Photonics News

Volume 09 February 2007

INTERNATIONAL SCHOOL OF PHOTONICS

INDO-UK WORKSHOP IN FIBRE OPTICS AND ITS APPLICATIONS

ISP CUSAT hosted Indo-UK workshop on fibre optics and its applications during August 29-31, 2006. The workshop was organized by International School of Photonics and Centre of Excellence in Lasers and Optoelectronic Sciences of CUSAT in collaboration with ISP-SPIE, ISP-OSA Student Chapters and Photonics Society of India.

The workshop was aimed at giving insight into various applications of fibre optics and thereby motivate students and researchers. Fibre optic sensor for industrial applications, fibre optic grating based sensors, finite element modeling in photonics, biomedical photonics, sensors for civil engineering structures, sensing in life science applications were the topics highlighted in the workshop. It also gave opportunity for the participants from various institutions to present their results and discuss recent developments.

The Workshop was inaugurated on 29.08.2006 by the Vice Chancellor of Cochin University of Science and Technology Dr. P.K.Abdul Azis. Dr. C.P. Girijavallabhan, Director, Centre of Excellence in Lasers and Optoelectronics Sciences welcomed the gathering and Dr.V.P.N.Nampoori, of International School of Photonics gave a brief report on the conduct and organization of the Indo-U.K. Workshop. In his inaugural address the Vice Chancellor stressed the need to get involved in High Technology research using International cooperation. Prof. Ken Grattan of the City University, London offered his felicitation on the occasion of inauguration of Indo-U.K. Workshop. Dr.P.Radhakrishnan, Director, ISP offered the Vote of Thanks.

The Workshop has opened up the way for serious collaboration between British Universities and Indian institutions like CUSAT in the field of Optics and Photonics. The British Professors participated in the Workshop have agreed to provide suitable Indian students with Scholarships and Post Doctoral fellowships. Lecturers on various research topics were given by resource persons from Indian as well as British Institutions. 33 scientists and research scholars from various parts of the country participated in the workshop.

Standing up to the cause of Photonics- Inaugural session of Indo-UK workshop

There was a cultural programme – "Kathakali" on 29th evening and "Padayani" on 30th evening.

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From the Editor's Desk

This is the ninth volume of Photonics News . This News Letter of Photonics Society of India highlights Photonics based Researches going on India. The year 2006 was packed with various activities in International School of Photonics (ISP) and Centre of Excellence in Lasers and Optoelectronic Sciences (CELOS). Prominent activities include Indo – UK workshop on Fibre Optics and its applications, Commonwealth of Learning sponsored e-content development for Digital Learning, Raman Day Celebration apart from the extension work like Optics to School Programme organized by ISP-SPIE Student Chapter. Indo- UK Workshop was the result of the initiative taken by Prof B M A Rahman of City University , London. Such bilateral workshops and conferences will strengthen the link of ISP with other International institutions and laboratories through joined projects and academic exchange programme.

ISP has recently acquired sub-pico second laser system which will form the part of a Central Facility to support studies going on in the area of ultra fast optical processes not only in CUSAT but in other part of the country. Year 2006 was fruitful one for the ISP-SPIE Student Chapter. The website of ISP-Student Chapter competed with other chapter- websites to bag the first prize. I take this opportunity to congratulate all those who worked behind in creating the wonderful website. This student Chapter also undertook extension activities like Optics to School Programme, Colloquium and Quiz Competitions for College Students and Blood Donation Camps . We appreciate the enthusiasm and the sincerity with which such programme were executed by the chapter members.

I wish the members of PSI a happy and prosperous 2007.

V. P. N. Nampoori

Editor-in-Chief

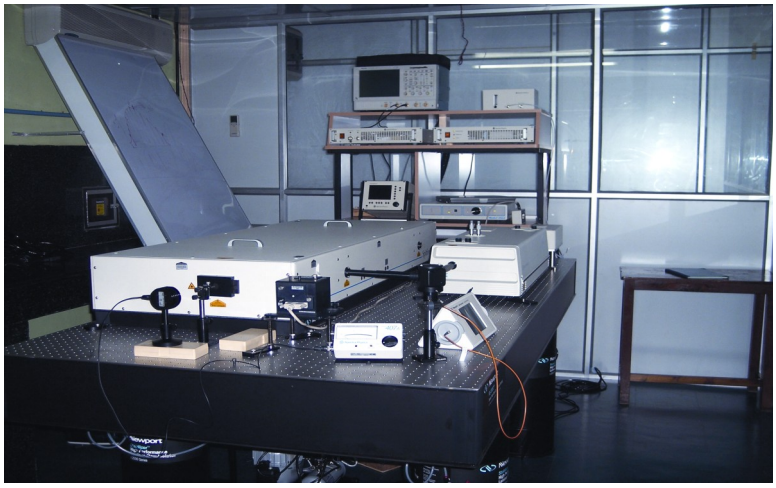
SUB PICO SECOND LASER SYSTEM INSTALLED

' The subpicosecond laser is one of the most advanced and sophisticated systems and CUSAT has become the second University in the country to posses such a system (other than the National Laboratories) '

In order to strengthen the research facilities at ISP, sub -Pico second laser system (A national facility sponsored by UGC) was installed in CELOS.

The function was formally inaugurated by the Vice Chancellor of Cochin University of Science and Technology Dr.P.K.Abdul Azis on 5th August, 2006.

The subpicosecond laser is one of the most advanced and sophisticated systems and CUSAT has become the second University in the country to posses such a system (other than the National Laboratories). The equipment supplied by Spectra Physics Co. in the U.S. comprises of a mode locked Ti-sapphire laser called the 'Tsunami' pumped by a 5 W CW diode pumped solid state laser (called the 'Millennium'). The output from this oscillator is amplified by a chirped pulse amplifier ('Spitfire' from Spectra Physics), which is pumped by 30 W Q-switched DPSS (the 'Empower'). The final laser pulses can be as short as 80 femtosecond with energy of 2.5 mJ per pulse. The pulse repetition frequency can be adjusted from few Hz to 1 KHz.

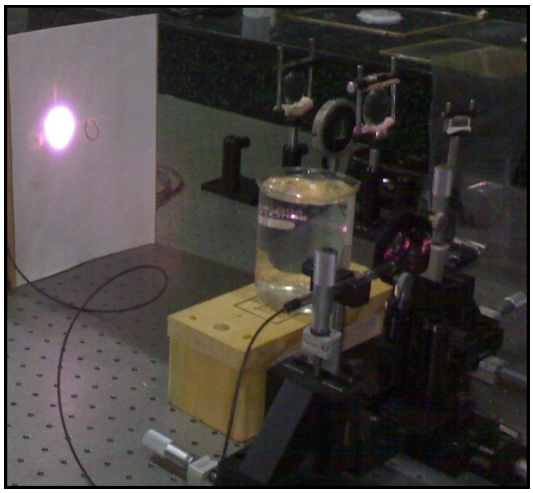


Femto second laser Facility at ISP Lab

From ISP Laboratories

Polymer Photonics

Optical diode can be conceived as a device which has unidirectional light transmission. Such optical device will have applications in instrumentation like ring cavity lasers. We were able to develop such a device by polymerizing monomer with dye which can be drawn into fiber with concentration gradient. We tested the optical diode property of the polymerized preform by studying the propagation and fluorescence characteristics both with axial and transverse pumping. The optical amplification studies of dye mixture doped PMMA based polymer optical fiber were carried out. Different dye concentration ratios of Rhodamine 6G and Rhodamine B were used for the present study. Compared to single dye, tuning of the amplification wavelength is possible over a wider range by using dye mixtures and 20dB gain is achieved with equal concentrations of dyes. Two photon fluorescence studies of dye doped polymer optical fiber has been carried out using the femto second laser. Supercontinuum spectrum of the PMMA preforms is also recorded.



fs Laser generates supercontinuum in water

Synchronization of chaos

The study of chaotic fluctuations in the output intensity of laser systems have attracted a lot of interest in the last few decades. Synchronization of chaotic laser system has its potential application in the field of secure communication. We are mainly studying the chaotic dynamics of Nd-YAG laser and its synchronization.Coupling of Nd-YAG lasers can be done in different ways to give various spatio temporal patterns.

The effect of parameter fluctuation on the synchronization of coupled chaotic systems is studied. This holds relevance in the realm of nonlinear dynamics because the parameters of actual physical systems can fluctuate due to various reasons. It is observed that the fluctuation rates or the number of modifications to the parameter in unit time is the most important factor which determines the stability of synchronization. The effect of parameter modulations is also studied wherein it is seen that the frequency of modulation plays a similar role to fluctuation rates on the stability of synchronization.

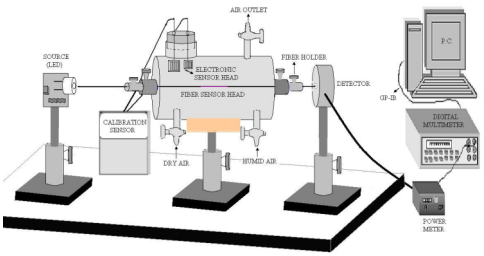
The study of chaotic fluctuations in the output intensity of laser systems have attracted a lot of interest in the last few decades. Synchronization of chaotic laser system has its potential application in the field of secure communication

Fiber optic sensors

A simple working model to determine the speed and weight of a vehicle in motion was investigated using PCS and polymer fibers. The fiber is surface mounted to a platform in such a way that the weight in motion strains the fiber at two fixed positions and measures the dips in the transmitted power when the moving vehicle apply strain at predetermined points. From these, we accurately calculated the speed of the vehicle and using proper calibration, determined the weight of the vehicle. The sensitivity of the device to strain is found to be better when polymer fiber is used.

Two fiber optic humidity sensors based on bio polymers such as Chitosan and Agarose were designed and developed. The Chitosan based sensor showed the sensitivity of 0.001dB/RH for 17-95% RH range with an accuracy of +/-7%. Meantime the Agarose based sensor showed the sensitivity of 0.001dB/RH for 40-95% RH range with an accuracy of +/-1%. Both sensors showed good response to the change in humidity level and reversible in nature. A chitosan based fiber optic sensor for the study of vegetable oil was also investigated.

Another fiber optic sensor developed is used to monitor the consolidation behavior of clay. The property of clay by which water goes out from low permeability soils like clay on the application of weight is known as Consolidation. As water goes out, clay compresses and the amount of compression and the time taken for compression depends on the sample. This is an important engineering property which must be addressed carefully when construction is done in clay fields. The changes in consolidation behavior due to various factors were investigated successfully. All the sensors are cost effective and easy to fabricate and maintain.



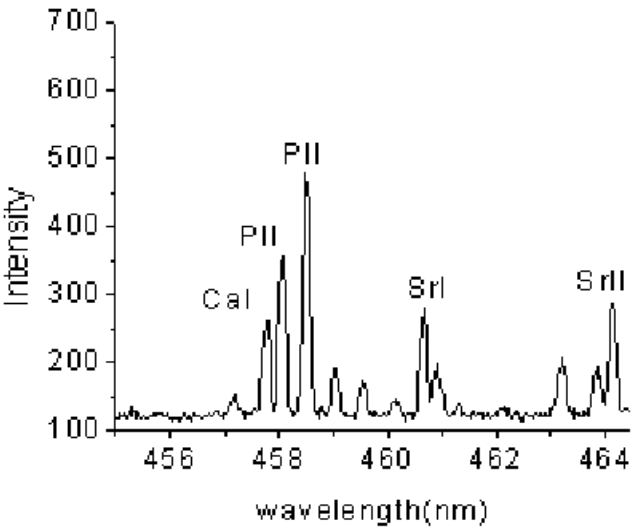
A fiber optic humidity calibration setup developed in ISP

Laser Produced Plasma Studies

From ISP Laboratories

The laser induced breakdown spectra (LIBS) of various coral samples have been investigated for elemental composition and the spatial variation of different plasma species in the coral plasma.

Comparative study of plasma production and its evolution processes from pure and composite targets has been done. Lasers with subpicosecond pulse widths are also being used for this study in addition to nanosecond pulses. The laser induced breakdown spectra (LIBS) of various coral samples have been investigated for elemental composition and the spatial variation of different plasma species in the coral plasma. The fluorescence studies are done at different excitation wavelengths to identify the characteristic proteins responsible for the fluorescence. In addition to spectroscopic characterization, electrical methods of novel importance also have been tested and found promising. Another interest is on the effects of external magnetic field on plasma dynamics. The studies are ongoing and in addition to the characterizations done, optical tomographic techniques are also being applied to laser produced plasma.

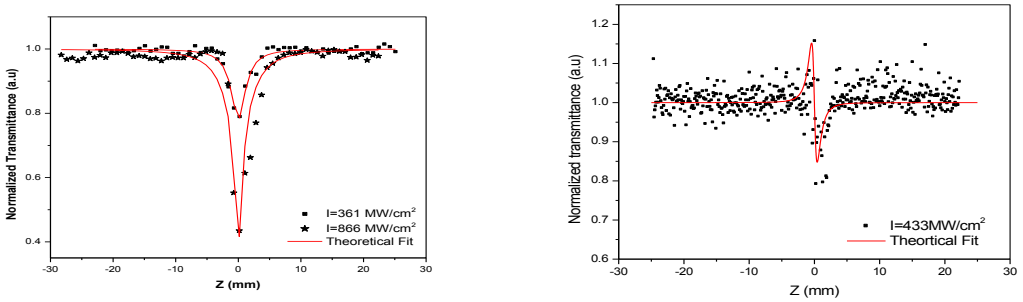


Nonlinear optical studies

Organic compounds are attractive materials with its high nonlinearities which can be used for optical storage, optical switching ,optical limiting etc. Laser dyes are less investigated for its nonlinearities. We have conducted nonlinear studies in C 540 dye doped polymer matrices. Different polymer matrices such as PMMA, polystyrene and polyvinyl chloride are doped with C 540 and films of ~100 micrometer thickness are prepared by free cast evaporation method. All the films show good nonlinearity with reversible saturable absorption. The optical limiting property is also studied. Among the different dye doped polymer matrices polystyrene samples show better nonlinearity.

Nonlinear studies are also conducted in laser gain media prepared in our lab. Nd doped silica gel samples are prepared at different doping concentrations of Nd. Open aperture Z scan studies are conducted to study the optical nonlinearities of these materials. At high fluence level the exhibited reverse saturable absorption.

Materials with large optical nonlinearities are good candidates for optical applications such as optical limiting optical switching and computing. Amongst the various nonlinear optical materials investigated, wide bandgap semiconductors, especially zinc oxide have attractive nonlinear properties that make them ideal candidates for NLO based devices. The nonlinearities of nanostructured materials attracted interest due to the considerable enhancement of their nonlinear response caused by quantum size effects. We have investigated the size dependent optical nonlinearity over wide range of sizes. ZnO colloids exhibit reverse saturable absorption and negative nonlinearity. The enhanced absorption at higher input intensities is due to strong two-photon absorption. The fluence dependence of nonlinear optical properties increases as particle size increases. ZnO was found to exhibit good optical limiting properties. Since the electrical and the optical properties are strongly affected by the interface and the microstructure of the films, we investigated the influences of the microcrystallite structure and interfacial state effect on the linear and nonlinear optical properties of the ZnO films on quartz substrates annealed at different temperatures. The nonlinear absorption coefficient increases with the increase of the annealing temperature due to the interfacial state enhancement. Nonlinear studies in nanocomposite include both metal and semiconductor doped ZnO and high nonlinearity is observed for nanocomposites.



Open aperture z scan curve and Closed aperture z scan curve for ZnO

Bio photonics at Centre for Laser Spectroscopy Manipal University

In recent years, photonics has developed to address many of the problems related to the health issues in living beings. Advancements in new light sources over a wide range of spectrum and measurement and detection methodologies have made a renaissance in the application of spectroscopic techniques in diagnostics as well as other health related areas. The dawn of this century has witnessed the emergence of biophotonics/biotechnology as one of the most promising research areas, where emphasis is laid on tackling clinical problems using technological aids. In order to strengthen and popularize the research activities in the field of biophotonics, a decade ago, the Centre for Laser Spectroscopy was instituted at Manipal University (then Manipal Academy of Higher Education), Karnataka. The centre is functioning with an aim to address the problems of clinicians using optical spectroscopic techniques, as well as to work as link between clinicians and scientists.

During the last decade, Centre for Laser Spectroscopy has developed Raman Spectroscopy as a diagnostic tool, where the inelastically scattered radiation from the tissue surface followed by excitation with Near Infrared Radiation at 785 nm is recorded using spectrograph-CCD assembly. With the usage of statistical tool such as Principal Component Analysis (PCA), the Centre was able to discriminate normal, pre-malignant, malignant and inflammatory conditions of different cancers such as Oral, Cervix, Breast Cancer, etc. In general, combination of radiation and chemotherapy is the choice of treatment for locally advanced stages of cancers and tumour response is known only after relatively long period. Due to intrinsic factors such as DNA aneuploidy, proliferation, kinetics and S-phase fraction and glutathione, tumours of same clinical stage and histology may respond differently. With an aim to develop non-invasive spectroscopic techniques to study the radiation response, Raman spectroscopy has been used to probe radiation therapy response in patients. Further research work on advanced areas such as Microraman spectroscopy and optical tweezers have been initiated in collaboration with Tata Institute of Fundamental Research, to investigate clinical samples as well as materials of interest in the biophotonics field.

Though the application of fluorescence spectroscopy for the early detection of cancer is in fairly advanced stage, the exact changes in the biochemical and biophysical processes during the progress of carcinoma are not well understood. Although contrast and discrimination is better, the exogenous fluorescence spectroscopy suffers from phototoxicity of the dye employed. As a result, researchers around the globe utilize auto-fluorescence of tissue for the discrimination of different types of cancers. Our centre has been utilizing the autofluorescence of tissues for the classification of various types of cancer. By utilising the Nd:YAG pumped MOPO system and scanning the excitation wavelength, it is proved that 325 nm radiation with appropriate match/mismatch condition of PCA, various types of cancer can be clearly classified. In order to benefit our research investigations for public, in collaboration with industry, research on the fabrication of a device for early detection of oral cancer is underway.

Eventhough photothermal techniques are well known in material science, exploitation of this technique in the biomedical field is still at its infancy. By recording the photoacoustic signal from the tissue surface using pressure sensitive transducer and using appropriate mathematical tools, clear discrimination among various cancer types has already been established. Further research and refinement of this technique for developing it as a diagnostic tool is in progress.

The basic approach of HPLC-LIF program depends on the understanding that a large number of biochemical steps are involved in the progression of tumor from a homogenous, proliferating clone, to a group of heterogeneous subpopulation of cells, some of which are progressively accumulated in the entire array of enzymes and surface molecules required for metasis. Even small primary cancers shed viable tumor cells into the circulatory system as they grow in their primary site. If the enzymes and surface molecules associated with tumour cells can be detected as early as possible, one should be able detect the early onset of malignancy. Our centre utilizes HPLC-LIF technique for the early detection of malignancy from tissue as well as from body fluids. It has been established that by using the chromatogram from blood serum with PCA based match/ mismatch process, clear discrimination of different types of oral, cervical and breast cancer is possible. With the interaction from industry, the Centre is currently focusing on the usage of saliva for identifying the tumour marker in oral cancer.

Dr. Sajan D George is presently working as an assistant professor at Centre for Laser Spectroscopy, Manipal Life Sciences Centre, Manipal University Manipal, India – 576 104

Apart from above mentioned established techniques, our Centre is also focusing on the development of an indigenous MALDI – TOF technique for the study of protein dynamics. Owing to the boom in the use of nanoparticle based systems in biomedical field, our Centre is also exploring the thermo-optical properties of nanosystems and also on their femto second laser based investigations.

"The environment people know we're an endangered species, the hunters know we're an endangered species... If only the lions knew we're an endangered species."

Insect wings to make lens coatings

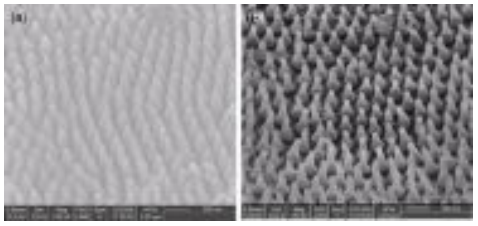
Scientists from Peking University, China have found how the intricate wings of cicadas can be used to replicate nanostructures that function as anti-reflective coatings.

Their method, based on nanoimprint lithography (NIL), could be used to make anti-reflective lens coatings and improved substrates for surface-enhanced Raman spectroscopy (SERS).

Cicada wings

Cicadas are insects that live mainly in tropical climates, easily recognizable by their large size (adults can be 2 inches long) and loud "singing" noises. Their wings are covered with thousands of tiny pillar-like projections that scatter incident light and prevent it from being reflected. Each conical pillar is 400 nm tall and inclined at a 30° angle to the surface.

In their technique, a section of the wing is thoroughly cleaned and then pressed against a heated layer of poly-methyl methacrylate (PMMA), a substance often used to make moulds. When the wing is removed, the PMMA mould has a series of nanowell arrays (ie. the reciprocal of the structures on the cicada wings). These moulds can then be used to replicate the nanostructures in a variety of surfaces.



Nanoimprint

Cicada wings can be used as stamps to replicate natural nanostructures which are very difficult to fabricate using traditional techniques. Cicada wings have a natural advantage for the NIL technique, since their surface is coated with a wax-like substance that refuses to stick to the plastic mould. This eliminates the need for applying an anti-adhesive layer prior to imprinting, as is the practice in traditional NIL techniques.

Thermal imager has the edge on cricket umpires

A thermal imaging camera based on indium antinomide chips could be used to decide whether or not batsmen playing cricket should be given "out".

When a bowler fires a cricket ball into a batsman's bat or protective pads at speeds of up to 100 mph, the split-second collision produces friction, and therefore a brief blast of low-level heat. The mid-infrared light emitted can be picked up by a highly sensitive camera that was originally developed for defence applications by the French company CEDIP.

Although the technology is not yet being used by the umpires that adjudicate the game, it can easily tell whether or not a ball has flicked the edge of a player's bat – and therefore whether or not he should be given out if the ball is caught by a opposition fielder, or adjudged to be "leg-before-wicket".

How's that?

The International Cricket Council has previously decided to aid umpires by allowing the use of television replays to decide on close decisions. Whether or not CEDIP's high-technology approach is sanctioned by the game's establishment for subsequent series of international cricket matches remains to be seen.

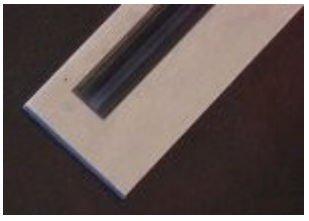
Femtosecond laser pulses create 'black metal'

Scientists in the US have found a way of dramatically increasing the light absorbing properties of metals. The team says that its femtosecond laser treatment could boost the efficiency of space telescopes and light meters among other applications.

To create so-called 'black metal', the researchers use intense pulses of light from a Ti:sapphire laser.The system consists of a femtosecond laser oscillator and a two-stage amplifier.Pulses lasting about 60 femtoseconds are released from the amplifier at a repetition rate of 1 kHz.

The bursts of light produce a mixture of micro- and nano-size structures on the metal surface. Black in appearance, the treated region can gather radiation more efficiently than the bare metal surface thanks to its vastly increased surface area.

Previously, researchers at Harvard University have been successful in using femtosecond pulses to create 'black silicon'. Regular silicon already absorbs most of the visible light that falls on it, and so black silicon only offers about a 30 percent improvement.In contrast, metals absorb only a few percent of visible light before processing. Another difference between the treatments for silicon and metal is that it doesn't require the use of corrosive gas.



'Black metal'

Photonics reveals cardiac threat

Most heart attacks occur when plaque deposits on the walls of coronary arteries break away and block vital blood flow to the heart's muscle. But not all arterial plaques behave in this way, so the furring up of coronary vessels does not necessarily indicate an imminent coronary event.

Evidence is mounting that plaques containing a high proportion of lipids are most likely to split from the vessel wall, but current diagnostic techniques are unable to distinguish lipid-rich from lipid-poor plaques. Enter InfraReDx, an early-stage medical-device company based in Burlington, Massachusetts, that has developed a near-infrared spectroscopic system for evaluating the make-up of coronary plaques.

Light work

InfraReDx's system includes a laser light source that is delivered into a patient's coronary artery through a fiber-optic catheter. Once the device is in place, light in the NIR region is directed at the vessel wall. The system then collects differential absorption data from reflected NIR light as the laser rotates through 360°.

This information is used to determine the molecular composition of any plaque deposits that may be present. An automated pull-back mechanism allows the source to scan the entire length of the artery, collating similar spectral data on all identifiable lesions.

The technique, known as NIR diffuse spectroscopy, is used commonly in fields such as drug development to evaluate the chemical make-up of unknown substances. But it has never before been applied to arterial plaques.

InfraReDx is pitching its technology for use in patients scheduled for coronary catheterization because of chest pain or an initial heart attack.

Fiber laser improves micro-crack repairs

Researchers from the Fraunhofer Institute for Material and Beam Technology (IWS) in Dresden developed a laser system that they say can better repair microscopic damage to welded metal pieces as varied as aircraft turbines or a worn injection mould.

Steffen Nowotny, engineer of the IWS says their new laser welding robot can repair expensive components such as turbines or complex tools such as inserts for injection moulding.

The flexible robot arm accurately focuses the laser beam on the damaged section of the component, which may be cracked or chipped. The energy from the laser beam causes the surface to melt as the laser scans the component dot by dot, producing microscopic puddles, each no larger than a few tenths of a millimeter.

Weld better

At the same time, powder is blown onto the surface by a stream of gas and bonds with the melt. As the powder granules are very small - typically, with a diameter in the micrometer range - they are completely melted by the laser beam and rapidly form a tight bond with the base material.

This laser method is flexible and can employ weld-assist metals such as titanium, nickel and cobalt, hard metals and even ceramics, which allows to seal cracks in tools, or rebuild chipped edges.The process can accurately reconstruct several millimeters of material, sufficient to repair damage such as that caused by a bird strike to the delicate blades of aircraft turbines.

Laser beam deposition welding has already been in use for several years. However, the new IWS system enables surfaces to be processed more accurately than previously. The

Laser beam deposition welding has already been in use for several years. However, the new IWS system enables surfaces to be processed more accurately than previously.

Fraunhofer researchers are using an innovative beam source: the fiber laser.

This laser is able to deposit material with unprecedented accuracy, yet without putting any strain on the component. This makes it possible to produce metal structures at a resolution of as little as 100 µm, equivalent to the thickness of a single hair.

Photonic Crystals through Chemical Synthesis

Alumni column

Santhi A

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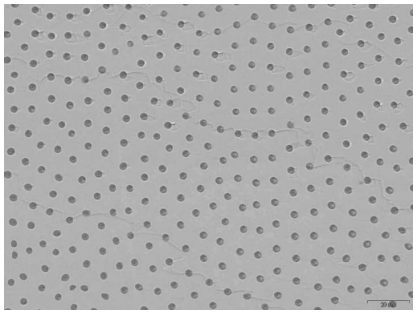
A brief description of the work carried out by the group of Dr. Poumellec [Dr. Bertrand Poumellec, Dr. Matthieu Lancry & Ms Santhi. A] at 'Advanced Material for Photonics (MAP)', Laboratoire de Physico-Chimie de L'Etat Solide, UMR CNRS-UPS 8648, Institut de Chimie Moléculaire et des Matériaux d'Orsay (ICMMO), University of Paris Sud, Orsay.

Metamaterials are composite materials, which can exhibit optical properties like negative refraction, which is usually not found in natural materials. Their peculiar properties give scientists the ability to control light, which opens a wide range of potential applications. Till recently no one has demonstrated subwavelength focalization effect. However, researchers at the U.S. Department of Energy's Ames Laboratory have developed a material with a negative refractive index for visible light, which is reported in the 2007 January issue of Science. J B Pendry and co-workers and also some other researchers have previously demonstrated negative refraction in some materials using microwaves. However, their methods for preparing the materials are largely based on lithography, which uses a prefabricated photomask as a master from which the final pattern is derived.

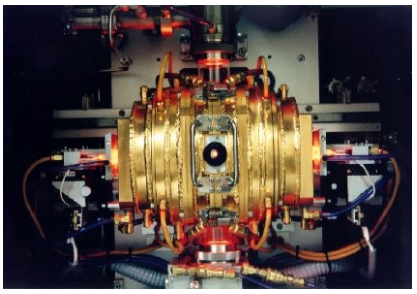
An unconventional way of manufacturing photonic crystals by purely chemical way would open new fields of application. The realization of photonic crystals by chemical way will avoid the problems related to engraving. The main objective of the research at ICMMO in the group of Dr. Bertrand Poumellec, is the use of this method for preparing metamaterials. The project also aims at the direct experimental demonstration of negative refraction and at a later stage, more applications like auto-collimation, control of the direction of light propagation etc. shall be achieved. This chemical method is based on making quasi-periodic self-organized structures from a two-phase material. A material possessing the characteristics close to those required has already been synthesized here (Figure 1) by Prof G. Dhalenne, Prof. A. Revcolevschi and co workers. It is a composite glass fibre material of silica distributed in a single-crystal matrix. It is obtained starting from a mixture of oxides carried to fusion in a floating zone furnace and solidified in a preferred direction. The matrix then consists of a saturated solid solution and the fibres are formed by precipitation of



SEM image of a section of material in the axis of growth showing the second $Ge_{0.7}Si_{0.3}O_2$ phase, consisted of fibres perpendicular to the photographs embedded in the single-crystal $CuGe_{1-x}Si_xO_3$ matrix.

the excess silica. The synthesized crystals usually have nearly periodical fiber structures embedded in a monocrystalline environment. This method is thus original and makes it possible to produce photonic crystals at low cost in great quantities. It is important to notice that the photonic crystals synthesized by chemical way could not be limited in the axis of the filaments. It will thus be possible in theory to have a structure really approaching the "simple" cases of 2D photonic crystals.

This technique has been carried out with several objectives, like the manipulation of the parameters controlling the microstructure of material presented above (diameter and distribution of fibres) and the search for new compositions making it possible



Photograph of the floating zone furnace used for crystal growth.

to work out similar structures. And some of these objectives are already met. For example we are able to achieve fiber sizes down to 1 µm and spacing as low as a few microns. It is important to note that the chemical composition of the starting mixtures makes it possible to obtain only certain types of microstructure because the volume fraction of the phase forming fibres is imposed by thermodynamic constraints. The access to microstructures as varied as possible can thus be conceived only by starting from the exploration of many binary systems.

A long-term aim of the group is to define a general method for the self-organization, starting from eutectic mixtures (liquid mixtures which break up with solidification). Further information is available in the group website at http://www.icmo.u-psud.fr/icmmo2007/php/w_LPCES.php

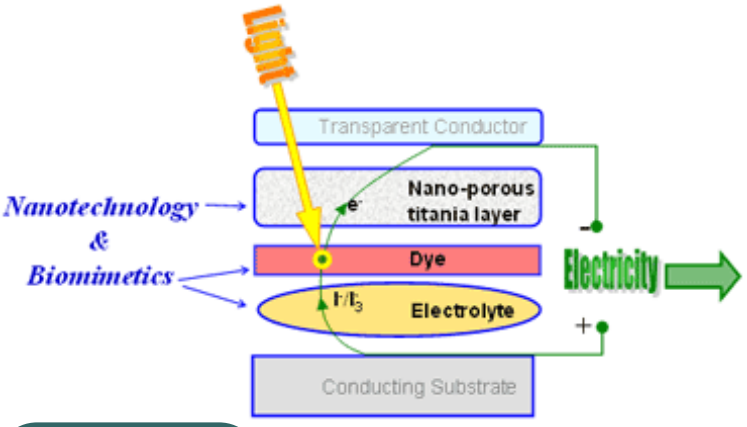
Alumni column

Dye Sensitized Nano Solar Cells

For solar energy to become competitive with conventional power sources, the currently used high purity silicon-based technology has to be replaced with a less costly yet highly efficient alternative. The most promising among these alternatives is dye sensitized solar cells (DSSC) based on nanoporous materials, discovered in 1988 by Michael Graetzel of Switzerland.

The working principle of DSSC is similar to artificial photosynthesis. Just like the chlorophyll in the leaves absorb solar energy and convert it into more useful forms, a dye attached to a nanoporous semiconductor film (eg. TiO2) absorb photons from sunlight, inject electrons to the semiconductor which further move through an external circuit, thus converting light into "green" power. An electrolyte recharges the dye. The basic scheme of a DSSC is shown in Fig. 1 The TiO2 thick film, made by screen printing technique, consists of nanoparticles of 15-20 nm. One main effect of the nano-structured film is to greatly amplify the light-sensitive surface area, thus acting as a light sponge.

A disadvantage is that the sunlight conversion efficiency of nano solar cells is typically low, mainly because electrons get lost while trying to find their way to the external circuit by hopping between nanoparticles within the cell. By replacing the nanoparticles with long single-crystal nanowires that run between the cell's electrodes, many researchers were able to get the electrons moving through the solar cell more efficiently. Solar cells based on ZnO nano rods are an important advance that could ultimately lead to more-efficient nano solar cells.



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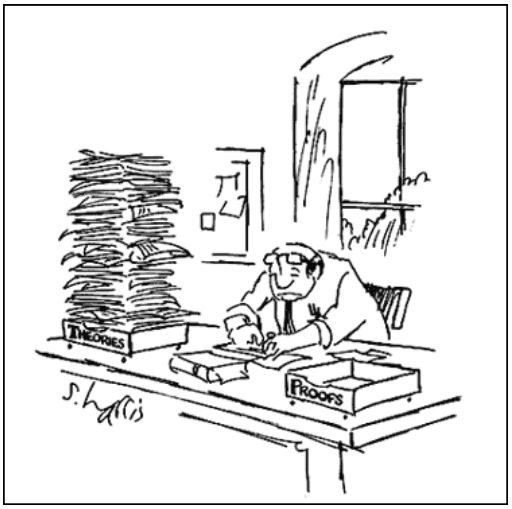
2D—OCDMA

Optical CDMA (OCDMA) requires a new set of codes called Optical Orthogonal Codes (OOCs). CDMA technology requires spreading a bit into a sequence. In the electrical domain, a spread sequence is transmitted as a 1 (pulse having no phase shift) and a -1 (pulse having a phase shift of 180^{o}). Since phase modulation is difficult to achieve in the optical domain, intensity modulation is the preferred alternative. Intensity modulation in OCDMA refers to encoding a bit '1' into a sequence of appropriately placed 1's (in the time domain) and nothing is transmitted for a bit '0'. There are various ways to encode a '1' into a sequence of 1's. One of them is Balanced Incomplete Block Designs (BIBDs).

The application of BIBDs in OOCs for OCDMA and 2D-OOCs for Two Dimensional OCDMA (2D-OCDMA) is being pursued. 2D-OCDMA is also known as Multi-Wavelength OCDMA (MW-OCDMA). 2D-OCDMA refers to OCDMA with two dimensional codes which are orthogonal in wavelength as well as time. 2D-OCDMA makes a better utilization of the available resources by exploiting maximum of the available bandwidth. Bit Error Rate (BER) in an OCDMA system can be decreased by spreading the bit '0' also.



ISP- SPIE Student chapter activities

The year 2006 has been remarkable for the chapter since the website of this chapter won the **best website award for SPIE Student chapter** in the year 2006. The former vice-president of the chapter, Mr. Rajesh M Nair represented the chapter in the 51st Annual Meeting of the SPIE at San Diego. The chapter has 55 members at present.

The chapter has conducted various seminars and actively participated in organizing Indo-UK workshop on Fiber Optics, APW-2006 and Spectra 2006. The chapter organized a project presentation competition for the senior M. Sc students on 24th February 2006. A visit to NeST Photonics, Kochi was organized for the M. Tech students in March. On December 2nd 2006 another industrial visit to Ranjini Eye Care Institute, Kochi and NeST Photonics, Kochi was organized for the chapter members.

The chapter members Jijo P U, Rajesh M and Vinu V N shared their knowledge on fiber optics to the post graduate students on 21st February 2006 in 'Fiber zest 2006'- a one day national level workshop on "Optical Fibre Communication" at Sri Krishna Arts and Science College, Coimbatore. This was a joint venture of the department of electronics and communication systems of SKAC and the ISP-SPIE student chapter.

The Optics to School Programme was conducted on 7th October at Cardinal HSS, Trikkakara. The chapter members helped the students to understand various optics experiments and phenomena. A video presentation on the possibilities of Optics as career was also screened. On 4th of May, 2006, half a day was reserved for the young school children spending their summer vacation in the University. Mauritius Vice President, H.E. Abdul Rauf Bundun and his team visited ISP laboratories on 15th May 2006

The chapter organized a chikun gunya awareness programme for the students and staff of the ISP and CELOS on October 11th and 12th. As a part of this programme campus cleaning was arranged on 11th and on12th. Dr. Thankamma, a medical practitioner, explained the precaution methods against this epidemic and distributed the preventive medicines.

Due to the overwhelming response from various schools to the optics to school programme, the chapter conducted an open house programme for the school and college students on November 6th 2006, as a part of the Spectra 2006. Over a thousand students came and discussed their doubts regarding various optics experiments.

The chapter has organized a voluntary blood donation camp on 26th January 2007 as a part of the republic day celebrations.

This year the chapter is planning to implement new activities along with the ongoing programmes in association with the ISP- OSA Student chapter.

Spectra 2006

Spectra 2006 was organized in the CUSAT campus during 4-7 of November 2006 to commemorate Raman day- the birthday of the legendary figure in the field of Indian physics-Sir C.V.Raman. Competitions such as the Physics Quiz and Colloquium were held for college and university students from South India. Attractive prizes including cash awards, merit certificates and books were presented to the winners. The event also had the ***Raman Memorial Lecture*** by Prof C Vijayan, Department of Physics, IIT Madras and by Dr Unnikrishnan, NPOL, Kochi along with several video and poster presentations.

Congratulations……

Rose Mary Receives the Nalanda Endowment Prize of 2006

The 2006 Nalanda Endowment Prize will be presented to Ms. Rose Mary during the inaugural function of APW-2007. The Nalanda Endowment Prize is instituted by Prof N. G. Devaki of Department of Hindi, CUSAT. This Prize includes cash, memento and merit certificate and is given every year to the student who stands first in the First Semester Examination of Integrated M Sc (Photonics) Degree of CUSAT.

PSI Prize to Agile Mathew

Mr. Agile Mathew receives the Photonics Society of India Prize of the year 2006 who stood first in the M Tech Degree Examination in Optoelectronics and Laser Technology conducted by CUSAT. The PSI prize is given every year to the student who stands first in the M. Tech. Degree Examination (OE& LT) of CUSAT. This Prize is instituted by Prof C P Girijavallabhan, Director of CELOS. The prize which includes cash, memento and merit certificate will be presented during the inaugural function of APW 2007. Mr. Agile is at present a doctoral student at the Centre for Nanotechnology, IIT Guwahati, working on solid-state quantum computing.

Seminars by Visitors

25 April, 2006: "Indian Contributions to Mathematics and Astronomy" by Dr V B Panicker, Retired Principal, Palakkad Engineering College.

8 August, 2006: "A. T. P. binding to the sodium pump studies by under graduate students" by Dr. Pramod R Prathap, University of North California, Greensboro.

6 October, 2006: "Fire Safety in Laboratories" by C Mahadevan, Head-Safety, Health and Environmental Department, IC.

1 December 2006: " Physical fitness for computer users", P Vinod Bhattathiripad, Chartered Systems Analyst & Software Architect.

8 May, 2006: "Fiber Optic Sensor for Industrial Applications" Dr K T V Grattan and Dr. Tong Sun, School of Engineering and Mathematical Sciences, City University, Northampton Square, London.

8 May, 2006: "Rigorous Design Optimization of Photonic Devices by using the Finite Element Method" Dr B M A Rahman, School of Engineering and Mathematical Sciences, City University, Northampton Square, London.

17 May, 2006: "Holographic Memory Storage techniques" by Dr. Joby Joseph, Department of Physics, IIT Delhi.

10 August, 2006: "Astronomical Masers" by Dr. Preeti Pratap, Massachusetts Institute of Technology, USA.

1 September 2006: "Measuring with qubits", Dr. Anil Shaji, Information Physics Group, Department of Physics and Astronomy, The University of New Mexico.

26 October 2006: "A new approach to the mathematical solutions" Dr. R Prathap, Emeritus Professor, ISP, CUSAT.

21 November 2006: "Digital Image Processing" Tomson D George, Lead Consultant, Wipro Technologies.

30 November, 2006: " Limitations of automating Grammar and Sentences in a language", P Vinod Bhattathiripad, Chartered Systems Analyst & Software Architect.

5 December 2006: "Plasma wakefield accelerator experiment", Dr. A V. Ravikumar, Institute of Plasma Research, Ahemmedabad.

18 January 2007: "Laser based technologies for the detection of traces", Dr. Jaipal Dudeja, Laser Science and Technology Centre, New Delhi.

2 February 2007: "Optical Networks", Mr. George Mathew, Deputy general manager, Southern telecom region, BSNL, Ernakulam.

New Doctorates from ISP

Dr. Rajesh.S has received his PhD for the thesis titled 'Non linear dynamics of semiconductor lasers: Control and synchronization of chaos'. He has completed his doctoral work under the guidance of Prof: V.M.Nandakumaran.

Now he is working as a postdoctoral fellow in Mathematical Modeling and Computational Biology Group at the Centre for Cellular and Molecular Biology, (CCMB) Hyderabad . His area of research is Modelling and Simulation of Spatiotemporal Organization in Biological System, such as coupled biochemical pathways and metapopulation dynamics in ecology.

Dr. Bindu Krishnan has received her PhD for the thesis titled 'Synthesis and laser induced studies of nanosized ZnO for photonic applications'. She has completed her doctoral work under the guidance of Prof:V.P.N.Nampoori.

Now she is working as a Scientist, in Centre for Materials for Electronics Technology(C-MET), Department of Information Technology, Govt.Of India, Mulankunnathukavu, Thrissur, Kerala.

Dr. Geetha.K has received her PhD for the thesis titled 'Design,fabrication and charsacterization of passive and active polymer photonic devices'. She did her thesis work in the fibre optics division of ISP under the guidance of Prof:P.Radhakrishnan.

Now she is working as a lecturer in Centre of Excellence in Lasers and Optoelectronic Sciences(CELOS), Cochin University of Science and Technology, Cochin, Kerala.

Dr. Rajesh M has received his PhD for the thesis titled 'Fabrication and characterization of polymer optical fibers for smart sensing and optical amplification'. He has completed his doctoral work under the guidance of Prof: V P N Nampoori.

Now he is working as a postdoctoral fellow in City University London. Current area of research is to develop fiber Bragg grating based sensors to detect the chemical reactions taking place within lime stone structures.

Recent Publications from ISP

1. A Santhi, Vinu V Namboodiri, P Radhakrishnan and V P N Nampoori, "Spectral dependence of third order nonlinear optical susceptibility of zinc phthalocyanine", Journal of Applied Physics, 100, 053109 (2006).

2. Mandanparambil Rajesh, Mavila Sheeba, Karinjamanna Geetha, Chakkalakkal P. G. Vallabhan, Padmanabhan Radhakrishnan, and Vadakkedathu P. N. Nampoori, "Fabrication and characterization of dye doped optical fiber as a light amplifier", Applied Optics, Vol. 46, No.1, 1 January 2007.

3. A Santhi, V N Vinu, P Radhakrishnan and V P N Nampoori, "Simultaneous determination of nonlinear optical and thermo-optic parameters of liquid samples", Applied Physics Letters, 89, 1 (2006).

4. K Geetha, M Rajesh, V P N Nampoori, C P G Vallabhan and P Radhakrishnan, "Laser emission from transversely pumped dye-doped free standing polymer film", Journal of optics A: Pure and Applied optics, 8, (2006) 189-193.

5. S Rajesh, V M Nndakumaran, "Control of bistability in a directly modulated semiconductor laser using delayed optoelectronic feedback", Elsevier Physica D 213 (2006) 113-120.

6. M Rajesh, K Geetha, M Sheeba, , C P G Vallabhan, P Radhakrishnan and V P N Nampoori, "Characterization of Rhodamine 6G doped polymer optical fiber by side illumination fluorescence", Optical Engineering, 45(7) 075003, July 2006.

7. Annieta Philip K , Lyjo K. Joseph , Litty M. Irimpan, Bindu Krishnan , P. Radhakrishnan , V. P. N. Nampoori , Raghu Natarajan, 'Thermal characterization of ceramic tapes using photoacoustic effect physica status solidi (a), (2007)

8. M Rajesh, K Geetha, M Sheeba, P Radhakrishnan , C P G Vallabhan and V P N Nampoori, "A fiber optic smart sensor for studying the setting characteristics of various grades of cement", Optics and Lasers in Engineering, Volume 44, Issue 5, May 2006, Pages 486-493.

9. M Rajesh, M Sheeba, K Geetha, C P G Vallabhan, P Radhakrishnan and V P N Nampoori, "Design and fabrication of dye-doped polymer optical fiber for optical amplification", SPIE Proceedings: Symposium on Optics & Photonics, August 2006, San Diego, California USA.

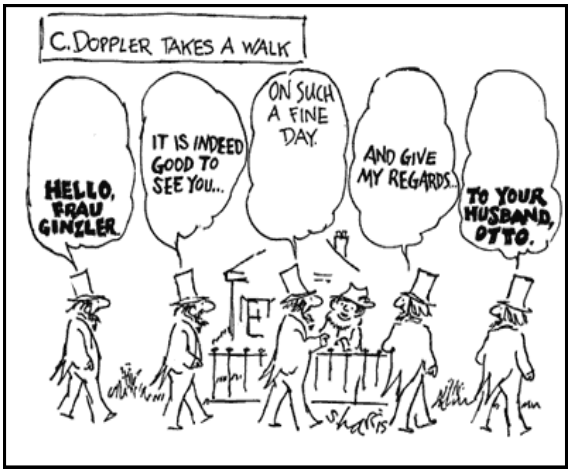
10. K Geetha, M Rajesh, V P N Nampoori, C P G Vallabhan and P Radhakrishnan, "Propagation characteristics and wavelength tuning of amplified spontaneous emission from dye doped polymer film waveguide", Appl. Opt. (In Press)

11. Ritty J.Nedumpara, Geetha K, Dann V. J, V. P .N .Nampoori, C.P.G.Vallabhan and P Radhakrishnan; "Light amplification in dye doped polymer films", J. of Opt.A:Pure and Appl.Opt.9 (2007) 7-14.

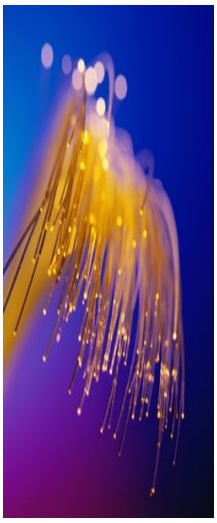
Celebrating the occasion of the National Science Day as well as the anniversary of International School of Photonics

Annual Photonics Workshop 2006

Celebrating the occasion of the National Science Day as well as the anniversary of its own inception, International School of Photonics organized a two day National Workshop in Photonics on the 27th and 28th of February, 2006. About 100 participants comprising of University and college teachers, researchers and scientists, and students with various background in science and engineering participated in this workshop with the focal theme: "Ultrafast Processes." A series of films on the well known astro physicist Stephen Hawking were screened on 28th February 2006 as a part of the national science day celebrations. The various notions and views of this distinguished scientist were well appreciated by the audience.



INTERNATIONAL SCHOOL OF PHOTONICS



The International School of Photonics (ISP) was established on February 27, 1995 by delinking the erstwhile Laser Division of the Dept of Physics of the Cochin University. Within its decade long existence, ISP has become one of the leading research centres in the country in the field of optics and photonics. The department has produced many talents through various courses such as the M Tech in Optoelectronics and Laser Technology, M Phil in Photonics and Ph D degrees in various topics.

ISP is a one among the three participating departments in the UGC sponsored Centre for Excellence in Lasers and Optoelectronic Sciences (CELOS) established in the University

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Annual Photonics Workshop 2007

APW - 2007

27,28 February 2007

at

International School of Photonics

Cochin University of Science and Technology

Cochin – 682 022

During the last several years, optics has once again become an area of considerable importance as a result of the emergence of new fields such as optical solitons, atom optics, meso and adaptive optics, optical networks, integrated optics etc. In view of this the International School of Photonics, which has been organizing annual workshops in various topics in Photonics, has decided to conduct a 2-day workshop (APW–2007) on "**Recent trends in Non linear Optics**" .

The main objectives of APW– 2007 is to give an introduction to the above topic to motivated persons interested in these. The target group will be young researchers and teachers who are planning to enter in the general area of Photonics. Tentative list of topics to be covered are recent trends in Optical Solitons, ultra fast optical processes, integrated Optics, Nano Photonics and Optical Computing. One Session will be devoted to poster presentation.

…….and the last word

"The greater the doubt, the greater the awakenings; the smaller the doubt, the smaller the awakening, no doubt, no awakening"

G. C. Chang

Seeing is believing

INDO UK WORKSHOP-CULTURAL PROGRAMME

INDO UK WORKSHOP

OPEN HOUSE

ONAM CELEBRATIONS

SIVATHANDAVAM

AT PHOTONICS 2006

OPTICS TO SCHOOL

ISP ON REPUBLIC DAY