumes as a potential future application of such a system.

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C2 – EU^{3+}-BASED BRIDGED SILSESQUIOXANES FOR TRANSPARENT LUMINESCENT SOLAR CONCENTRATORS

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Abstract. The conversion of solar energy into electricity through photovoltaic (PV) cells is not efficient enough and market competitive yet, remaining an obstacle for their large-scale dissemination. Luminescent solar concentrators (LSCs) are composed of films bearing optically active centers that collect the incident sunlight and reemit it partially at a specific wavelength. Part of this emitted light is trapped inside the layer and concentrated at the edge of the film where it can be collected by a PV cell. Here, LSC will be produced using sol-gel derived bridged silsesquioxane containing Eu^{3+} salts and 2-thienoyltrifluoracetonate prepared from a new ethane tetracarboxamide-based organosilane [1]. Free-standing films with thicknesses up to 440 μm and maximum absolute quantum yield (q) of 0.34±0.03 (excitation at 320 nm) were prepared by the drop cast method, while thin films (~200–400 nm) spin-coated on glass substrates led to highly luminescent coatings with q=0.60±0.02 (excitation at 345 nm). The thin films were tested as luminescent solar concentrators and the optimized device displays an optical conversion efficiency of 12.3% in the absorbing spectral region of the active layer (300–380 nm) [1]. This is the first quantitative report for Eu^{3+}- LSCs providing evidence of the potential of lanthanide-based hybrid coatings to enable the commercial development of prototypes.

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C3 – SEARCH FOR NEW HEAVY VECTOR-LIKE QUARKS IN THE ATLAS EXPERIMENT AT THE LHC

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The discovery of the Higgs boson at the LHC in July 4th of 2012 brought light on several areas of modern particle physics which try to answer the open questions left by the Standard Model. One of them is the number of fermions families and the possibility that heavier quarks than the top might exist. New chiral families have been studied in the past years and both experimentalist and theorists have been involved in the search of such new quarks. But the presence of a light Higgs boson makes this scenario very constrained by the couplings of this new heavy quarks with the Higgs. Nevertheless, there is still the possibility that these new heavy quarks are not chiral partners of the Standard Model quarks but they are vector-like. Vector-like quarks transforms in the same way under the symmetry group SU(2) both the left and right chiralities and, due to this, they don't need to couple with the Higgs boson to obtain mass. In this talk the analysis done within the ATLAS collaboration focused on the search of vector-like quarks decaying to a Z boson will be presented.

C4 – ON A SMALL SATELLITE TO INTEGRATE MULTIPLE CAPABILITIES FOR OCEAN MONITORING

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The oceans cover about 70% of Earth's surface. It is crucial to monitor the oceans state since variations on its features have an effect on the rest of the planet. Satellites for the observation of Earth are an essential tool for extending existing monitoring capabilities [1]. There are a number of oceanography relevant parameters that can be measured and monitored with satellites, such as ocean colour, height, waves, wind and salinity [2]. On a local scale, monitoring of coastal erosion, shipping, and fishing locations drives the study of the oceans.

Small satellites are of particular relevance given their low-cost and flexibility. Although debatable, a satellite is considered small if its mass is lower than 1000 kg [3]. Smaller satellites (e.g. micro satellites with less than 100 kg, and nano satellites with less than 10 kg) have shorter periods of design and production. The power available is usually of the same order of the mass. Another important feature of small satellites is their capability to link *in situ* experiments with manned ground stations.

Maritime monitoring and control are key aspects to governments and organizations around the world. As an example, within Canada's extended continental shelf, approximately 1600 ships per day can be found. Most of the control is performed using maritime radars and by ground based Automatic Identification System (AIS) [4]. This limits the detection range, making it practical only on ports and maritime choke points. Therefore, to overcome this limitation, Canada launch a new small satellite (85 kg) in April 2015, the M3MSat (Maritime Monitoring and Messaging Microsatellite). It has two main payload instruments: an AIS module, and a low data rate system (used for supporting *in situ* sensor data collection).

Portugal has a long legacy of ocean exploration. Over the last decade there has been a prompted renewed interest in ocean related activities, together with the proposal for the extension of the Portuguese continental shelf. About 65% of the marine traffic to Europe will pass through this enlarged shelf (about 4 million km^2). This area is impossible to monitor without the help of an array of integrated system of surveillance and monitoring.

The Departamento de Física e Astronomia, Faculdade de Ciências and the group of robotics [5] of Faculdade de Engenharia, both of Universidade do Porto, are collaborating in the development of a platform and sensors for ocean monitoring. Furthermore, this system of surveillance should be capable of gathering data from other vehicles (including autonomous underwater, surface, and aerial vehicles). In order to minimise the mission cost, the most suitable platform is a small/micro/nano satellite (small enough to piggyback on another launch).

The payloads under consideration include a Synthetic Aperture Radar (SAR) and a hyper/multi spectral imager. SAR is capable of providing very rich data about the oceans, and also observe man made platforms and vessels. Together with the independence from solar illumination conditions and cloud cover, makes SAR the premier sensor for target detection and monitor of Earth parameters [6]. The integration of an AIS system is also a possibility to further extend its surveillance capabilities.

This work is still in an early stage of setting requirements and constraints. The mentioned payloads must necessarily be adapted to suit the platform, making the miniaturization of sensors one of the main challenges ahead.

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D1 – OPE FOR ALL HELICITY AMPLITUDES

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We extend the Operator Product Expansion (OPE) for scattering amplitudes in planar N=4 SYM to account for all possible helicities of the external states. This is done by constructing a simple map between helicity configurations and so-called charged pentagon transitions. These OPE building blocks are generalizations of the bosonic pentagons entering MHV amplitudes and they can be bootstrapped at finite coupling from the integrable dynamics of the color flux tube. A byproduct of our map is a simple realization of parity in the super Wilson loop picture.

D2 – KERR BLACK HOLES WITH SELF-INTERACTING SCALAR HAIR

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We study families of asymptotically flat, rotating black holes with self-interacting scalar hair and a regular horizon, within the framework of four dimensional general relativity coupled to a complex, massive scalar field.
When the self-interaction vanishes, the solutions reduce to the Kerr black holes with scalar hair (KBHsSH) found in [1]. These solutions interpolate continuously between the corresponding family of boson stars, for a vanishing horizon, and a subset of vacuum Kerr black hole, as the scalar field vanishes.
These new families of solutions are supported by rotation, have no static limit and are described by their mass, angular momenta and conserved Noether charge.
Various self-interactions can be considered, such as quartic or hexic [2].
Here we will discuss a quartic self-interaction which has the same Kerr limit as that of the KBHsSH.

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D3 – THE UNIVERSALITY OF PEER-INFLUENCE IN SOCIAL NETWORKS

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Social networks pervade our everyday lives: we interact, influence and are influenced by our friends and acquaintances. The recent availability of large amounts of data on social networks has fostered quantitative analyses of the distribution of information on them, including behavioral traits and fads. In particular, recent studies have shown the existence of positive correlations in the distribution of traits in a social network composed by the participants of the *Framing- ham Heart* study [1,2]. Surprisingly the peer-influence patterns found among the participants went beyond the influence of their closest peers, but also their friends' friends, up to three degrees of influence.

In [3] we show how similar patterns of correlations between peers emerge in networked populations through standard models (yet reflecting intrinsically different mechanisms) of information spreading such as the Voter's Model, the SIR epidemic model and Evolutionary Game Theory models of cooperation. We argue that empirically observed patterns of correlation among peers emerge naturally from a wide range of dynamical processes, being essentially independent of the type of information, on how it spreads, and even on the class of underlying network that inter-connects individuals. Finally, we show that the sparser and clustered the network, the more far-reaching the influence of each individual will be.

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P1 – ENHANCING MAGNETOELECTRICITY IN $TbMnO_3$ & $DyMnO_3$ BY Fe^{3+} SUBSTITUTION

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Multiferroics, where spontaneous long-range magnetic and polar orderings coexist, represent an attractive class of compounds combining rich physics with potential for multifunctional applications. $TbMnO_3$ and $DyMnO_3$ are multiferroics compounds exhibiting magnetic ordering of Mn^{3+} ions, with a sinusoidal modulated collinear structure below T_N = 41 K and 39 K, respectively [1]. This magnetic structure changes to a cycloidal one below T_{lock} = 27 K and 18 K, respectively, which is accompanied by the emergence of spontaneous ferroelectric polarization [1,2], accordingly to the Dzyaloshinskii-Moriya model [3].

Usually, the magnetoelectric coupling has rather small magnitude. However, larger magnetoelectric effect can be found in frustrated magnetic materials. In rare-earth perovskite manganites, the magnetic frustration depends on the balance between the ferro and antiferromagnetic exchange interactions among nearest and next-nearest neighbors of Mn^{3+}. In order to tune this balance, we have studied the effect of Mn^{3+} substitution by Fe^{3+} on selected physical properties of $TbMn_{1-x}Fe_xO_3$ and $DyMn_{1-y}Fe_yO_3$, with x/y = 0 to 0.05. Since Fe^{3+} has the same ionic radius as Mn^{3+} and different magnetic moment and anisotropy, this substitution induces only small structural distortions but clearly changes the magnetic interactions, which play an important role on the magnetoelectric properties.

Though this substitution weakens the ferroelectricity, stable only up to x = 0.05 and y = 0.04, there is a strong increase of the magnetoelectric effect within this range. For the highest x/y, the polarization becomes so sensible to the magnetic field that it is possible to almost suppress it. The magnetoelectric (x/y, T) phase diagrams for these systems are proposed.

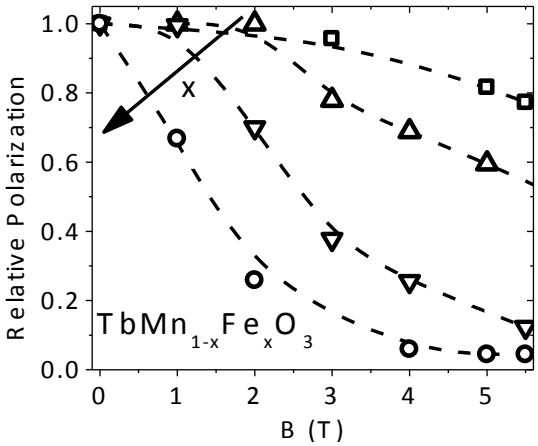

Figure: Relative polarization of $TbMn_{1-x}Fe_xO_3$, $0 \leq x \leq 0.05$, as a function of magnetic field.

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P2 - MULTI-STACKS OF EPITAXIAL GESN SELF-ASSEMBLED DOTS IN SI: STRUCTURAL ANALYSIS

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We report on the growth and structural and morphologic characterization of stacked layers of self-assembled GeSn dots grown on Si (100) substrates by molecular beam epitaxy at low substrate temperature T = 350 °C. Samples consist of layers (from 1 up to 10) of Ge0.96Sn0.04 self-assembled dots separated by Si spacer layers, 10 nm thick. Their structural analysis was performed based on transmission electron microscopy, atomic force microscopy and Raman scattering. We found that up to 4 stacks of dots could be grown with good dot layer homogeneity, making the GeSn dots interesting candidates for optoelectronic device applications.

P3 – BOUNDARY CONDITIONS FOR MAXWELL PERTURBATIONS IN KERR-ADS BLACK HOLES

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Perturbations of asymptotically Anti-de-Sitter (AdS) spacetimes are often considered by imposing field vanishing boundary conditions (BCs) at the AdS boundary. Such BCs, of Dirichlet-type, imply a vanishing energy flux at the boundary, but the converse is, generically, not true. Regarding AdS as a gravitational box, we consider vanishing energy flux (VEF) BCs as a more fundamental physical requirement and we show that these BCs can lead to a new branch of modes. As a concrete example, we consider Maxwell perturbations on Kerr-AdS black holes in the Teukolsky formalism, but our formulation applies also for other spin fields. Imposing VEF BCs, we find a set of two Robin BCs, even for Schwarzschild-AdS black holes. The Robin BCs on the Teukolsky variables can be used to study quasinormal modes, superradiant instabilities and vector clouds. As a first application, we consider here the quasinormal modes of Schwarzschild-AdS black holes. We find that one of the Robin BCs yields the quasinormal spectrum reported in the literature, while the other one unveils a new branch for the quasinormal spectrum.

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P4 – GD5SI1.3GE2.7 GIANT MAGNETOCALORIC THIN FILM: SYNTHESIS AND POST TREATMENTS

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Magnetic refrigeration (MR) based on the magnetocaloric effect (MCE) is one of the best alternatives to compete with vapor-compression technology [1]. This effect is largely enhanced in materials where there is a strong coupling between magnetic and lattice degrees of freedom. Despite the recent discovery of other compounds presenting GMCE, the $Gd_5(Si_xGe_{1-x})_4$ still are the family presenting the highest MCE for the broadest temperature interval [2]. The most interesting feature in this family of compounds is its multifuntionality, since, besides the GMCE, these compounds present other magnetic effects, such as: a colossal magnetostriction (up to 1.8%), a giant magnetoresistance (up to 20%) and also spontaneous generation of voltage [3]. Nowadays the MR research at micro/nano scale is still in its early stage with surprisingly few reports dedicated to the nanostructuring of the magnetocaloric materials in general and of the $Gd_5(Si_xGe_{1-x})_4$ compositions in particular.

Here we present a $Gd_5Si_{2.7}Ge_{1.3}$ thin film, produced by pulsed femtosecond laser deposition onto an oxidized Si substrate (SiO_2 on top of Si). SEM images and EDS spectra revealed a ~ 790 nm thick film with a granular-type morphology, with a distribution of particle sizes varying from few nanometers to 250 nm. In order to inspect the behavior of the as deposited and heat treated $Gd_5Si_{2.7}Ge_{1.3}$ thin film, a structural and magnetic characterization as a function of temperature and field was performed using Synchrotron X-ray diffraction and SQUID magnetometer. The results have shown that the as deposited thin film undergoes a magnetostructural transition from an [O(I), FM] (at low temperatures) to an [O(II), PM] state (at higher temperatures) at T_{MS}~ 190K. The changes in the lattice parameters are highly anisotropic: the ***a*** parameter is the one showing the most dramatic change - an increase of 1.20% (12000 p.p.m), whereas ***b*** decreased its value by just 0.03% and ***c*** also decreased by 0.40%. Such changes in the lattice parameters result in a giant expansion on the unit cell volume of 0.81% (8100 p.p.m), in accordance with the bulk counterpart results [4]. Both the thermal and field hysteresis observed in the M(T) and M(H) measured curves indicate a magnetic transition of first-order nature. Finally the magnetic entropy change was estimated from the magnetic isotherms, giving $\Delta Sm_{MAX}^{corrected} \sim 13.6$ J Kg^{-1} K^{-1} for $\Delta H = 5T$ at $T \sim 192K$, one of the highest values found in thin films so far, being only surpassed by the MnAs epitaxial layers [5].
Additionally, different thermal treatments were performed on Gd5Si1.3Ge2.7 thin film in order to evaluate their effect on the correlation between crystal structure, magnetic phase transition and magnetocaloric effect. For annealing temperatures higher than 773 K, the samples showed a typical paramagnetic behavior. On the other hand, annealing below 773 K promoted the suppression of the magnetostructural transition at 190 K, while the magnetic transition around 249 K was not affected. This magnetostructural transition extinction imparts reflected in the magnetocaloric behavior and

resulted in a drastic decrease in the entropy change peak value. Nevertheless, an increase in 25% of the T_C and an increase of ΔT_{FWHM} from 23 to 49 K (operation temperature interval, ΔT).
This suggests that, as in the bulk case, the magnetostructural transition and consequently the interesting magnetic responses can be tuned by heat treatments. Finally, with this work we hope to open up new avenues in the development of innovative nano/microrefrigerators and thermal/magnetic/temperature sensors and actuators (due to strain) using this multifunctional thin film.

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P5 – STRUCTURAL AND ELECTRONIC CHARACTERIZATION OF GA2O3 SAMPLES USING PERTURBED ANGULAR CORRELATIONS

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The importance of functional nanomaterials, such as nanowires (NW) and thin-films, in science and technology has been increasing exponentially over the years. Due to their small size and increasing surface-to-volume ratio, new (predictable or unsuspected) properties arise with potential applications in industry, such as the miniaturization of devices. However, the smaller the devices get, the more their properties depend on the scale factor, geometry, symmetry and localized interactions of defects and impurities, which are no longer diluted in the constituent materials. Moreover, it is known that the atomic positions and charge valences severely influence the properties of nanomaterials, since they depend on the local character of the electron density. In particular for NW, their integration in devices require the control of electrical properties and optical homogeneity, which is not systemically achieved.

Since doping during growth is mainly ruled by thermodynamic reactions, a dramatical change of morphology, density, alignment and homogeneity can occur during the process. Alternatively, ion implantation proves to be a versatile doping technique. However, it has some inherent and undesirable features regarding the effects of the implantation damage, which needs to be removed, generally by thermal annealing, in order to activate the dopants.

In this context, we have studied NW and bulk crystals of the wide gap oxide Ga2O3 using the γ-γ Perturbed Angular Correlation technique (γ-γ PAC), which allows studying the interactions between implanted probes and point-like defects and impurities / dopants, revealing, particularly, their position at the atomic scale.

Furthermore, we combine γ-γ PAC with e-γ PAC providing, for the first time, a dynamic picture of locally induced electronic excitations and subsequent recombination phenomena into the probe's neighborhood.

The experimental results are later compared with density functional theory simulations of different electronic model configurations.

P6 - STORM SURGE CHANGES ALONG THE COAST OF MOZAMBIQUE FOR FUTURE CLIMATE SCENARIOS

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The combined effects of atmospheric pressure and wind forcing on sea level, produces oscillations known as storm surges. Due to its geographical localization, Mozambique is affected by tropical cyclones which are formed in the Indian Ocean, most of time causing storm surges along the coast. The sea level oscillations respond continuously to astronomical, oceanography and atmospheric pressure and near-surface winds interactions over a wide range of periods [1]. When a low atmospheric pressure system coincides with a high water spring tide, extreme sea level can be expected representing potential disaster condition for the population and infrastructures along the coast. The increase of the intensity and frequency of tropical cyclone occurrence can have effects in the behaviour of storm surge, regarding its generation, propagation and dissipation. Therefore, knowledge about the storm surge behaviour is of a greater practical importance.

This study uses an analytical model to estimate sea level, particularly extreme sea level (storm surges) to be used with pressure and wind generated by climate models which consider climate changes. Here, we are mainly concerned in the validation of the analytical model for Mozambique, concentrating on the influence of changing storm climate scenarios on surges. It aims to provide an overview of the relevant mechanisms and to describe approaches by means of which the impact of future climate change on the storm surge can be understood and quantified.

To achieve this we force the model with pressure and wind data recorded to generate sea level time series which are later compared against sea level gauge records. The tide gauge records database of Mozambique is not continuous since it has many missing data and is limited for only some tide gauges. The station of Maputo is the only one with nearly completed data of about 13 years. Due to this scarcity of tide gauge data availability we have used 30 years data sets of sea level pressure, wind speed and direction for Maputo to proceed with this study.

Hourly sea level records, from the selected tide gauge station and hourly averages of the atmospheric pressure and wind, at the selected meteorological station in Mozambique were used. Oscillations with patterns of the astronomical tide were extracted from the tide gauge records using the Thompson low-pass filter [2]. The inverted barometric effect, which is the response of sea level to change in atmospheric pressure, according to [3], was used with sea level pressure data to obtain the storm surge level. Moreover the wind setup effects, which was decomposed in an onshore and alongshore components, were also taken into account. Statistical techniques were applied to analyse the data and results.

Approaches and methodologies are described and the results and remaining problems discussed. For a given future climate scenarios, the storm surge changes effects can be estimated with some confidence. The analysis of the distribution curves of relative and cumulative frequencies, allowed the definition of three classes of storm surges namely: significant, very significant and highly significant for the percentile that appears above 95, 99 and 99.9 respectively. The model was validated with very encouraging result, showing statistically a good approximation between the storm surge height obtained from the tide gauge and that from the sea level pressure and wind.

Next, the analytical model was used with atmospheric and wind data generated by climate change simulations, to evaluate changes in the statistical properties of storm surges for future climate change scenarios along the Mozambican coast. The data from present climatological period, from 1986-2005, were computed by using the analytical model. The obtained results, for the present

period, were compared with the results obtained from the computed future climatological data scenarios for analyse. The results suggest some enhancement of extreme surge elevations.

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P7 – TBA

Carlos Amorim

P8 – HYDROSTATIC PRESSURE IN $CDCR_2S_4$: EFFECT ON LOCAL MAGNETIC CLUSTERS

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Modern society has a critical demand for materials with multifunctional physical properties. They have become an integrating part of many applications, especially those that display a strong coupling between magnetic and polar degrees of freedom, the so-called magnetoelectrics. These materials, promise a paradigm-shift on technologies for magnetic data storage, high-frequency magnetic devices, spintronics, and micro-electromechanical systems.[1,2] The clear determination of the complex interplay between electronic, magnetic, and lattice degrees of freedom usually is the solution to explain the mechanisms behind the exhibited physical properties.[3]
Among the numerous materials with an intimate coupling between all the degrees of freedom are the group of ACr_2X_4 spinels (A= Zn, Cd, Hg; X= O, S, Se).[4]
The tight alliance between structural, vibrational, magnetic, and charge degrees of freedom, makes the variation of lattice by external pressure an appealing route for studying the physical properties of these materials. Measuring the pressure dependence of the magnetic transition temperature may assist in getting new insights about the ordering mechanism and its relationship to the electronic structure (*e.g.* disordered local moments coupled with frustration mechanisms). In fact, external pressures are known to control bond lengths and bond angles as well as the degree of overlap between electron orbitals in solids. A shift and/or split of the energy levels and changes in exchange interactions strength in response to pressure variations can also occur. External pressures when compared to the chemical pressure, is a cleaner tool to avoid substitutional induced disorder and spurious effects due to different chemical compositions. Several studies reported structural and electronic transitions under pressure for various Cr-based spinels. Nevertheless, studies on the relaxor-like temperature zone are not yet reported.
Our results of dc magnetisation measurements under hydrostatic pressure for the $CdCr_2S_4$ spinel compound will be presented. The measurements have been performed on a polycrystalline sample under different applied hydrostatic pressures (up to 14 kbar) in the 30-220 K temperature range (with 3 Oe applied magnetic field). The anomalous behaviour of the magnetic susceptibility indicates that the local-cluster-phase that exists at low applied magnetic fields[5] persists with applied pressures up to 14 kbar and has a dependency on the applied pressure. This effect will be presented and discussed in the framework of the complex competition between the electric, magnetic, and lattice interactions.

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P9 – OPTICAL FIBER SENSORS FOR EXTREME ENVIRONMENTS

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Abstract: Optical fiber sensors, due to their inherent characteristics, are suitable for many different applications, such as in sensing of physical, chemical and biological parameters. Particularly, the measurement of temperature, that can be higher than 900 ºC, is very important in many industries, and these structures can be an alternative to conventional sensors. In this work, three different configurations, based on Fabry-Perot cavities are described. The first, obtained by fusion splicing a short section of a hollow core ring photonic crystal fiber to single mode fiber, was subjected to temperatures up to 500 ºC and a nonlinear response was obtained. The maximum sensitivity for this cavity was of ~7.5 pm/ºC, in a range between 250 and 500 ºC [1]. The second structure is based on a diaphragm-free hollow-core silica tube. In this case, the temperature range was of 950 ºC and a maximum sensitivity of 8.1 pm/ºC was achieved [2]. Finally, a new hollow core silica tube design, more robust than the previous one, is proposed for the measurement of strain at high temperatures. The Fabry-Perot cavity was obtained by splicing this silica tube between two sections of single mode fiber. The temperature sensitivity was in this case lower than 1 pm/ºC. Thus, the cross-sensitivity of this parameter with strain was expected to be low. However, at temperatures between 750 ºC and 900 ºC, there was a change in the strain response. The influence of thermal annealing was investigated in order to improve the sensing head response [3].

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P10 – CUPROUS OXIDE AS A PROMISING SOLAR WATER SPLITTING PHOTOCATHODE – SOLVING THE STABILITY TECHNOLOGICAL PROBLEMS

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The possibility of producing chemical fuels from solar energy has become increasingly attractive as sustainable, clean and efficient solution to our ever-growing energy demands. Photoelectrochemical (PEC) water splitting has been much improved since the first reports by Fujishima and Honda[1] and nowadays researchers aim to find inexpensive, efficient and stable materials to perform PEC water splitting. Cuprous oxide, Cu_2O, is very interesting since it has a 2 eV bandgap with favorable energy band positions, good conductivity and it can be processed with low-cost methods such as electrodeposition.[2]

Cu_2O has been proven an efficient material with current densities up to 7.5 mA cm^{-2} under AM 1.5 illumination and biased at 0 V_{RHE}[3] nevertheless it is not stable in contact with the electrolyte. The best-reported approaches to extend its stability refer less than one hour of photocurrent with a variation loss < 10 %. In this work, we present three different approaches to enhance the Cu_2O stability up to 60 h with only 10 % loss. A new catalyst was implemented that offers great Faradaic efficiency as well as extends the stability of the device up to 8 h (chopping conditions).[3] New over layers were also tested together with heat treatments that protect the semiconductor surface from the electrolyte more efficiently. These overlayers deposited by atomic layer deposition (ALD) offer a solid and homogeneous cover to the semiconductor. These new results open a much needed window to make this semiconductor a strong competitor for solar water splitting applications.

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