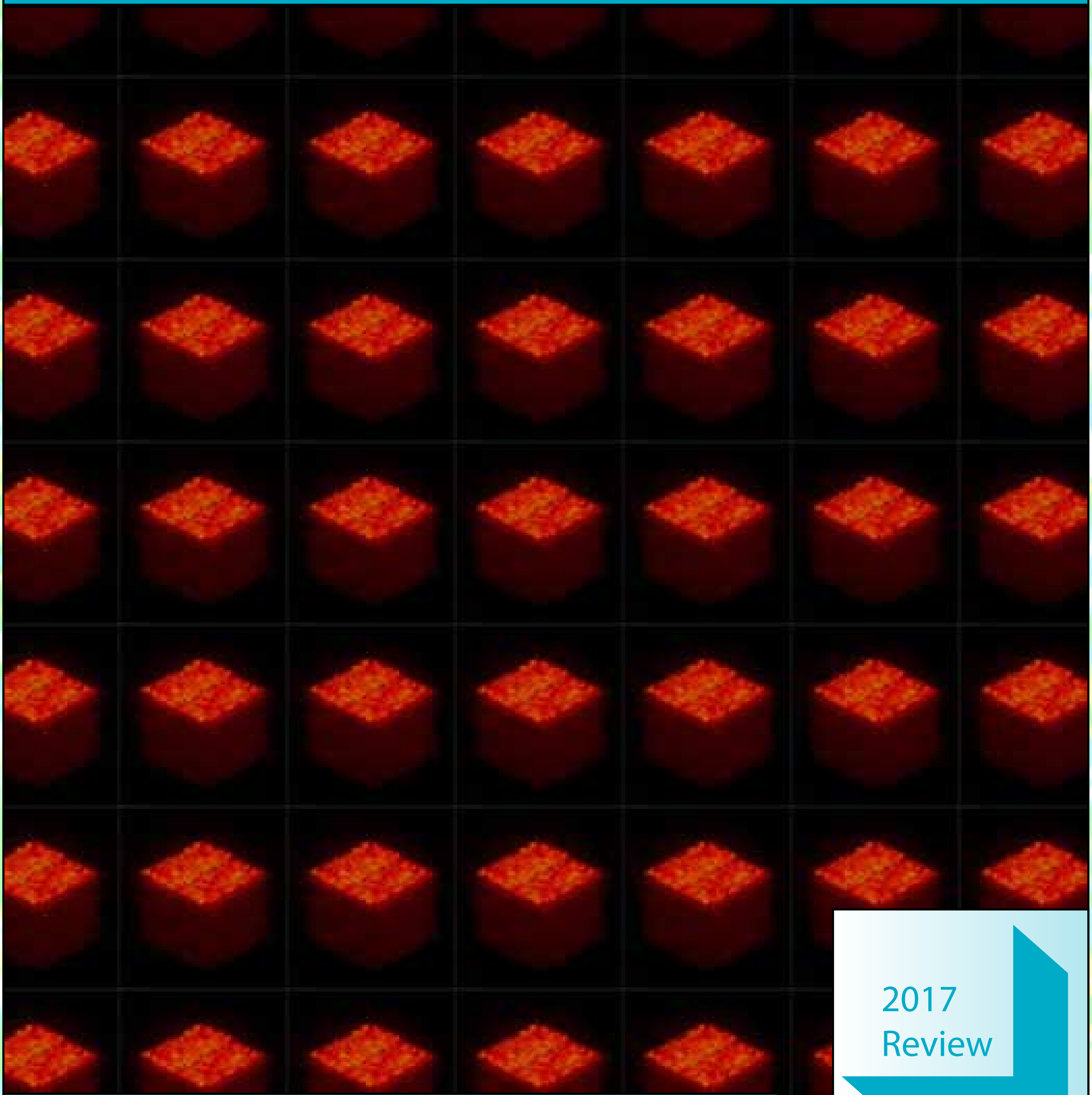
Faculty of Natural & Mathematical Sciences
Department of Physics

King's College London

Nanostrand

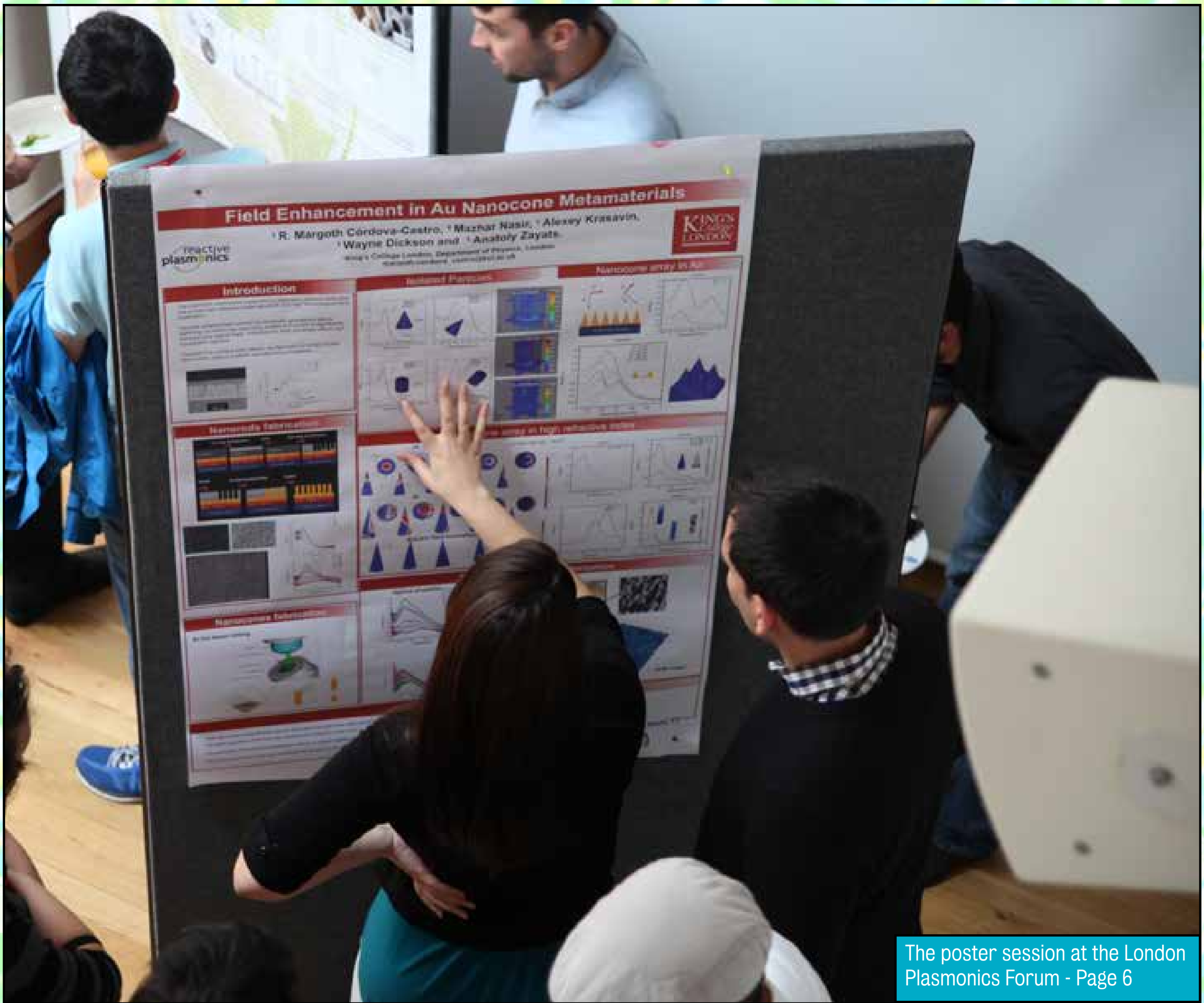
The Photonics & Nanotechnology Research Group

The Biological Physics & Soft Matter Group



LIGHT MANIPULATED TO MAKE 2D SURFACES APPEAR AS 3D OBJECTS - PAGE 5

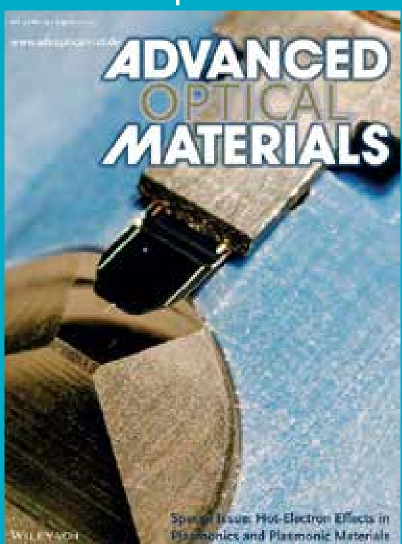
2017 Review



The poster session at the London Plasmonics Forum - Page 6

Welcome to Nanostrand, the newsletter for the Photonics & Nanotechnology Group and the Biological Physics & Soft Matter Group at King's College London.

Newsflash - Special Edition of Advanced Optical Materials



Head of P&N Professor Anatoly Zayats is a guest editor for a special edition of Advanced Optical Materials.

The special edition, entitled 'Hot-Electron Effects in Plasmonics and Plasmonic Materials' has been edited alongside Professor Stefan Maier from Imperial College London.

Zayats and Maier are both investigators on the EPSRC programme grant Reactive Plasmonics, a multidisciplinary collaborative project between King's College London and Imperial College London and are co-directors of the London Institute for Light (see story on page 4)

New Research Groups

The Department of Physics has two new research groups, the Photonics and Nanotechnology Group (P&N) led by Professor Anatoly Zayats and the Biological Physics and Soft Matter Group (BPSM) led by Professor Sergi Garcia Maynes.

The two new groups have grown out of the old Experimental Biophysics and Nanotechnology Group which has now split. "With the rapid growth of the Experimental Biophysics and Nanotechnology (EBN) Group over recent years, enabled by significant investment in science and technology areas at King's, its structure became too restrictive to fairly reflect new research interests and directions" said Professor Zayats, former Head of EBN. "The new P&N Group will focus on research in photonics, nanoparticles and advanced photonic materials and their applications in 21st century technologies."

Members of the EBN Group before the split into two new groups

The other new group is BPSM, led by Professor Sergi Garcia Maynes who said, "The Biological Physics and Soft Matter group aims to use bespoke technology and analytical methods borrowed from the Physical Sciences to address important fundamental questions in Biology. Building upon a strong tradition in Biophysics at King's, the purpose of the new research group is to employ cutting-edge experimental and computational approaches to tackle the most exciting unresolved scientific challenges in this highly interdisciplinary field."

Professor Peter Main, Head of the Physics Department said "This is an exciting time for the Department of Physics at King's College London. We have been able to appoint a lot of talented new staff. In parallel with that, we have rearranged our research groups and now have two new groups. These two areas are strategically important for our department and our aim is to build on our already leading international reputation. Our two other research group TPPC and TSCM have also had an influx of new blood and continue to thrive at the very highest level."

New Appointments

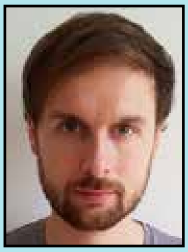
2017 saw a number of new appointments of academic staff in the new research groups.

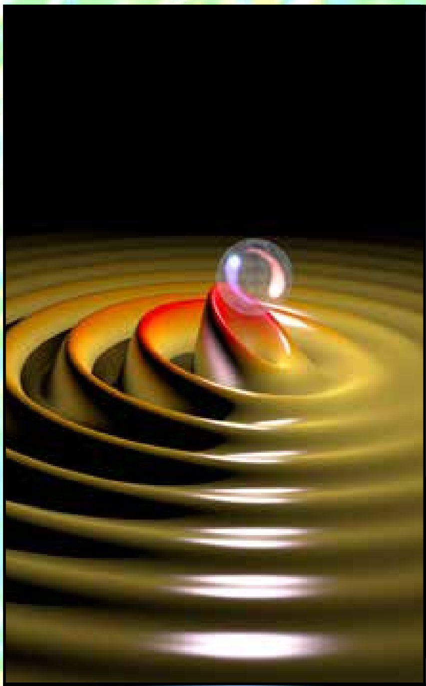
Dr Amelle Zaïr joined the P&N Group in July 2017 as a lecturer. She specialises in Attosecond Physics and her research interests include ultrafast laser-matter interaction and capturing and controlling attosecond time scaled phenomena.

Dr Katelyn Spillane joined the BPSM Group as a lecturer in January 2018. Her research focuses on biophysical aspects of immune cell behaviour especially B cells which are white blood cells that are central to adaptive immune responses

Dr Aliaksandra Rakovich joined the P&N Group as a Research Fellow & Proleptic Lecturer. Her research interests lie at the interface of nano- and bio-physics including biomimetic nanophotonic systems and nano-enhanced biophotonic materials.

Dr James Millen will be joining the P&N Group in April 2018 as a lecturer. He was recently awarded the David Bates Prize by the Institute of Physics for his pioneering experimental and theoretical contributions to the field of quantum optomechanics.





London Institute for Advanced Light Technologies

A new research network has been set up by the Head of Photonics and Nanotechnology Group, Anatoly Zayats along with Stefan Maier at Imperial College London . The London Institute for Advanced Light Technologies is a multidisciplinary research network which brings together scientists and industries in London who work on emerging photonic technologies. Its mission is to provide an interdisciplinary and collaborative environment to explore new opportunities for growing research and applications of light, a framework for interactions with the photonic industry, and training for PhD students. To find out more please visit www.london-light.org

Department of Physics achieves silver award in Sustainable Laboratories programme

Dr Simon Fairclough and Bill Luckhurst from the Department of Physics have achieved a silver award in the Sustainable Laboratories programme at King's College London.

Laboratories entail energy and waste footprints that are 3-10 times greater than comparably sized non-research spaces. Therefore, engaging with researchers and technical staff in the lab is integral to the university both achieving its carbon reduction targets and using resources more efficiently for scientific research.

The Silver Award requires, amongst other things, consolidation of cold storage facilities, shut down processes are in place to ensure that all non-essential equipment is turned off, the sashes of fume cupboards are closed, equipment is well maintained and shared, procurement of energy-efficient equipment and that waste streams have clear signage with as much material as possible being diverted away from hazardous waste streams where appropriate.

Tytus Murphy, Sustainability Projects Officer at King's said 'Simon and Bill have created a positive culture with respect to reducing environmental impacts, promoting lab efficiency and sharing best practice throughout the wider King's networks.'

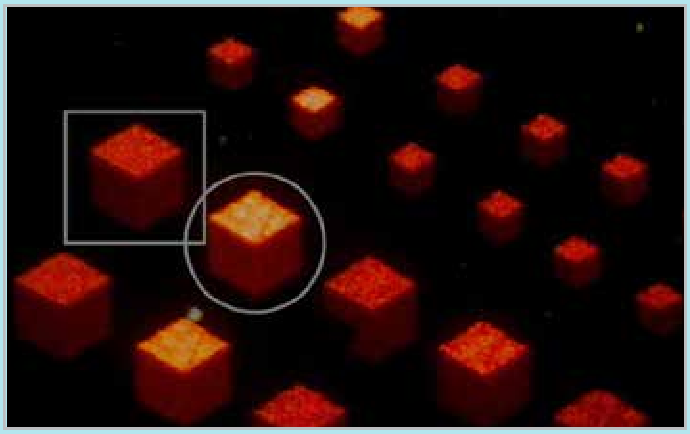
Professor Anatoly Zayats, Head of the Photonics & Nanotechnology Group said 'We are delighted and proud that we can contribute to making this world more sustainable for the future.'

The P&N Labs at KCL

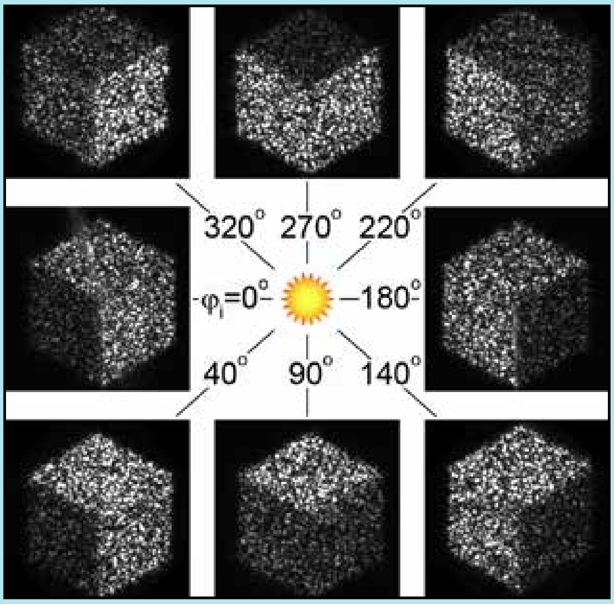
Manipulating light to make flat surfaces appear as 3D objects

P&N Scientists have created new 2D nano-surfaces which appear as realistic 3D objects – including shading and shadows - using cutting edge nano-engineering.

When light hits an object, the colour, texture, and shape affect how light is absorbed and reflected, allowing you to make out the object in front of you. By altering the surface to change how light is reflected, it is possible to manipulate how it appears. The researchers developed layered materials, incorporating precisely designed nano-features smaller than the wavelength of light – called metasurfaces. This allowed them to control how light is reflected in highly precise ways, so that a 2D surface reflects light just as a 3D object would. Borrowing a technique from 3D graphics called Normal Mapping, researchers encoded shadow effects into the image, creating 3D images more realistic than holograms or 3D cinema. As a proof of concept, the researchers fabricated a flat metasurface imitating lighting and shading effects of a 3D cube.



The technique could have huge implications for the optical industries, including in TV screens and photography. Professor Anatoly Zayats of the Photonics & Nanotechnology group said: “Metasurfaces are amazing. They open up unprecedented freedom in directing and manipulating light. One might ultimately imagine a TV screen which appears exactly the same as you move around it, or a new movement of 3D art”.



The ability to control light could bring new functionality to small camera lenses. A flat surface can be made to appear optically convex by designing appropriate metasurface properties. Future generations of smartphone cameras could use the tiny flat metasurfaces which mimic the properties of sophisticated curved camera lenses, allowing much greater control of angle and depth field. The wafer thin materials could also replace heavy optical lenses in applications such as satellites, where weight and size have a big impact on efficiency. More immediately, the novel nano-materials could already be used to create unique complex 3D images for security and anti-counterfeiting applications, as well as for new measurement applications requiring precise control of light.

Dr Alexander Minovich, Newton International Fellow at King’s College London, said: “The normal mapping demonstrated with our metasurface is a completely new concept, but it could have very important implications for a wide range of optical industries, both in introducing new functionality and making products smaller and lighter”.

Wheatstone Lecture 2017

The 5th annual Wheatstone Lecture was given in February 2017 by Professor Miles Padgett from the University of Glasgow.

Professor Padgett explained that cameras are often marketed in terms of the number of pixels they have – the more pixels the “better” the camera, however his team have been developing cameras that have a single pixel. Such single pixel approaches are particularly useful for imaging at wavelengths where detector arrays are either very expensive or even unobtainable. The ability to image at unusual wavelengths means that one can make cameras that can see through fog or smoke or even image invisible gases as they leak from pipes. Beyond imaging at these unusual wavelengths, by adding time resolution to the camera it is possible to see in 3D, perhaps useful for autonomous vehicles and other robotic applications.

From L-R: Professor Miles Padgett, University of Glasgow, Professor Peter Main, Head of the Department of Physics @ KCL, Professor Anatoly Zayats, Head of the P&N Group @ KCL

London Plasmonics Forum 2017

From L-R: Dr James Dimmock, Sharp Laboratories of Europe, Dr Susannah Cooke, EPSRC, Professor Anatoly Zayats, Head of P&N Group @ KCL

The 3rd London Plasmonics Forum was held on the 14th June at King's College London. The event continues to grow with 100 attendees from London and from further afield. The session started with a keynote talk by Dr. James Dimmock of Sharp Laboratories of Europe on the subject of metal layers for photodetectors and solar cells.

The current challenge in solar power technology is to increase the panels' efficiency. One way to do this is to use the temperature gradient induced by the illumination on the electrons to harness energy. The systems, called Hot Carrier Solar Cells, can be further improved by using metallic layers, whose characteristically high and broadband absorption increase the harnessed energy. There are two ways that allow to extract energy from the system: a Schottky barrier or tunnelling across the metal layer. Dr Dimmock showed how different they are, especially under dual-beam illumination.

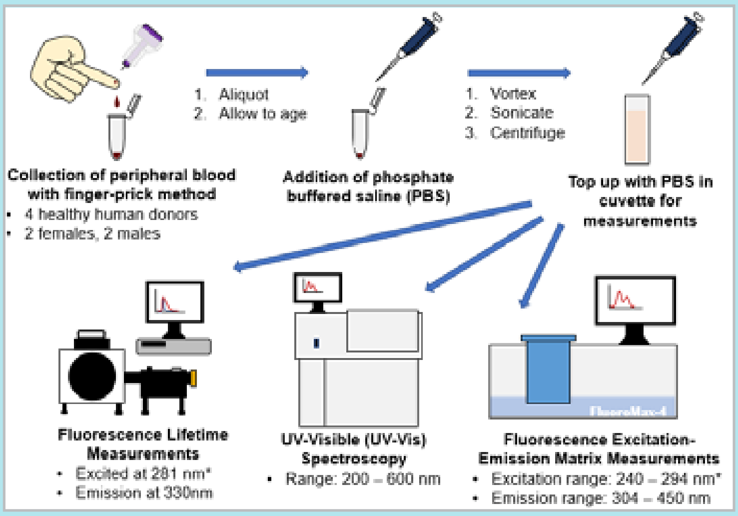
Each year the Forum invites early researchers to apply to give a talk or present a poster. The next event will be held on the 7th June. If you would like more details please email Plasmonics-Forum@kcl.ac.uk.

The poster session at the 2017 London Plasmonics Forum

A new method for analysis of bloodstains

Scientists from the Biological Physics & Soft Matter Group have been working on research to provide new methods of analysis for blood stains at crime scenes. New techniques could help forensic experts to more accurately predict the age of victims and suspects as well as how long it has been since a blood stain was deposited.

Bodily fluids are among the most important biological evidence recovered from crime scenes, but predicting the age of a sample donor is challenging.



Members of the group are working on a technique which uses ultraviolet light of a certain wavelength to determine the time from the creation of a bloodstain. It does this by looking at the florescence present in the blood, which fades over time. This allows more accurate estimations of the age of a bloodstain from hours to those that have been there for more than a week.

Uncertainty of the age of blood deposits has led to the rejection of forensically valuable evidence in the past. The new method could help police gather more accurate evidence such as information about the time a crime occurred or to discount irrelevant blood at crime scenes.

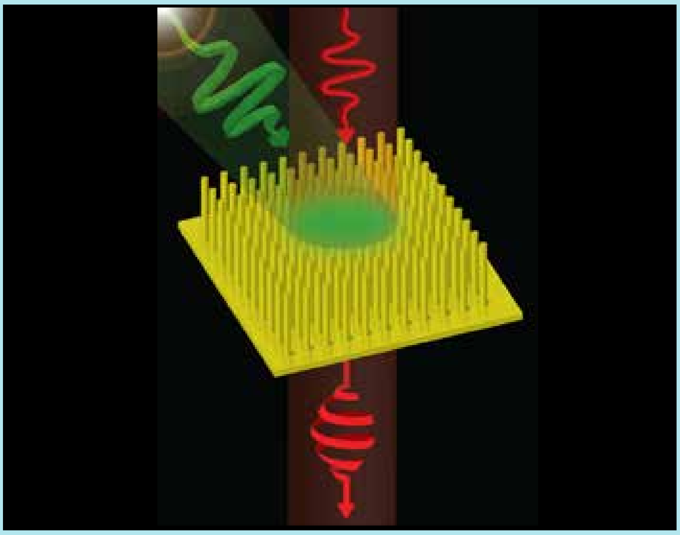
Professor Klaus Suhling from the BPSM Group, said: 'Even small bloodstains can be dated and used by police to determine when the crime was committed. Blood fluoresces naturally under ultra-violet light, and so this technique could be highly accurate and the next stage now is to move to further trials in the field.'

Schematic diagram showing the collection and preparation of blood samples for subsequent

Image Credit: Ching Leung

P&N scientists develop ultra fast method of changing fundamental property of light

Researchers from the Photonics & Nanotechnology Group have developed a new method for rapidly changing the polarisation of light, one of its fundamental properties. The research, published in Nature Photonics, could lead to much faster data transfer and advance research into nano-materials.



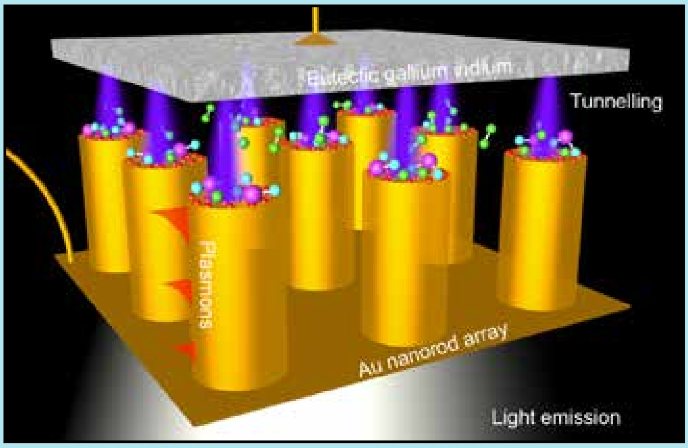
A light wave undulates in different ways – known as its polarisation. The polarisation of light is changed by the material it passes through, so we can use it to learn about unseen nano-scale worlds such as drug chemistry and quantum electronics. Switching polarisation is also used to transfer digital information along fibre optic cables.

The electronic methods currently used to control the light polarisation in such applications is reaching its physical speed limit. Researchers at King's have overcome this problem, allowing polarisation to be switched at timescales of less than a millionth of a millionth of a second – hundreds of times faster than current electronic methods.

This will allow us to 'see' very fast nano-scale processes such as chemical reactions for the first time, by illuminating them with rapidly changing light. This helps us to understand the difference in formation of nasty chemicals and life-saving drugs, and allows us to study new materials that will bring about the next technological revolutions. This will also represent a major advance in data transfer speeds. By rapidly changing the polarisation of light – to represent a one or a zero – data can be passed along fibre optic cables and into your living room more rapidly. This will help meet growing data sharing demands driven by streaming and cloud services.

New nanomaterial could enable new types of chemical processes in pharma, materials and chemical industries

Researchers from the Photonics & Nanotechnology Group have engineered a new nanoscale device which creates a controlled stream of 'hot electrons' – high energy electrons which allow unusual chemical reactions to take place.



The research, published in Nature Nanotechnology, describes how a metamaterial – a material with properties not found in nature – can be constructed and use quantum effects to turn electrons flowing through a circuit into hot electrons and light, in a highly controlled manner. The creation of hot elections is useful to a wide range of industries that are interested in making new chemicals that do not occur under normal conditions. For example, synthesising new molecules in pharma and chemical industries. The metamaterial can be used for developing and understanding new chemical reactions where precise stimulation and monitoring are paramount.

The material can reliably detect hydrogen and oxygen, two chemicals where there is a great need for sensitive monitoring. Detecting hydrogen leaks is important in the production of fuel cells, and monitoring the presence of oxygen is vital in a wide variety of controlled chemical reactions, such as in the manufacture of drugs. The material can be modified to be sensitive to different molecules, making it viable as a highly sensitive, cheap, and easy to use sensor to detect molecules.

The material could also be used in small scale electronics instead of bulky semiconductor lasers. Since it can generate light it can be used to transmit information between or within microchips by turning the light on and off to produce 1s and 0s.

A selection of our recent publications

Photonics & Nanotechnology Group

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