4th AFRICAN LASER CENTRE STUDENT WORKSHOP

9-13 November 2011
Zevenwacht Wine Estate
Stellenbosch, South Africa

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ZEVENWACHT WINE ESTATE

Zevenwacht Wine Farm is situated on the Stellenbosch Wine Route. It has strong viticultural roots penetrating deep into the historic past of South Africa. The land, known as Langverwacht (Long Awaited), was granted to Jean Le Roux of Normandy, one of the French Hugenot wine farmers who fled France in 1688. Peter de Waal, owner from 1798, extended the vineyards through the purchase of the neighboring property, Zevenfontein (Seven Springs). Divided when de Waal sold Langerwacht to his son Adrian, the two farms again became a single property in 1978, united under the new name of Zevenwacht. Interpreted perhaps as Seven Expectations, the new name exemplifies the abundant delights that await visitors to the Zevenwacht Wine Farm.

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GENERAL INFORMATION

- The Conference proceedings will take place in the Auditorium which is part of the Country Inn.

- If you plan to use the data projector, it is your responsibility to ensure that your Powerpoint presentation has been successfully downloaded to the computer in the lecture room. **Please do so a session in advance**. A technical assistant will be available to help you.

- Poster presentations will be housed just outside the auditorium according to your abstract number on the allocated space. Velcro attachments will be provided to mount the posters. Please mount your poster on Thursday morning.

- Please check the daily program where the meals will be served. Breakfast in the Restaurant, Lunch at the Auditorium, Dinner in the Lapa or the Restaurant.

- The Opening Dinner will be served at the Conference Venue on Thursday evening.

- Registration will take place upon arrival, when your accommodation will be allocated as well.

- Transport will be provided between Vineyard Cottages, Restaurant and Auditorium.

INVITED SPEAKERS

Prof. Andrea Galterossa

Polarization of light in optical communications: an impairment or a resource?

Andrea Galtarossa was born in Padova in 1958. He received the degree in Electronic Engineering from the University of Padova in 1984. Afterwards he was a recipient of a one-year fellowship by Telettra S.p.A. to work on the design of multilayer dielectric filters for WDM devices. In 1986 he joined SAIFO, a new company aimed to support the diffusion of optical technologies and to organize research and teaching laboratory in SME's. Finally , he joined the Department of Information Engineering (DEI), University of Padova, as assistant professor in Electromagnetic Fields (1990), associate professor in Microwave (1998) and full professor in Microwave (2006).

His research activity is dedicated to propagation effects in optical devices, in particular single-mode optical fibers. Mainly, the research is carried out by means of analytical and numerical methods followed, whenever possible, by experimental validations. The main topics are birefringence effects in step-index single-mode fibers; measurement of polarization mode dispersion (PMD) in fibers and optical components; PMD effects in high bit rate systems; distributed measurements of birefringence in optical fibers by means of POTDR techniques; PMD mitigation techniques; design of ultra-low-PMD spun fibers; polarization effects in standard and special fibers.

Dr James Uhomoibhi

Laser Light scattering detection and measurements of micro-rheological structures and dynamics of complex systems (foams and its ageing) and measurement of uniform translational motion.

Dr James Uhomoibhi FBCS CITP, CPhys, MInstP, MIET, FHEA, is Laser Physicist with specialisation in the generation of soft x-ray lasers from high-temperature plasmas. He has extensive research experience in the areas of multimedia and computing, computational physics, low temperature plasmas, surface science and rheology of complex fluids. He is Chair of the British Computer Society (BCS) E-Learning Specialist Group, Faculty E-Learning Coordinator at the University of Ulster, past Chair and current Education and Professional Development Adviser of the BCS Belfast Branch; He is a member of the TREE (Teaching and Research in Engineering in Europe), EUGENE (European Global ENgineering Education) Thematic Networks and also a member of the European EUNIS E-Learning Task Force (ELTF), where he heads the E-Learning Future and Visions Group. His current research area is Laser Engineering Applications and Photonics (LEAP), which focuses on the studies of the structures and dynamics of complex systems using novel laser light scattering and allied diagnostic techniques.

Prof Mourad Zghal

Supercontinuum generation in photonic crystal fibers

Mourad Zghal received his Ph.D in electrical engineering from the National Engineering School of Tunis (ENIT-Tunis El-Manar Univ.) in 2000. He is actually associate professor at the Engineering School of Communication of Tunis (Sup'Com-Univ. of Carthage). Dr. Zghal founded and is in charge of the "new photonic devices for optical network'' group in Sup'Com. He has published more than 100 papers in areas that include integrated nonlinear optical devices, design and characterization of photonic crystal fibers, and nonlinear propagation of ultrashort laser pulses. He also served at numerous program or steering committee of international scientific conferences. In addition to his research activities, Dr. Zghal has been extremely active in promoting photonics in Tunisia and Africa. He is the founder and treasurer of the Optical Society of Tunisia, a member of the ICO family. He also founded the African Laser Center, an organization encouraging exchange of researchers and students across Africa. Dr. Zghal has been awarded the 2008 ICO/ICTP Gallieno Denardo prize for "his original work in the development of numerical modelling techniques for photonic crystal fibres, and for his active commitment aimed at the diffusion of research in optics in Africa". Dr. Zghal is senior member of OSA and SPIE.

PROGRAM

Wednesday, 9 November			
10:00 – 17:00	Arrive at Venue		
18:30 – 22:00	Opening Proceedings & Dinner (Auditorium)		
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09:00 – 09:20	Analysis of degradation of CPV cells using Laser Beam Induced Current measurements.	W. Okullo, M. K. Munji, R.D. Schultz, E. E. van Dyk and F. J. Vorster	T1
09:20 – 09:40	The anticancer potential of Artemisia afra.	L Spies, TC Koekemoer, AA Sowemimo, M Van de Venter	T2
09:40 – 10:00	Beam-shaping using a laser incorporating an intracavity spatial light modulator.	L. Burger, I. Litvin and A. Forbes	T3
10:00 – 10:20	High Resolution Beams.	S. Ngcobo, A. Forbes and K. Ait-Amear	T4
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	its ageing) and measurement of uniform translational motion.		
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11:50 – 12:10	Exciton dynamics in tetracene single crystals studied using femtosecond nonlinear spectroscopy.	Z. Birech, D. C. J Van der Westhuizen and H. Schwoerer	T6
12:10 – 12:30	Investigating Si/SiO_2 interfaces using EFISH technique.	W.I. Ndebeka, G Nyamuda, P. Neethling, C.M. Steenkamp, H. Stafast and E.G. Rohwer	T7
12:30 – 12:50	Design and Development of an All-Optical Active Q-switched Erbium Doped Fibre Ring Laser.	J.J.M Kaboko and Rodolfo M. Manuel	T8
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Session 3	***Chair: Ernest van Dyk***		
			Abstract
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14:20 – 14:40	Use of Raman spectroscopy to study fatigue type processes in polycrystalline diamond (PCD).	M Vhareta, R.M. Erasmus and J.D. Comins	T10
14:40 – 15:00	Surface modification of TiC reinforced 304L austenitic and 2507 duplex stainless steel matrix composite fabricated by laser melt injection.	B.A. Obadele, Z.H. Masuku and P.A. Olubambi	T11

15:00 – 15:20	Assessment of levels of trace metals in sediments using laser-induced breakdown spectroscopy.	K.N. Mekonnen, A.A. Ambushe, B.S. Chandravanshi, M. Redi-Abshiro, A du Plessis and R.I. McCrindle	T12
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15:50 – 17:00	Tea & Poster Session	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10	
17:00 – 18:30	Wine Tasting		
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09:00 – 09:20	The effect of polarization mode dispersion on fibre optic parametric amplifiers.	D. W. Waswa, E. Rotich and A. W. R. Leitch	T13
09:20 – 09:40	Reflectometric Measurements of Polarization Mode Dispersion in Optical Fibers.	S. K. Fosuhene, D.Waswa, T.B.Gibbon and A.W. Leitch	T14
09:40 – 10:00	Assessment of DNA Damage after Photodynamic therapy (PDT) using a Metallophthalocyanine Photosensitizer.	A. El-Hussein , M. Harith and H. Abrahamse	T15
10:00 – 10:20	Cell death in Human Breast Cancer Cells using Zinc Phthalocyanine and Laser Irradiation.	I.M.Tynga, N.N. Houreld and H. Abrahamse	T16
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Session 6	***Chair: Erich Rohwer***		
			Abstract
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Session 7	***Chair: Erich Rohwer***		
			Abstract
14:00 – 15:00	Attosecond Physics.	Prof Heinrich Schwoerer	ST2
15:00 – 16:0 0	"Optical fiber: birefringence properties and measurements and application of innovative sensors."	Prof Andrew Leitch	ST3
16:00 – 16:20	Tea		
16:20 – 17:20	Optical sensors: new solutions for advanced applications.	Prof Andrea Galtarossa	ST4
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			Abstract
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09:10 – 10:10	Laser interferometry: Ultimate limit determination, configurations, vibrometry, distance and angle parameter measurements, and profilometry.	Dr James Uhomoibhi	ST6
10:10– 10:30	Tea		
10:30 – 11:30	Ultrafast electron diffraction: Exciting developments and applications.	Dr Günther Kassier	ST7
11:30 – 12:30	Basics in steady state and time resolved Spectroscopy.	Dr Christian Litwinsky	ST8
12:30 -12:40	Conclusion and Awards Ceremony		
12:40 – 19:00	Lunch (Auditorium) & Excursion		
19:30 – 22:00	Dinner (Manor House Restaurant)		

Sunday, 13 November

07:00 – 08:00	Breakfast (Manor House Restaurant)
08:30 – 12:00	Departure for Airport

INVITED ORAL ABSTRACTS

INV 01

Polarization of light in optical communications: an impairment or a resource?

Prof. Andrea Galterossa
Department of Information Engineering, University of PADOVA, Italy

The main problem related to transmission of polarized optical signals in standard single-mode fibers is that fiber birefringence causes polarization dependent dispersion. Pioneering research activities on optical communication tried to overcome this limitation by using two different approaches: coherent detection in conjunction with polarization maintained fibers or by producing low birefringent fibers. The latter solution has been considered the winner up to now, since large improvements in fiber drawing technology allow production of excellent fibers. However, the continuous increase in the bit rate moving toward 100 Gbit/s and beyond, brings the problem related to polarization mode dispersion to the forefront. New solutions are spun fibers and dispersion compensators, on one side, and new modulation formats, on the other side. All these solutions will be considered and discussed during the presentation.

INV 02

Laser Light scattering detection and measurements of micro-rheological structures and dynamics of complex systems (foams and its ageing) and measurement of uniform translational motion

Dr James Uhomoibhi
Faculty of Computing & Engineering, University of Ulster, Northern Ireland, UK

Studies of complex systems such as optically dense media such as colloids and foams have always been faced with difficulties yet understanding the structure and dynamics of such systems are matters of considerable interest both from the point of view of science and technology advancements as well as industrial applications. Analyses of DWS signals from dense systems subject to flow fields have treated only motions due to velocity fields. Diffusive and other internal effects upon the particle motions are ignored. We use the technique of diffusing wave spectroscopy (DWS) to study the ageing of foams and to investigate the response of the system's signal itself in what we call a uniform translational motion, in which there is no structural dynamics to obscure the motion, in a flow field where velocity gradients are absent. We used a highly reproducible foam, Gillette shaving cream with very low absorption of light. Our DWS measurements were carried out over a period of six hours utilizing both the forward and backscattering geometries using the 488 nm wavelength line of an Argon ion laser. In the case of the uniform translational motion, we observe what appears to be initial exponential components on the Gaussian form of the correlation function and compare them to strong localization of light under diffusive propagation conditions. This leads to the conclusion that for dens systems, DWS displays time dependence, governed by the translational motion. For the measurements of ageing foam, we found that initially forward scattering intensity correlation function has a simple exponential form with a time constant of 6 msec. As the foam aged, teh correlation functions became more elaborate. We used both the non-negatively constrained least squares regularised programme, Contin and the Williams-Watts stretched exponential functions for our data analysis. Both fits show that the time constant rose by more than one order of magnitude over the six hours. The βw-w parameter fell from unity to about 0.55 as a function stretches out. These functions provide better fits than the cumulants expressions previously used. They imply the transport mean free path, l*, rising by an order of magnitude. These changes reflect bubble size evolution confirmed by direct observation. The addition of polyethylene glycol (PEG) to the foam was shown to delay the ageing effects on both the time constant and the distribution parameter, βw-w. PEG400 and PEG200 when present in eth same proportion in the foam were found to be similarly effective. The use of laser light scattering technique thus lead to a better understanding of the evolution of bubble sizes and hence of the micro-rheological study of these complex systems. It also provides an enhanced description of the manner in which a dissolved macromolecule affects the structural dynamics of foam.

INV 03

Supercontinuum generation in photonic crystal fibers

M. Zghal

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University of Carthage, Ghazala Technopark, Ariana 2083, Tunisia

A supercontinuum is a broad spectrum beyond all visible colors with the properties of a laser. The interaction of ultrashort pulses with a nonlinear photonic crystal fiber (PCF) leads to spectral broadening. The properties of the resulting supercontinuum depend primarily on the input pulse and PCF parameters. The first observation of a supercontinuum generated in a PCF dates back to 1999 by Ranka et al. As one of the most successful examples in nanophotonics, their applications have been reported ranging from sensors to lasers and to different types of passive and active waveguide devices. We will also review the physics behind the process of supercontinuum generation in photonic crystal fibers.

ORAL ABSTRACTS

T1

Analysis of degradation of CPV cells using Laser Beam Induced Current measurements

W. Okullo[1,2], M. K. Munji[1,3], R.D. Schultz[1], E. E. van Dyk[1] and F. J. Vorster[1]

[1]*Department of Physics, Nelson Mandela Metropolitan University, Port Elizabeth, SA*
[2]*Department of Physics, Makerere University, Kampala, Uganda*
[3]*Department of Physics, Kenyatta University, Nairobi, Kenya*

Keywords: LBIC, CPV cell degradation, thermal defects

Concentrated photovoltaic (CPV) cells are usually subjected to a high solar flux resulting in high current densities and temperature. This may lead to premature degradation and possible failure if optical non-uniformities are present or if there is inadequate thermal management. Optical non-uniformities lead to non-uniform spatial and spectral illumination intensity distribution on the cell surface. In this work the Laser Beam Induced Current (LBIC) technique was used to identify and analyse the evolution of degradation modes in cells in a working CPV module. Defects observed included cell-encapsulant delamination, hot-spot point defects, current mismatch between junctions in triple junction cells and partial cell failure. The LBIC technique, which utilises a Laser beam probe, enabled the mapping of the spatial distribution of current inhibiting defects. A Solar-LBIC (S-LBIC) system that utilises focussed solar radiation as beam probe was also used in the study. An added benefit of both the LBIC and S-LBIC systems used is that they enabled the measurement of point-by-point current-voltage (I-V) characteristics of a CPV cell. Device parameter extraction algorithms applied to these I-V characteristics enabled the mapping of the respective parameters across the cell under investigation. In this paper we will present the current status of our project and discuss results obtained to date.

T2

The anticancer potential of *Artemisia afra*

L Spies[1], TC Koekemoer[1], AA Sowemimo[2], M Van de Venter[1].

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[2] Department of Pharmacognosy, Faculty of Pharmacy, College of Medicine, University of Lagos, Nigeria.

Keywords: *A. afra*, cytotoxicity, apoptosis

Artemisia afra is one of the oldest, most well known and widely used traditional medicinal plants in South Africa. It is used to treat many different medical conditions, particularly respiratory and inflammatory ailments (Liu *et al.*, 2009). There is no reported evidence of its use for the treatment of cancer but due to its reported cytotoxicity (Fouche *et al.*, 2008; Mativandlela *et al.*, 2008), we investigated the effect of *A. afra* extracts on 2 cancer cell lines. IC_{50} values of 18.21 µg/mL and 31.88 µg/mL of ethanol extracts were determined against U937 and HeLa cancer cells, respectively. An IC_{50} value of the aqueous extract was greater than 250 µg/mL. Dose response assays were also performed using confluent HeLa cells, yielding an IC_{50} value greater than 250 µg/mL. The effect of the cytotoxic ethanolic *A. afra* extract (20 µg/mL) on U937 and HeLa cells and their progression through the cell cycle, apoptosis and mitochondrial membrane potential was investigated using laser based flow cytometry. Melphalan was used as a positive control. After 24 hours of treatment with melphalan, an increase in sub G1 phase was evident. Treatment of cells with *A. afra* showed a delay in G2/M phase of the cell cycle. Apoptosis was confirmed using the TUNEL assay for DNA fragmentation, which was evident with the positive control and *A. afra* treatment at 24 and 48 hours. JC-1 staining showed a decrease in mitochondrial membrane potential at 24 hours. The results obtained suggest that *A. afra* potentially has medicinal anticancer properties.

T3

Beam-shaping using a laser incorporating an intracavity spatial light modulator

L. Burger[1, 2], I. Litvin[1] and A. Forbes[1, 2]

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[2]*Laser Research Institute, University of Stellenbosch, Stellenbosch, South Africa*

Keywords: Intracavity beam-shaping, SLM

It is well understood that the fundamental mode of a cavity may be selected by suitable choice of intra-cavity amplitude or phase elements. If one wishes to control the mode dynamically, for example to manage thermal aberrations, then intra-cavity elements that are dynamically controllable are required. Adaptive mirrors have been used for this purpose, but they are unwieldy and limited in terms of the number of controllable elements. A spatial light modulator (SLM) typically contains more than a million individually controllable elements that are easily controlled by changing a bitmap. We present the first use of an intra-cavity spatial light modulator (SLM) for dynamic beam-shaping. In this presentation we highlight some expected and unexpected problems encountered in the development of this device. We show examples of some of the modes produced in this way.

T4

High Resolution Beams

S. Ngcobo[1], A. Forbes[1] and K. Ait-Amear[2]

[1]*National Laser Centre, CSIR, Pretoria, South Africa*
[2]*Center de Recherche sur les lons, Universite de Caen, France*

Keywords: Diffractive Optical Element, Laguerre Gaussian Beam and Beam Shaping

The transformation of a Gaussian beam (GB) into a symmetrical higher order TEMp0 Laguerre Gaussian beam (LGB) intensity distribution of which is further rectified and transformed into a Gaussian intensity distribution in the plane of a converging lens will produce a sharper focused beam which has transverse high resolution properties. The generated high resolution beam is very useful in improving the spatial resolution of optical imaging microscopes by making the central diffractive spot smaller than the Airy spot. The intracavity beam shaping of the GB is achieved by using an annular binary Diffractive Optical Element (DOE) whose geometry is in connection with the location of the Laguerre polynomial zeros. The DOE imposes positions of p zeros of intensity distributions on the GB, resulting to a generation of TEMp0 beams where there are minimum losses. The focused high resolution beams will then be achieved by shaping the generated higher order LG TEMp0 beams using a binary DOE which has annular zones capable of introducing a phase shift of zero or π on the alternately out of phase rings of the TEMp0 beams into a unified phase and then focusing the rectified beam to generate a high resolution beam which has a Gaussian beam intensity distribution at the focus.

References:

1. Cagniot E. et al. (2011) J. Opt. Soc. Am. A **28**, 1709-1715

T5

Dielectric barrier discharge CO_2 TEA laser operated at frequencies up to 400 Hz

P. Baricholo[2], T. Stehmann[1], D.J. Hlatywayo[2] and H.M. von Bergmann[1]

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[2] *Department of Applied Physics, National University of Science and Technology, Bulawayo, Zimbabwe*

Keywords: Dielectric barrier discharge, carbon dioxide, transversely excited atmospheric, laser

Dielectric barrier discharges (DBDs) have been investigated and applied to he excitation of transversely excited, atmospheric pressure CO_2 laser. DBDs are generated between dielectric covered electrodes and are self-extinguishing due to charge accumulation on the dielectrics. Because of this, they are intrinsically stable, easily scalable and adaptable to a variety of discharge geometries. Experimental and theoretical investigations have been carried out on the plasma dynamics using this novel technique of laser excitation and the factors affecting power output of a dielectric barrier discharge excited TEA CO_2 laser. A small laser system has been designed using cylindrical, glass coated discharge electrodes of 400 mm length and gap sizes of 5 and 10 mm. The laser is excited by a thyratron driven power supply which produces pulses with maximum voltages of 40 kV at varying repetition rates with rise time of 100 ns. CO_2 laser gas mixtures of CO_2:N_2:He with ratios 1:1:3 and 1:1:8 were used. The laser was operated at pressures up to 500 mbar with excitation pulse frequencies of up to 400 Hz. The effect of gas pressure, resonator length and excitation pulse frequency on the optical output of the laser system was investigated and optimum operating parameters are derived. The voltage across and current through the discharge were measured using a commercial high voltage probe and a locally developed double shielded current probe, respectively. Optical pulse energy was obtained by integrating over the pulse optical power and was found to be about 10 μJ.

T6

Exciton dynamics in tetracene single crystals studied using femtosecond nonlinear spectroscopy

Z. Birech, D. C. J Van der Westhuizen and H. Schwoerer

LRI, Department of Physics, University of Stellenbosch.

Tetracene is increasingly generating a lot of interest in the electronics industry due to its electrical and optical properties. Demonstrations on its use in making ambipolar light-emitting transistors, organic field-effect transistors and in organic solar cells has been done recently. Fluorescence and photoluminescence measurements revealed existence of free and trapped excitons, exciton fission and fusion and superradiance. Here, we report on results from femtosecond transient grating spectroscopy done on Tetracene single crystals revealing 47fs decay time constant of the initially generated electronic populations with a residual offset. The offset suggests transfer of populations to the triplet state resulting from singlet exciton fission. The generation of multiple excitons from a single photon has been shown to enhance the efficiency of a solar cell in other studies.

T7

Investigating Si/SiO_2 interfaces using EFISH technique

W.I. Ndebeka[1], G Nyamuda[1], P. Neethling[1], C.M. Steenkamp[1], H. Stafast[2] and E.G. Rohwer*

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[2]*Institute of Photonic Technology, Albert Einstein, Jena,Germany*

Keywords: Second harmonic, silicon dioxide.

Increasing device integration densities and miniaturization in modern metal-oxide-semiconductor (MOS) technology requires proper understanding of the structure and particularly the electronic properties of the materials and interfaces. The charge carrier dynamics as well as the defect related effects are influenced by the presence of interfaces and surfaces in ultra-thin semiconductor layers. The electric field induced second harmonic (EFISH) process provides a valuable tool to investigate the mechanisms of charge transfer and trap generation process in the interfaces and surfaces of these ultra-thin semiconductor layers. Recently it has been demonstrated that EFISH generation of femtosecond (fs) laser pulse (λ = 800 nm, τ = 75 ± 5 fs, rep. rate = 80 MHz, $E_{pulse} \leq 10$ nJ) is observed in transmission through a thin free-standing silicon (Si) membrane of 10 μm thickness and compared to the well-known EFISH results in reflection by use of the z-scan technique. These results indicate that second harmonic generation is a powerful tool to study the buried interfaces of Si and SiO_2, opening new questions for further investigation. In the continuation of this work the dynamics of the EFISH process will be investigated by setting up a pump probe setup to measure the time evolution of the interfacial electric field on short time scales for samples with different doping concentration.

T8

Design and Development of an All-Optical Active Q-switched Erbium Doped Fibre Ring Laser

J.J.M Kaboko and Rodolfo M. Manuel

Photonics Research Group, Department of Electrical and Electronics Engineering Sciences, University of Johannesburg, Johannesburg, South Africa

Keywords: All-optical, Q-switched laser, Fibre laser, Erbium-doped fibre

A design and experimental characterizationof an all-optical active Q-switched Erbium-doped fibre (EDF) ring laser isreported. The aim of this research is to propose another approach of Q-switching mechanism for a fibre laser based on all-optical components. The all-optical active Q-switch device proposed in this project is realized by combining a fibre Bragg grating with the fibre Fabry-Perot tunable filter (FF-PTF). The Q-switching technique is based on the overlap condition between the fixed spectral wavelength of the FBG and that shifted in and out of the FF-PTF. Thus, when the two spectra wavelength overlap, the laser output light is released, otherwise, the laser output light is not produced. To characterize the all-optical active Q-switched fibre laser system, a series of tests are performed. The aim of this experimental characterization is to optimize the parameters of the Q-switched fibre laser cavity, which includes the length of the EDF, the output coupling ratio of the fibre laser, the concentration of the Erbium doped fibre and repetition rate of pulses, to obtain an efficient Q-switched laser condition. This means the maximum output peak and the shortest time duration of the output laser pulses. Two types of Erbium doped fibre are used to conduct the experiment. The difference between the two EDFs is based on the pump absorption characteristic of the fibre, which is related to the concentration of Erbium ions into the fibre. Using the developed all-optical Q-switch device, a simple and cheap all-optical Q-switched fibre laser is demonstrated. A maximum output peak power of 580 mW and pulse time duration of 13 μs are obtained at 1 KHz of repetition rate. These output pulse characteristics are achieved under optimal Q-switched fibre laser cavity of 3.5 m of EDF, pumped with 80 mW, and 90 % of output transmission light, using the Erbium Doped Fibre with less pump absorption.

T9

Stress relaxation by surface Brillouin scattering of RF sputtered Cr_3C_2 thin films

D.M.Wamwangi[1], C.Sumanya[1], T. Wittkowski[2] and J.D. Comins[1]

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Keywords: surface brillouin scattering, thin films, stress relaxation, hard materials

Cr_3C_2 films on Si have been grown by RF magnetron sputtering at 0 and -60V bias to observe stress relaxation using surface Brillouin scattering. A RF power of 175W and Ar_2 working gas pressure of 5.0 $x10^{-3}$mBar was used to yield a deposition rate of 0.16nm/s as determined by SEM. Surface Brillouin studies on the -60V biased and the unbiased samples show high frequency Sezawa modes indicative of high film quality. SBS measurement on -60Vthin Cr_3C_2 films has shown an increase in sound velocity of the Sezawa indicative of changes in elastic constants. The dispersion curves have shown an increase in the elastic constants corresponding to an increase in residual stress upon biasing. The elastic constants will be extracted and correlated to the induced residual stress.

T10

Use of Raman spectroscopy to study fatigue type processes in polycrystalline diamond (PCD)

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Keywords: Raman spectroscopy, polycrystalline diamond (PCD), fatigue

Polycrystalline diamond (PCD) cylindrical cutters used in oil well drilling are susceptible to fracture due to the hostile environment of randomly occurring high impact loads. The fact that the cutters fail after repeated use gives rise to the possibility of fatigue type processes in diamond [1]. Crack initiation in polycrystalline brittle material like diamond can emanate from nucleation sites at stress concentrations at boundaries caused by various flaws, such as small cavities or precipitates often introduced by sintering techniques [2]. The study of stress fields and their relative geometries thus becomes crucial in the quest to have extended lives for these cutters. Since the diamond Raman line reveals both the nature and magnitude of the stress present in the material, this technique was employed in this work. The 514.5 nm line of an Ar^+ ion laser was used as an excitation source with an 1800 grooves/mm grating in the single spectrograph mode of a Jobin-Yvon T64000 Raman spectrometer. Room temperature measurements show a general compressive stress field on the surface of the un-fatigued PCD. Samples fatigued to 100 000 cycles at 88% of failure load showed no significant change in the stress fields. However samples fatigued to more than 350 000cycles show some evidence for development of localised areas of tensile strain, as well as an overall decrease in compressive stress on the surface of the PCD cutters.

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T11

Surface modification of TiC reinforced 304L austenitic and 2507 duplex stainless steel matrix composite fabricated by laser melt injection

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Keywords: Duplex stainless steel; laser melt injection (LMI); Microstructure; Properties

The present study focuses on the microstructure, hardness and corrosion properties of TiC reinforced 304L austenitic (ASS) and 2507 duplex stainless steels (DSS) surface composite fabricated by laser melt injection technique. TiC powder was injected laterally into the molten surface layers of the steels using a 4.4 kW Nd:YAG laser beam, operated at power of 1.5 kW, scan speed of 0.4 to 1.0 m/min and beam diameter of 3 mm. Morphologies and microstructures of the composite coatings were investigated using optical microscopy and high resolution scanning electron microscopy equipped with an energy dispersive spectroscopy (EDS), while the phase change were observed using x-ray diffraction. Surface hardness was determined using the Vickers microhardness tester while the corrosion behaviour in 3.5% NaCl solution was investigated by using Potentiodynamic polarization curve measurement method. Since the melting point of TiC (3140^{o}C) is higher than that of stainless steel (1400^{o}C), TiC particles melted partially during interaction with the laser beam. The reinforced steel matrix composites show homogeneous distribution of TiC with absence of new phases which resulted in the hardness of the composite coatings significantly 547 $Hv_{0.1}$ compared to the hardness of the substrate 250$Hv_{0.1}$. TiC reinforced 2507 DSS shows a greater resistance to corrosion than 304L ASS in the medium. This was attributed to the presence of titanium, equal volume proportion of ferrite and austenite in the structure of DSS coupled with higher content of chromium in its composition.

T12

Assessment of levels of trace metals in sediments using laser-induced breakdown spectroscopy

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Keywords: Trace metals; Sediment; LIBS; Ethiopia

Laser-induced breakdown spectroscopy (LIBS) is an efficient and fast spectro-chemical technique that can be used for direct analysis of solid, liquid or gas regardless of the physical state of the material [1, 2]. In this work, LIBS has been employed to analyse trace metals in sediment samples collected from Tinshu Akaki River, Lakes Awassa and Ziway, Ethiopia. Pellets of sediment samples were prepared using a manual hydraulic press under a pressure of 8000 psi after mixing finely grinded sediment samples with boric acid as a binder. The experimental set-up was designed using a Q-switched Nd:YAG laser at 1064 nm and the emission signals were collected by a lens into an optical fibre coupled to a high resolution Andor Shamrock SR303i Spectrometer with ICCD detector. The validity of LIBS technique was tested by comparing LIBS results with the results obtained using ICP-MS and F-AAS.

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T13

The effect of polarization mode dispersion on fibre optic parameter amplifiers

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Keywords: Fibre parametric amplifier, polarization-dependent gain, polarization-mode dispersion (PMD).

Optical amplifiers are key elements in many types of optical systems including optical fibre communication links. An interesting alternative to the mature Erbium-doped fibre amplifier is the fibre parametric amplifier (FOPA). FOPAs not only are useful for wavelength conversion but they can also offer a large, flat gain over a wide bandwidth when designed suitably [1]. The underlying mechanism is the nonlinear phenomenon of four-wave mixing (FWM) in which two photons from a single pump or two pumps interact with a signal photon to create a fourth photon at the idler frequency [1]. The strict phase-matching condition required for FWM and the anisotropic nature of the third-order nonlinearity make the FOPA susceptible to fibre imperfections. One such fibre imperfection is randomly fluctuating residual birefringence ever present in fibres. This imperfection leads to polarization-mode dispersion (PMD), a phenomenon that has been studied extensively as it limits the performance of high-capacity lightwave systems [2]. In the context of FWM, it introduces residual phase mismatch and changes the state of polarization (SOP) of all optical fields randomly. Effects of polarization-mode dispersion (PMD) on dual-pump parametric amplifiers are investigated numerically. It is found that PMD induces large fluctuations in the signal power that can affect the system performance by enhancing the outage probability. The average gain itself is reduced by more than 10 dB even for a relatively small value of 0.05 ps $km^{1/2}$ for the PMD parameter. For larger values of the PMD parameter, the gain spectrum begins to distort and loses its flatness.

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T14

Reflectometric Measurements of Polarization Mode Dispersion in Optical Fibers.

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Polarization Mode Dispersion (PMD) is an important factor negatively affecting the successful implementation of long haul optical fibres networks operating at bit rates of 10 Gb/s and above. PMD measurements are important for quality control during manufacturing and cabling processes. It is also useful to network operators planning to upgrade bitrates in existing networks to10 Gb/s and beyond. PMD is mainly cause by birefringence which results in the light signal splitting into two non-degenerate, orthogonal pair of (fast and slow) axes each propagating with different speeds. The difference in the arrival times of the two signals is the differential group delay (DGD), which is the modulus of the PMD vector. PMD measurement techniques are mainly grouped into time domain and frequency domain depending on the coherence time (T_c) of the light source and the magnitude of the DGD ($\Delta\tau$) being measured. In time domain $T_c < \Delta\tau$ and PMD is the average or root mean square time delay between the two orthogonal polarization modes. In frequency domain $T_c > \Delta\tau$ and then the PMD value is obtained by measuring the wavelength dependent rotation of the output polarization state. PMD measurements can further be classified into reflectometric or forward measurements. In forward measurements the source and the detector are located at different ends of the fibre. In reflectometric measurements the probe (optical source) and the detector are located at the same end of the fibre under test. In the field, installed fibres may be located several hundreds of kilometres apart. This results in a great deal of travel between fibre ends and hence time wasting in performing forward PMD measurements. We present novel reflectometric measurements of PMD in time and frequency domain. We modify the general interferometric measurement technique (GINTY) as a single end PMD measurement technique. Our techniques are practical and suitable for the field measurement of PMD.

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T15

Assessment of DNA Damage after Photodynamic therapy (PDT) using a Metallophthalocyanine Photosensitizer

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Keywords: DNA damage; Photodynamic therapy; Metallophthalocyanines

Cancer is considered one of the commonest causes of death worldwide. However, it is a misconception to think that all forms of cancer are untreatable and deadly. Photodynamic therapy (PDT) is a chemotherapeutic approach that utilizes a bi-functional reagent, a photosensitizer (PS) that localizes to the target tissue relative to the surrounding tissue and is toxic to the target tissue when exposed to laser light. PDT rapidly induces apoptosis, inflammatory reactions, tumor-specific and/or -non-specific immune reactions and damage of the microvasculature of the tumor bed. Critical sites of action for reactive species in PDT include mitochondria and lipid membranes, with DNA serving as another potential target. DNA damage can result from a variety of factors including ultraviolet light, X-rays, ionizing radiation, toxins, chemicals, or reactive oxygen species. In this study, single-cell gel electrophoresis (SCGE) -the comet assay- was used to evaluate DNA damage and repair in three different cancerous cell lines – lung, breast and esophagus. The results of the current research revealed that cells may become refractory to the detrimental effect of ionizing radiation when previously exposed to ionizing radiation and this phenomenon is termed by adaptive response to radiation. There was a severe effect of the used PS in the viability of the PDT treated cells and a lesser reduction in the adaptive group as well as a dramatic change in the morphology of the PDT treated cell. Marked DNA damage has been observed in the previously mentioned cancerous cells after PDT using metallophthalocyanine and a lesser damage in the adaptive group giving evidence that the used PS may be localized in the mitochondria and lysosomes after intruding the cells through the plasma membrane. This study assessed the molecular effects of laser irradiation and PSs on three cancer cell lines.

T16

Cell death in Human Breast Cancer Cells using Zinc Phthalocyanine and Laser Irradiation

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Key words: Breast cancer, PDT, ZnPC, cell death.

In the last ten years, breast cancer has become the most common cancer both in developed and developing countries. Female breast cancer incidence and death rates decreased as a result of earlier detection, advanced treatment and increased awareness[1]. Although this decrease in the number of breast cancer affected people, the condition is by far the most frequent among women with an estimated of 1, 38 million new cases diagnosed in 2008 and it is the leading cancer faced by women in South Africa and worldwide[2]. Women's 21st century lifestyle is one of the main causes and has led to a more destructive, faster growing and harder to defeat type of breast cancer[1]. Photodynamic therapy (PDT) is a light induced chemotherapeutic process used for cancer treatment. The drug, also known as photosensitizer (PS), is activated when exposed to laser irradiation at a specific wavelength. For optimal effect, PS concentration and laser fluency need to be determined[3, 4]. This study aimed to determine the effects of Zinc Phthalocyanine (ZnPC) on human malignant breast (MCF-7) cells and identify the optimum ZnPC concentration and laser fluency. ZnPc was activated in MCF-7 cells at a wavelength of 680 nm and a fluency of 5, 10 and 15 J/cm^2. In order to determine the ability of ZnPc to induce cell death in MCF-7 cells the following assays were performed: cellular morphology (inverted microscopy), viability (trypan blue staining and adenosine triphosphate, ATP, luminescence), proliferation (AlamarBlue® assay) and cytotoxicity (Lactate Dehydrogenase, LDH). Most PDT treated cells rounded off and were identified as free floating structures. Cellular viability of cells treated with 0.5 μM ZnPC at 10 J/cm^2, was approximately reduced to half, while a low proliferation, high cytotoxicity was observed with the same cells and apoptosis was also found to be the prominent cell death route. ZnPC-mediated PDT was able to induce human breast cancer cell death. The dose response study was carried out to determine optimal ZnPC concentration and laser fluency; 05 μM and 10 J/cm^2 was found to be the optimal condition to have approximately a decrease of 50% viability. Gene expression examination will follow to give a clear understanding of this photochemotherapeutical treatment modality on human breast cancer.

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T17

Influence of the working atmosphere on $Y_3(Al,Ga)_5O_{12}$:Tb thin films fabricated by PLD technique

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Keywords: PLD, $Y_3(Al,Ga)_5O_{12}$:Tb, thin films, working atmosphere

$Y_3(Al,Ga)_5O_{12}$:Tb thin films have been grown on Si(100) substrates by using the pulsed laser deposition (PLD) method (Nd:YAG 266 nm). The influence of working atmosphere (base pressure, O_2 and Ar), on the morphology, structure and luminescence properties of the thin films were investigated by different techniques, atomic force microscopy (AFM), scanning electron microscopy (SEM), X-ray diffraction (XRD) and energy dispersive X-ray spectroscopy (EDS). Auger electron spectroscopy (AES) combined with cathodoluminescent (CL) spectroscopy were employed for the surface characterization and electron-beam induced degradation of the films. $Y_3(Al,Ga)_5O_{12}$:Tb thin films deposited in the gas backgrounds gave superior PL properties to that deposited in vacuum. The AES analysis for each film was done before and after degradation to study the surface elemental composition changes resulting from the electron bombardment. The annealing effects on photoluminescence (PL) and structural properties of the thin films will be discussed. The influence of the surface roughness on the luminescent properties and the effect of total internal reflection will be explained in details.

T18

Energy transfer in Ce/Tb co-doped sol-gel silica

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Keywords: sol-gel; silica; luminescence; energy transfer

Ce and Tb single-doped as well as Ce/Tb co-doped silica (SiO_2) was prepared using the sol-gel method, with the aim of studying the possible energy transfer from Ce to Tb ions. After annealing in air at 600 and 1000°C, different analytical techniques were used to study the samples. X-ray diffraction showed that all the samples were amorphous. Infrared absorption measurements indicated that annealing at 600°C was not sufficient to remove all water and hydroxyl ions. Luminescence properties were studied using cathodoluminescence (CL) and photoluminescence (PL) using a variety of different excitation sources including a 325 nm He-Cd laser as well as a xenon lamp. The Ce single-doped sample exhibited CL but not PL, suggesting that most Ce in the studied sample was incorporated in the tetravalent state, which is optically inactive, instead of as optically active trivalent ions. The results of optical absorption measurements also showed the signature of Ce^{4+} rather than Ce^{3+} ions. For the co-doped sample the presence of Ce ions decreased the Tb emission intensity, implying that energy transfer did not occur. These observations led us to anneal the samples in a reducing atmosphere so as to convert Ce^{4+} ions to Ce^{3+} in the sample. Annealing was performed in a flowing 4% hydrogen in argon atmosphere at 1000°C. These reduced Ce-doped samples exhibited bright fluorescence when excited optically and the optical absorption measurements showed the characteristic features of Ce^{3+} ions. X-ray photo-electron spectroscopy (XPS) measurements were done on both annealed and reduced samples to determine the relative concentration of Ce^{3+} and Ce^{4+} in every sample and indicated that although Ce^{4+} was not eliminated, the amount of Ce^{3+} was increased significantly. Now for co-doped Ce/Tb silica samples excited at the Ce absorption wavelength, characteristic Tb emission was observed (and negligible Ce emission) showing that very efficient energy transfer was achieved. Using such co-doped silica samples exhibiting energy transfer, it is possible to obtain effective luminescence from the Tb^{3+} ions via excitation of Ce^{3+} ions at 325 nm, instead of exciting the Tb^{3+} ions directly which requires a shorter wavelength of about 225 nm.

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T19

Estimation of Effective Single Scattering Albedo over South Africa Using Regional Climate Model

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Keywords: Effective Single-Scattering Albedo, broad band radiative transfer theories

Atmospheric aerosols are ubiquitous in the Earth's atmosphere and are crucial for multi environmental issues, such as: range of atmospheric chemistry variations, air quality degradation, several ecological concerns and perturbation of the radiation balance of the Earth, through scattering and absorption of solar and infrared radiation in the atmosphere. Effective Single-Scattering Albedo (ESSA) is one of the valuable aerosol optical properties, for broad band radiative transfer theories; in order to evaluate the aerosol radiative forcing effect. In this study, by modifying the optical parameterization of Regional Climate model (RegCM), we computed and evaluated the ESSA; which is a representative of visible (VIS) spectral region: VIS (380-760 nm). Areas of South Africa which are arid/semi-arid and agriculturally active showed a higher ESSA (> 0.93). Due to intensive biomass burning and atmospheric processes of carbonaceous particles in the south-east coastal areas, lower values of ESSA were observed (~ 0.73 to 0.88). Accordingly, the evaluation of the simulated ESSA, in comparison with MISR retrieved data and SAFARI-2000 campaign, exhibited a very good agreement (deviation < 8%). The regional scale spatial variability of ESSA indicates that the impacts of aerosols on climate must be understood and quantified on a regional scale rather than a global-average basis. As well as, a good agreement between simulated and experimentally observed ESSA values reveals the ability of RegCM4.0 in estimating the complex aerosol processes and their optical properties.

POSTER ABSTRACTS

P1

Laser-induced breakdown spectroscopy for fast monitoring of heavy metals in soils and sediments

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Keywords: LIBS; Heavy metals; Soils; Sediments

Laser-induced breakdown spectroscopy (LIBS) has emerged as a good alternative technique for monitoring of heavy metals in environmental matrices. LIBS technique requires very little or even no sample preparation. Moreover, the speed of analysis is far superior to other techniques, and the technique may be exploited for in situ pollution monitoring. In this work, we demonstrate the feasibility of LIBS for detection and quantification of heavy metals in soils and sediments and identify best experimental parameters for such analysis.

P2

DFT calculation of dithizonatophenylmercury II isomerisation reactions

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Keywords: DFT, Dithizonatophenylmercury II, Absorption Spectra, Potential Energy Surface Scans

Understanding molecular dynamics on potential energy surfaces has been at the heart of ultrafast transient absorption in the recent years [1, 2]. Based on the on-going experiment at our ultrafast laboratory, we ran density functional calculations (DFT) on dithizonatophenylmercury II (DPM) isomers, starting with their kernel molecule, formaldimine, to validate what we observe experimentally. These molecules undergo photo-isomerisation reactions around C=N double bond chromophores when induced with light; causing a dihedral rotation from 0 – 180o – formaldimine reactant rotates to formaldimine product and DPM from orange reactants to blue products. The absorption spectra and potential energy surface scans for these molecules were obtained using different functional offered by Gaussian (09) DFT program and UV/Vis. spectroscopy. As first examples, the results obtained for formaldimine and DPM agreed with previous calculations [2 – 4]. The overall results show that B3LYP (Becke3-parameter exchange energy (B3) and Lee-Yang-Parr (LYP) correlation energy) functional combined with CEP-31G basis set gave the closest results to the experimentally observed data.

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P3

First and second order PMD statistics

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Keywords: polarization mode dispersion, PMD statistics, Maxwellian distribution

Changes in the optical fibre properties due to both intrinsic and extrinsic variations result in polarization mode dispersion (PMD) and state of polarization (SOP) becoming stochastic in nature. The statistics for first-order PMD (FO-PMD) and second-order PMD (SO-PMD) with wavelength approach the Maxwellian [1],[2] and Foschini *et al.* (2000) distributions [3] respectively when measured using the Jones matrix eigenanalysis (JME). FO-PMD and SO-PMD measurements presented here were obtained from ITU-T G.652 deployed buried optical fibres that are each, 14.2 km long, in the same cable. The fibres are owned by Telkom South Africa and are deployed in Port Elizabeth. We made two different links with the use of patchcords to enable us obtain an end to end access. In the first link (link 1), we joined four optical fibres together to obtain a 56.8 km long optical fibre. The second link (link 2), we considered only two of these four optical fibres to obtain a link which was 28.4 km long. The JME method was used for the PMD measurements and the wavelength range was from 1520 to 1570 nm in steps of 0.05 nm so as to get rid of noisy spectra. It was found that the FO-PMD or DGD statistical distribution of link 1 approaches the theoretical Maxwellian distribution. However, the statistical distribution of link 2 does not approach the Maxwellian distribution. The reason for this is because in link 2 there is limited random mode coupling as compared to link 1 which is double the length. It should be remembered that random coupling is responsible for the significant variations of FO-PMD and PSPs as a function of wavelength. During SO-PMD measurements and analyses, it was observed that links which had high SO-PMD approached the Foschini *et al.* (2000) distribution compared to those with low SO-PMD.

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P4

Synthesis, characterization and photo-induced ESR phenomena of α-Cr_2O_3 mono-dispersed *Particles*

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Keywords: Chromium (III) Oxide; *Aqueous Chemical Growth*; photo-induced (ESR);

Monodispersed *spherical particles of* Chromium (III) Oxide, α-Cr_2O_3, were successfully synthesized from a diluted solution of $KCr(SO_4)_2.12H_2O$ using a low temperature soft chemistry preparative technique. The spherical α-Cr_2O_3 particles obtained were characterized by SEM to study the surface morphology. Optical properties were obtained from transmittance and absorbance measurements of the samples in the wavelength range of 200-1100 nm using UV-visible spectroscopy. The crystalline structure of the films was characterized by X-ray diffraction (XRD). Chemical bonding in the particles was studied by *attenuated total reflection* (ATR) spectroscopy, running in the range from 400 to 4000 cm^{-1}. The photo-induced phenomena on mono-dispersed spherical α-Cr_2O_3 particles is currently being investigated at room temperature using an X-band electron-spin resonance (ESR) spectrometer and a SQUID magnetometer to clarify magnetic behavior in the α-Cr_2O_3 under the illumination of NIR light (λ~ 1064 nm). The light-induced ESR signal appears above 250K and is remarkably enhanced around room temperature. Contrary, with visible green light (l ~ 532 nm), the ESR profile does not show any change. The light-induced ESR is strongly dependent on the irradiation light wavelength. It was concluded then that the light-induced ESR below the Neel temperature T_N may come from light-excited carriers associating with reentrance from antiferromagnetic to paramagnetic spin order [1].

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P5

Polarization pulling during Raman distributed amplification in single mode fibres with low PMD

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Key words: Raman Amplification, Raman gain, PMD, PDG

Raman fibre amplifier (RFA) has become indispensable in optical communication and has found applications in long haul transmission. It has also been tested in passive optical networks (PONs) and was seen to command outstanding performance compared with other optical amplifiers. The success and resilience of RFAs is deeply rooted in their unique optical properties and new technologies which have allowed the amplifier to come to age. However, the potential of RFA in optical communication still remains largely unexploited because its polarization properties have not been fully understood. Raman amplification in optical fibre is based on stimulated Raman scattering (SRS) where a strong optical pump transfers part of its energy to the signal as both propagate in the transmission fibre. The phenomenon of SRS results in polarization dependent gain (PDG) which in the present applications is overcome by depolarizing the pump. Pump depolarization reduces the amplifier efficiency resulting in reduced signal gain. In this study we investigate by simulation and experiments the behaviour of Raman PDG in the modern fibre which has low polarization mode dispersion (PMD). Fibre PMD is cause by birefringence and mode coupling and has been known to influence the RFA gain. Using fibres of PMD coefficient $\leq 0.01 \text{pskm}^{-1/2}$ and moderate pump powers we demonstrate polarization pulling of the signal to the pump state of polarization. This pulling effect which is a manifestation of Raman PDG can be exploited in distributed amplification thus eliminating the need for pump depolarization.Pitois, S.; Fatome, J.; Picozzi, A.; Millot, G.; , "New concepts based on nonlinear polarization effects and Raman amplification in optical fibers," *IEEE/LEOS Winter Topicals Meeting Series, 2009* , vol., no., pp.223-224, 12-14 Jan. 2009

P6

Fibre Bragg grating sensor for vibration

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Keywords: Fibre Bragg Grating, Vibration sensor.

We report the development of a prototype of fibre Bragg grating (FBG) sensors for real time vibration detection. Fibre Bragg grating consists in a periodic modulation of the effective refractive index in the core of an optical fibre. These FBGs are made by inscribing the periodic variation of refractive index into the core of an optical fibre using an intense ultraviolet (UV) laser source. Two methods are used to obtain the FBG, either interference or masking. The periodic variation created in the fibre, causes the fibre to reflect a specific wavelength called the Bragg wavelength and transmit all the other wavelengths. The Bragg wavelength shifts when external perturbations, as strain or vibration, are applied to the fibre. This shift characteristic is considered to be an advantage allowing the fibre Bragg grating to be used in optical sensing applications as vibration in structure health monitoring. In fact, vibration is detected by monitoring the shift in the Bragg wavelength that occurs when vibration is applied to the fibre. The vibration monitoring presents some challenges in the signal processing as the Bragg wavelength shift occurs at high frequencies that an Optical Spectrum Analyser cannot handle. We propose three different methods of data acquisition and signal processing that considerably solve the detection problem. As well, we introduce the gravity centre algorithm in the signal processing to conduct a considerable increase in the resolution of the system. The proposed sensor configuration uses standard components for telecommunication; therefore the prototype is relatively inexpensive and easy to implement.

P7

Terahertz time domain spectroscopy

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Keywords: Terahertz, spectroscopy, Fourier transform

Terahertz time domain spectroscopy (THz-TDS) has emerged over the last number of years as a useful new tool for analyzing material properties. The strength of the method is that the measurement is performed in the time domain and hence both amplitude and phase information is contained in the data. Using this data, it is therefore possible to obtain the complex dielectric function of a material in the THz region.
This poster deals with the theoretical description of such a THz-TDS setup as well as the experimental characterization of the setup. The setup consists of a pair of photoconductive antennas; one used as emitter and one as detector. A femtosecond laser is used to trigger the biased emitter to generate a short (< 1 ps) THz pulse. The same femtosecond laser is used to gate the detector antenna in order to measure the THz pulse in a cross-correlation scheme. In this way the electric field of the THz pulse is measured in the time domain. Frequency information is obtained by performing a Fourier transform on the measured pulse. Preliminary results are displayed and discussed.

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P8

4f Pulse Shaper

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Keywords: SLM, pulse characterization.

This poster will contain 4f-pulse shaper set-up used to control the temporal shape of ultra short pulses. The shaper is then used to characterize these pulses. The 4f-pulse shaper consists of a diffraction grating to disperse the incident pulse, a cylindrical lens to collimate the diffracted light, a computer controlled liquid crystal spatial light modulator (LC-SLM) to modulate pulse, another cylindrical lens to refocus the light and a final diffraction grating that recombines all the frequency components into a single beam. Each element is separated by a distance equal to the focal length, f, of the cylindrical lenses. This set-up can be described using Fourier analysis. The frequency components of the incident beam are mapped to unique spatial positions by the gratinglens pair. The LC-SLM, which is a spatial device, can then impose a transfer function on the pulse in the frequency domain. The last lens-grating pair maps these transformed frequency components originating from different spatial positions back into a singlebeam. Since we have changed the frequency components of our incident pulse, we must also have changed its temporal profile. The LC-SLM allows us to apply an arbitrary transfer function to our incident pulse. It can change both the amplitude and phase of the individual frequency components. One example of a transfer function imposed by the LC-SLM is a sinusoidal phase function. By applying a sinusoidal phase function to our incident pulse, the pulse is split into two exact replicas of the original, separated in time. By changing the frequency of the sinusoidal function, the temporal separation between the pulses can be changed. By focusing these two pulses into a non-linear medium, suitable for second harmonic generation, and systematically changing the delay between them, it is possible to perform an autocorrelation measurement. Since the two pulses are replicas of the original pulse, the original pulse can be characterized. Experimental results of this will be shown. The main advantage of this technique over conventional autocorrelation techniques is that this technique allows characterization of the desired pulse at the position of the experiment.

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P9

Transient absorption spectroscopy study of Zinc Phthalocyanine in different solvents

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Keywords: Transient absorption, Zinc Phthalocyanine, Picosecond, Solvents

Zinc Phthalocyanine (ZnPc) is a promising Photodynamic therapy (PDT) photo-sensitiser that exhibits photodynamic activity. ZnPc has suitable photophysical properties for PDT. The high yield of molecules in the triplet state results in a high yield of singlet oxygen, which leads to the destruction of the tumor. It has been suggested that the energy transfer from the singlet excited state to the triplet excited state transition is influenced by photophysical processe that take place on ultrafast timescales. The photophysical processes of Zinc Phthalocyanine in different solvents and using different pump wavelengths have been measured by femtosecond pump-probe spectroscopy. The femtosecond transient absorption measurements reveal new results in picoseconds timescale which is due to solvent dynamics. It has been shown that there is a high signal loss which could be due to solvent dynamics, and demonstrates the need for further investigation.

P10

Deposition of Ti/TiC_xN_{1-x} multilayers for hard coatings applications

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Keywords: Ti(C,N),sputtering, Raman spectroscopy, hardness

Transition metal carbides, nitrides and carbonitrides have unique properties that give them significant technological importance. Nitrides and carbides of titanium are of great interest in the field of tribological applications due to their hardness and wear resistance. Their chemical and thermal stability are sought to protect tools from corrosion in harsh environments and at high temperatures. Among these nitrides and carbides, the compounds of titanium are of particular importance. For the deposition of TiC_xN_{1-x} several processes are used: chemical vapour deposition (CVD), plasma assisted chemical vapour deposition and physical vapour deposition (PVD). Different physical vapour deposition processes for Ti(C, N) at low temperatures have been used through the years [1-3]. In this paper, synthesis and characterization of Ti(C,N) films prepared under different deposition conditions by reactive sputtering and we present the effect of the plasma deposition parameters on the mechanical properties of Ti/TiC_xN_{1-x} multilayers.

The elaboration of our films has been carried out by RF-Magnetron Sputtering (13.56 MHz) under methane, nitrogen and argon reactive plasma at low pressure. The film depositions have been done on silicon and steel substrates. The total pressure was set between 4mTorr to 10mTorr.The study confirmed that the TiC_xN_{1-x} layer composition depends on the reactive sputtering gas composition and substrate bias voltage. The attention was given to study the influence of different parameters as deposition time, RF power, total pressure and gas mixture (Ar+CH4) on the film growth rates, thickness, resistivity and hardness. The deposited multilayers were characterized by X-ray diffraction (XRD), energy dispersive spectroscopy (EDS), atomic force microscopy (AFM) Raman spectroscopy and nanoindentation. The layers are uniform and have very low average and roughness values were found to be in the range of 20-120nm. The pure Ti deposition process presents the highest deposition rate (96nm/min). The hardness increase with bias voltage in all the case (x= 0, 0.5,0.75,1),when bias is applied to the substrate, the number of ionized particles on the substrate increase and therefore causes increasing of the number of collisions at the substrate by ions of argon, nitrogen and methane, this new organization is accompanied by an increase in the densification of the layer.

TUTORIALS

ST1

Digital Holography

Prof Andrew Forbes
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Traditionally monochromatic holograms are generated by illuminating an object with a suitable laser beam, and then recording the interference pattern between this object beam and an undisturbed reference beam on photographic film. However, there are many cases where one would like a hologram of an object that does not physically exist; a so–called digital hologram. While the theory required to create such digital holograms has been around for a number of years, it has only recently been possible to demonstrate these techniques with the advent and commercialisation of birefringent liquid crystal displays. In this paper we will introduce the core concepts of phase–only modulation of optical fields using spatial light modulators in the form of liquid crystal displays, and will highlight the use of such devices for the generation of digital holograms. We will present experimental data on the generation of non–diffracting and vortex beams by suitable digital holograms, and highlight the application of these beams in quantum and classical optics.

ST2

Attosecond Physics

Prof Heinrich Schwoerer
LRI, Physics, University of Stellenbosch, South Africa

This presentation is an attempt to introduce the basic physical and technological concepts and the visions of attosecond laser spectroscopy. One attosecond is 10^{-18} sec, and thereby much shorter than any atomic motion in matter. However, it is the time scale of electron dynamics within atoms. Attosecond spectroscopy aims for the real time observation of processes such as photoionization, inner shell energy redistribution (eg. Auger effect) or even electron wavepacket evolution in atoms or simple molecules. In order to observe these processes, light pulses of duration much shorter than one femtosecond and photon energies in the range of 100 eV are necessary as trigger events, together with a synchronized probe scheme with the same temporal accuracy. We describe how the generation of High Harmonics of ultrashort NIR laser pulses in nobel gases can provide these tools. We present the ground breaking experiments on mapping the electric field of laser pulses and the measurement of Auger life times with single attosecond light pulses, and end with the recent progress towards electron wavepacket spectroscopy.

ST3

“Optical fiber: birefringence properties and measurements and application of innovative sensors.”

Prof Andrew Leitch
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The optical characteristics of optical fibres and cables, with emphasis on the assessment of polarization mode dispersion (PMD) will be discussed. PMD is the phenomenon whereby the two polarization states of a light wave are transmitted at different speeds through the fibre, resulting in a measured dispersion of the signal. It is attributed to the intrinsic birefringence in the fibre, as well as external stresses that may be present (due to, for example, thermal fluctuations). PMD is believed to be one of the factors that will ultimately limit high data transmission rates in the future. Innovative sensors for the measurement of magnetic fields and landslides monitoring will also be addressed.

ST4

Optical sensors: new solutions for advanced applications

Prof Andrea Galtarossa
Department of Information Engineering, University of PADOVA, Italy

Optical fiber sensors are largely diffused with application for damage detection, structural health and temperature monitoring, in particular in high risk environments. There are many examples all over the world of installation for real time monitoring of bridges, tunnels, dams, etc. Commercial available solutions are mainly based on Brillouin and Raman scattering, and on cascaded fiber Bragg gratings. The basic structure of all these solutions will be briefly described during the presentation with additional consideration on advantages and disadvantages. The last part of the presentation will be dedicated to some new applications of optical fiber sensors, like micro-tremors detection in rock mass and distributed mapping of very high intensive magnetic fields.

ST5

Basics of fiber optics

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Fiber-optic lines are strands of optically pure glass as thin as a human hair that carry digital information over long distances. They are also used in medical imaging and mechanical engineering inspection. Fiber-optic lines have revolutionized long-distance phone calls, cable TV and the Internet. In this tutorial, we will show how these tiny strands of glass transmit light and the fascinating way that they are made. We will also review their main important characteristics.

ST6

Laser interferometry: Ultimate limit determination, configurations, vibrometry, distance and angle parameter measurements, and profilometry

Dr James Uhomoibhi
Faculty of Computing & Engineering, University of Ulster, Northern Ireland, UK

Interferometry is a well known technique utilized now for exploiting the long coherence length of lasers. It has been used in optics since early 19th century (1800s). The first laser interferometer appeared in 1965 and since then between two and five thousand units have been sold annually. It has been used in scientific experiments such as in measurements of the earth crust tides (1968), Doppler velocimeters (1970s), ESPI vibration/strain analysers (1975), interferometric profilometry microscope (1990) and interferometric antennas for GW in construction (2005) etc.. There is today a growing widespread application in various fields. Laser Interferometry (LI) has roots in optics, electronics, electromagnetic (e.m.) fields, measurement science and technology. It has spread out with branches in engineering, Physics and others areas for sensing and measurement applications. In this presentation and tutorial session, an overview of applications, the basic Laser Interferometer is given. We describe the performance parameters and cover some of the ultimate limits such as quantum and thermodynamical phase noise, temporal and spatial coherence, Brownian motion and speckle-related errors. We touch on the external, internal, injection or self-mixing read-out configurations of interferometry. Some of the applications are reported such as laser vibrometry, measurements of short, medium, large distances and angles as well as remote echoes. Mention is made of white light interferomertry and profilometry. Examples and solved problems are used to highlight specific cases as appropriate.

ST7

Ultrafast Electron Diffraction: Exciting Developments and Applications

Dr Günther Kassier

LRI, Physics, University of Stellenbosch, South Africa

Ultrafast electron diffraction (UED) aims to combine the atomic scale spatial resolution of conventional electron diffraction experiments with the atomic scale temporal resolution of femtosecond laser spectroscopy, thereby allowing direct observation of ultrafast structural phenomena. The technique is rapidly gaining popularity worldwide, offering an exciting new real time perspective on structural rearrangements, particularly in crystalline matter. Apart from exciting applications in science, the development of electron sources capable of producing sufficiently short and coherent electron pulses, as well as the temporal characterisation of such pulses, poses interesting challenges in itself. During the past few years, a state of the art UED source has been constructed at the Laser Research Institute (LRI) in Stellenbosch. In this talk, I shall introduce the UED technique and report on the successful implementation of a high resolution streak camera for temporal characterisation of femtosecond electron pulses, as well as construction of a new type of electron bunch compressor that will deliver electron pulses of greatly enhanced brightness. Observation of sub-picosecond structural dynamics in the charge density wave material Tantalum Diselenide ($TaSe_2$) will be presented as our most important application of the UED technique to date. I shall also highlight our future research plans which will include investigations into interesting new pulsed electron sources and material systems.

ST8

Basics in steady state and time resolved Spectroscopy

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Nanotechnology Innovation Centre, Department of Chemistry, Rhodes University, Grahamstown, South Africa

Keywords: absorption spectroscopy, fluorescence spectroscopy, x-ray photoelectron spectroscopy

This talk will present the basics of spectroscopic methods used in the DST/Mintek Nanotechnology Innovation Centre (NIC) at Rhodes University. Examples of simple steady state absorption measurements to check the purity of synthesized molecules and nanoparticles will be shown. Important considerations for steady state fluorescence technique will be discussed in order to use fluorescence as a sensitive tool to investigate molecules in solution. The technique of time correlated single photon counting (TCSPC) will be explained and examples of energy transfer between phthalocyanines and nanoparticles will be shown. Sensitive surface analysis with x-ray photoelectron spectroscopy will be presented and different applications discussed.