ICTP-ICO-MCTP College on

April 28 - May 9 2014

Tuxtla Gutiérrez, Chiapas, Mexico

ICTP-ICO-MCTP College on Optics and Energy

Short courses

C1 – Photonics for solar energy: Fundamentals of photovoltaics

C2 – Lighting: New energy saving sources

C3 – Solar energy harvesting

C4 – Power generation diagnostic with optical spectroscopy techniques

C5 – Solar energy storage

C6 - **Principles of organic solar cells and current research tendencies to increase their efficiency**

C7 - Novel photovoltaic materials and light harvesting structures

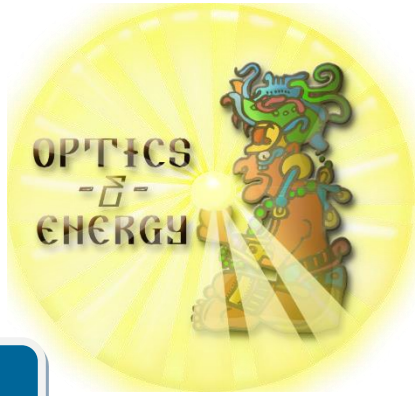
C8 - Optical design and novel technologies for high performance solar concentrators

C9 - Characterization of solar cell systems

C10 - **Smart grid applications: optical fiber communication and sensors.**

C11 – **Nanomaterials for the latest generation of solar cells**

C12 – Metrology and Regulation for solid state lighting



Workshops

W1 – Efficient lighting for saving energy

W2 – Measuring the local solar spectrum for efficient solar energy harvesting with low cost

W3 – Characterization of solar cell systems

ICTP-ICO-MCTP College on Optics and Energy

First Week: April 28th – May 2nd, 2014

	Monday 28	Tuesday 29	Wednesday 30	Thursday 1	Friday 2
8:30 – 9:00	Registration				
9:00 –10:00	C1 - M. L. Calvo	C2 – I. Moreno	C1 - M. L. Calvo	C6 – O. Barbosa	
10:00 – 11:00	Opening Ceremony		C4 - E. Golinelli		
11:00 – 11:30	Visit to MCTP	Coffee break			
11:30– 12:30		C4 – E. Golinelli	C4 - E. Golinelli	C4 - E. Golinelli	C5 A. Fernández
12:30 – 2:00	Lunch				
2:00 – 4:00	C2 – I. Moreno	W1 I. Moreno / W2 O. Ormachea	W1 I. Moreno / W2 O. Ormachea	C5 A. Fernández	C5 A. Fernández
4:00 – 4:30	Coffee break				
4:30 – 5:30	C3 – O. Ormachea	W1 I. Moreno / W2 O. Ormachea	W1 I. Moreno / W2 O. Ormachea	Poster session	C6 O. Barbosa

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Second Week: May 5th – 9th, 2014

	Monday 5	Tuesday 6	Wednesday 7	Thursday 8	Friday 9
9:00 – 11:00	C10- A.Guzman	C8 – J. C. Miñano	C7 – R. Menon	C8 – J. C. Miñano	C12 –E. Rosas
11:00 – 11:30	Coffee break				
11:30 – 12:30	C8 – J. C. Miñano	C7 – R. Menon	C11 – E. de la Rosa		A. Morales-Acevedo
12:30 – 2:00	Lunch				
2:00 – 3:00	C9 – M. Torres-Cisneros	C11 – E. de la Rosa	W3 – M. Torres-Cisneros	C7 – R. Menon	A. Morales-Acevedo
3:00 – 4:00				C12 –E. Rosas	A.Varela
4:00 – 4:30	Coffee break				
4:30 – 5:30	C7- R. Menon	Poster session	W3 – M. Torres-Cisneros	Panel: Optics & Energy in Latin America	Closing ceremony

Panel: "Optics and Energy in Latin America."

Panelists: R. Menon, J. C. Miñano, M. Torres-Cisneros, E. de la Rosa, E. Rosas, A. Morales-Acevedo, A. Varela.
Moderator: A. Guzmán

Invited talks:

Arturo Morales-Acevedo, CINVESTAV, Mexico: "Photovoltaic systems to help meet the expected electrical energy demand growth in Latin America: The Mexican case."
Alberto Varela, Saint Thomas University, FL, USA: "Domestic and International Implications of STU's Solar Project"

CONTRIBUTED PAPERS

Titanium oxide:fullerene composite films as electron collector layer in organic solar cells and the use of an easy-deposition cathode

Dr. Enrique Pérez-Gutiérrez

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ABSTRACT

Here is reported the use of a titanium oxide:fullerene (TiOx:PC71BM) composite film as electron collector layer in organic photovoltaic devices (OPV cells). OPV cells were fabricated under the bulk heterojunction architecture: the active layer was a blend of either the photoconductor polymer MEH-PPV or P3HT with the fullerene derivative PC71BM. As cathode the eutectic alloy of Bi, In and Sn, known as Field´s metal, was used. The melting point of this alloy is above 62 °C, which makes it suitable for a vacuum-free deposition process and easy and fast device test. Cell fabrication and testing were carried out at normal room conditions. For OPV cells based on MEH-PPV, the composite thin electron collector layer improved the power conversion efficiency from 1.12 % to 2.07 %, thus the efficiency increase was about 85 %. Meanwhile, for devices based on P3HT the use of the composite film improved the photocurrent in almost 1 mA/cm^2 and the efficiency slightly increase from 2.48 % to 2.68 %.

Characterization of Sol-Gel deposited TiO 2:Ag thin films

Erick Espinosa–Villatoro[1], Roger C. Palomera[1], G. Pérez-Hernández[2], L.Rojas-Blanco[2], Jesús Muñiz–Soria[1], Erik R. Morales[2]*

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ABSTRACT

TiO 2 :Ag thin films with different concentrations of Ag were obtained by adding appropriate amounts (0, 0.2, 0.6, 0.8, 1 and 4 wt %) of a silver salt in the precursor solution. The materials properties were studied using the techniques X-ray, and UV-VIS transmittance spectroscopy. The films exhibited anatase phase after annealing above 500 o C. The band gap of the as deposited film was 3.3 eV, which lowered significantly due to the incorporation of Ag. The room temperature electrical resistivity showed a dependence on the amount of Ag incorporated. The stability of the TiO 2 :Ag thin films in aqueous medium was studied by analyzing the corrosion potential and current.

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Optical feedback interferometry sensor for peristaltic pump flow measurements

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ABSTRACT

Optical feedback interferometry (OFI) is a compact interferometric method where the reference and probe electromagnetic waves mix in a laser cavity. The probe electromagnetic wave re-enters the laser cavity after being back-scattered by the moving target, thus due to the Doppler effect or optical path changes, it induces interferences that affect directly the laser's power and wavelength. This phenomenon is known as self-mixing effect and occurs mainly in lasers with high gain media. Due to its one beam configuration, it is a self-aligned technique that requires minimum optical components. Also, taking advantages from the light amplification in the laser cavity where the interferences take place, it is sensitive to very low levels of back-scattered optical power. While OFI sensors have primarily been developed for solid target in mechatronics and avionics, they have recently been introduced successfully for milli and microfluidics applications as an alternative optofluidic implementation to other more expensive and bulky techniques. We describe the basics of self-mixing effect in semiconductor lasers and present a sensor capable to measure fluid flow. A simple signal processing associated to the sensor measurements is proposed. We validate experimentally the sensor flow measurements by reconstructing the period of a peristaltic pump using the signal of the photodiode included in the laser module.

Interface for real-time communication between a MEMS ISSD5 Solar Sensor and Matlab/Simulink®

Arturo Díaz-Ponce, Rubén A. Garrido-Moctezuma and Arturo Morales-Acevedo

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ABSTRACT

At present, high concentration photovoltaic modules, based on tandem cells, reach efficiencies up to 40%, exceeding the 15% efficiency of conventional modules. For concentration levels of the order of 400 X or more, a very accurate tracking of the solar path is necessary, so that the tracking error is less than 0.1° in order to make the generated electrical energy profitable. The solar sensor ISSD5 of Solar MEMS Technologies S.L. allows a tracking error less than 0.1°, increasing the uptake of solar radiation for the photovoltaic module. In this paper, a communication interface between Matlab/Simulink® and the ISSD5 sensor is presented for using it in real-time through the QUARC® software. This sensor is the most accurate and reliable on the market now. The sensor can be connected to a computer using the "Solar MEMS ISSX v1.30b" program using the Modbus RTU protocol. With the development of the communication interface several advantages are obtained: Tracking error less than 0.1°, current consumption of only 33 mA, knowledge of the level of direct radiation and of the sensor temperature, in addition to being designed for working in open air. Moreover, with this communication interface we can take advantage of Matlab® Simulink® to perform the tracking for concentrating the sun's radiation on the photovoltaic module efficiently. The results obtained with the communication interface are shown, and then the control system design using this new type of sensor is presented.

Luminescence of Europium divalent in KBr single crystal under high pressure

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ABSTRACT

Pressure-induced structure change in the KBr doped with europium ions has been studied by optical spectroscopy analysis. The crystal structure of KBr is of NaCl type or B1 phase, when the crystal is doped with europium divalent ions, they are introduced sustitutionally in the lattice in the potassium sites, preserving the B1 phase. The europium emission depends on crystalline environment in KBr matrix; the emission peak is at 420 nm for samples quenched with 100 ppm to 500 ppm of europium ions. When the samples are under high pressure in the DAC (diamond anvil Cell) shows the emission shifted toward higher wavelength at ~ 434 nm, but its intensity decreases and when the pressure induce the phase transitions to CsCl-type or B2 phase at ~1.7 GPa and the luminescence is extinguished at ~ 3 GPa. This behavior is due to a new crystal structure, where the europium ion is in the center of the cubic cell and the bromides in the corners.

Keywords: Luminescence, extinction, pressure.

References:
[1] E. V. Mejía-Uriarte *et al*. **"**Studies of the thermal dissolution process of the Suzuki phase of the Eu^{2+} ion in KBr single crystals by analysis of the photoacoustic signals" *J. Phys.: Condens. Matter* **15** No. 40, 2003, p.p 6889-6898.
[2] Pedrero N. *et al*. "Analysis of Optical Behavior of Eu 2+ ions in CsCl Crystals", *Physica Status Solidi B*, vol 203, No. 2, 1997, p.p. 591-98.

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InGaN-based heterostructures and Solar Concentrators for High-efficiency Photovoltaic Cells.

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ABSTRACT

The recent discovery and understanding of inexpensive routes to grow high quality InGaN nano– and micro–columns could lead to the fabrication of high efficiency optoelectronic devices, such as solar cells. The use of nanostructures in photovoltaics offers the potential for high efficiency conversion and the possibility to reach the theoretical maximum by tailoring the material properties via multi-junction structures with different bandgap controlled by the concentration of the components. In this research our approach will be to stack p-n junctions of $In_xGa_{1-x}N$ for various In compositions that will absorb light across the full range of the visible solar spectrum. The p-n junctions will be interconnected via tunnel junction where the electric current generated at each diode will be matched across the full multijunction. The great challenge of this goal is the growth of diodes with In-composition ranging from x = 0 to x = 0.4. We are using a high-growth-rate chemical vapor deposition technique with gallium-indium metallic alloys, ammonium chloride and ultra-high purity ammonia as source materials and ultra-high purity nitrogen as carrier gas in a three–zone horizontal quartz tube reactor to investigate the growth of the III-nitrides. Though this research it is expect to reach substantial advances in the synthesis of semiconductor heterostructures to produce higher efficiency, long lasting, photovoltaic cells.

A comparative evaluation of MPPT algorithms by means of MATLAB Simulink

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ABSTRACT

Development of inverters for photovoltaic systems connected to the grid requires the optimum operation of the photovoltaic array in order to obtain the maximum power to be injected into the grid. Then, the PV modules must be operating continuously at the maximum power point. This is usually achieved by means of control systems programmed with what are named “maximum power tracking (MPPT) algorithms”. We have developed a platform, based on MATLAB Simulink, to simulate the behavior of a full PV system, including the performance of different MPPT algorithms, so that we can improve them before the circuits are built. This process implies time and expense savings together with an optimum design of the devices to be connected to the PV array. Using the above platform we have studied the behavior of a MPPT controller connected to a DC-DC converter which varies the apparent charge of the PV array so that it always operates at its maximum power point, accordingly to three MPPT algorithms: The Hill-climbing (HC) and the Incremental Conductance (IC), both with a constant control step, and also the adaptive step Incremental conductance (AIC) algorithm. It will be shown that the latter is the best performing algorithm under transient solar irradiation conditions. We shall describe the PV modules model and the behavioral DC-DC converter model used in the SIMULINK platform. It is shown that power tracking efficiencies between 95% and 97% can be achieved using optimum parameters. In the near future we expect to develop a new improved MPPT algorithm with a power tracking efficiency above 99%.

Micro-fotoluminiscencia de esporas y estructuras intraradicales de hongos micorrícicos arbusculares.

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ABSTRACT

En investigaciones realizadas en años recientes se ha reportado que algunas especies de hongos micorrícicos arbusculares (MA) emiten luz visible cuando son excitadas bajo radiación ultravioleta y visible (A. Pérez et al. 2009, B. Dreyer et al. 2006, B. Dreyer y A. Morte. 2009). El empleo de la fotoluminiscencia ya ha sido propuesto para la observación y la cuantificación de la colonización MA, como alternativa a métodos que usan colorantes vitales y no vitales y sustancias corrosivas (Gange et al. 1999, B. Dreyer y A. Morte. 2009). Además se ha reportado que el uso de fotoluminiscencia muestra niveles de colonización más altos y más consistentes que los demás métodos (Gange et al. 1999). En el presente trabajo se muestran resultados obtenidos de fotoluminiscencia de esporas del hongo MA Glomus mosseae y de estructuras producidas por este hongo en raíces de Sorghum bicolore por micro-fotoluminiscencia (Micro-PL). Las esporas fueron preparadas utilizando una modificación del método de tamizado húmedo y decantación (J. W. Gerdemann y T. H. Nicolson. 1963). Las raíces fueron cortadas en segmentos longitudinales, unas fueron colocadas inmediatamente al microscopio y otras pasaron por un proceso de digestión en KOH caliente por 1 h. El montaje experimental para las medidas de Micro-PL consiste de un microscopio de epifluorescencia (Ceti Topic T) acoplado a un espectrógrafo (Ocean Optics USB4000) mediante una fibra óptica. Las muestras fueron excitadas con una lámpara de vapor de mercurio, seleccionando principalmente la línea de emisión a 435 nm con un filtro pasa banda. El arreglo experimental permite registrar espectros de fotoluminiscencia en el rango de 530 a 660 nm, con una resolución aproximada de 10 nm. La emisión de las estructuras intra y extra radicales son muy similares, presentando máximos alrededor de los 550 nm. Esta información podría ser empleada en el futuro para el diseño de sensores para medir niveles de colonización micorrícica de forma rápida y mínimamente invasiva.

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Contribution of the different separations of glomalin extracts to the photoluminescence of arbuscular mycorrhizal (AM) fungi spores

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ABSTRACT

Previous investigations taking place on the last years have reported some species of AM fungi emit light when excited with UV and visible light (A. Pérez et al. 2009, B. Dreyer et al. 2006, B. Dreyer y A. Morte. 2009). This work shows results for emission of extracts of glomalin and AM fungi spores, using photoluminescence (PL) techniques and micro-photoluminescence (micro-PL). The glomalin samples were obtained using the easily-extractable glomalin protocol (Wright, S. y F. Upadhyaya. 1996) and an alternative method to obtain glomalin (Driver et al. 2004), the spores were prepared using a modification of the wet sifting and decanting method (J. W. Gerdemann y T. H. Nicolson. 1963). The experimental design for the Micro-PL measurements consists of a epifluorescence microscope (Ceti Topic T) coupled to a spectrograph by means of a optic fiber; the PL design, consists on a mercury lamp, band-filters, and lenses arrangement, then the emitted signal is transmitted by means of optic fiber to an spectrograph (Ocean Optics USB4000). The working resolution was around 10nm. Both measurements show luminescence spectra within 400 nm – 680 nm. The photoluminescence of the glomalin is really similar to the spores' emission, but not to the emission of the separations. Therefore can be said the glomalin contributes to the MA fungi emission. On the other hand, is not discarded to associate contributions to the MA fungi emission to the different components on the fungi's cellular wall and cytoplasm as has been reported (J. Pontón. 2008, M. Shaun et al. 2006, R. Balestrini y P. Bofante. 2005).

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Micro LIBS. Composition of the metallic elements of the banner of the 1893 El Gavilán Chorale Society

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ABSTRACT

The banner of the El Gavilán Chorale Society kept at the National Museum of Music identified the first Cuban chorale society founded in 1893. It is a textile piece with metallic inlays and embroideries. The delicate nature of the constituent materials and the adverse environment to which it was exposed caused its advanced state of decay.

Using a Laser Induced Breakdown Spectroscopy (LIBS) prototype with coupled microscope the elementary composition of the metallic accessories was investigated, in order to diagnose the deterioration degree and to make a correct proposal for the artwork restoration. Experimental results evidenced that the threads and spangles are of different metallic alloys, therefore the cleansing treatments should differ.

The results obtained by using LIBS were compared with those obtained by using EDS/SEM and there were coincidences. As LIBS is a portable technique that can be applied “in situ” with minimum damage to pieces and minimal energy consumption it is advantageous to use over other techniques.

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