The research commercialisation office of the University of Oxford, previously called **Isis Innovation**, has been renamed **Oxford University Innovation**

All documents and other materials will be updated accordingly. In the meantime the remaining content of this Isis Innovation document is still valid.

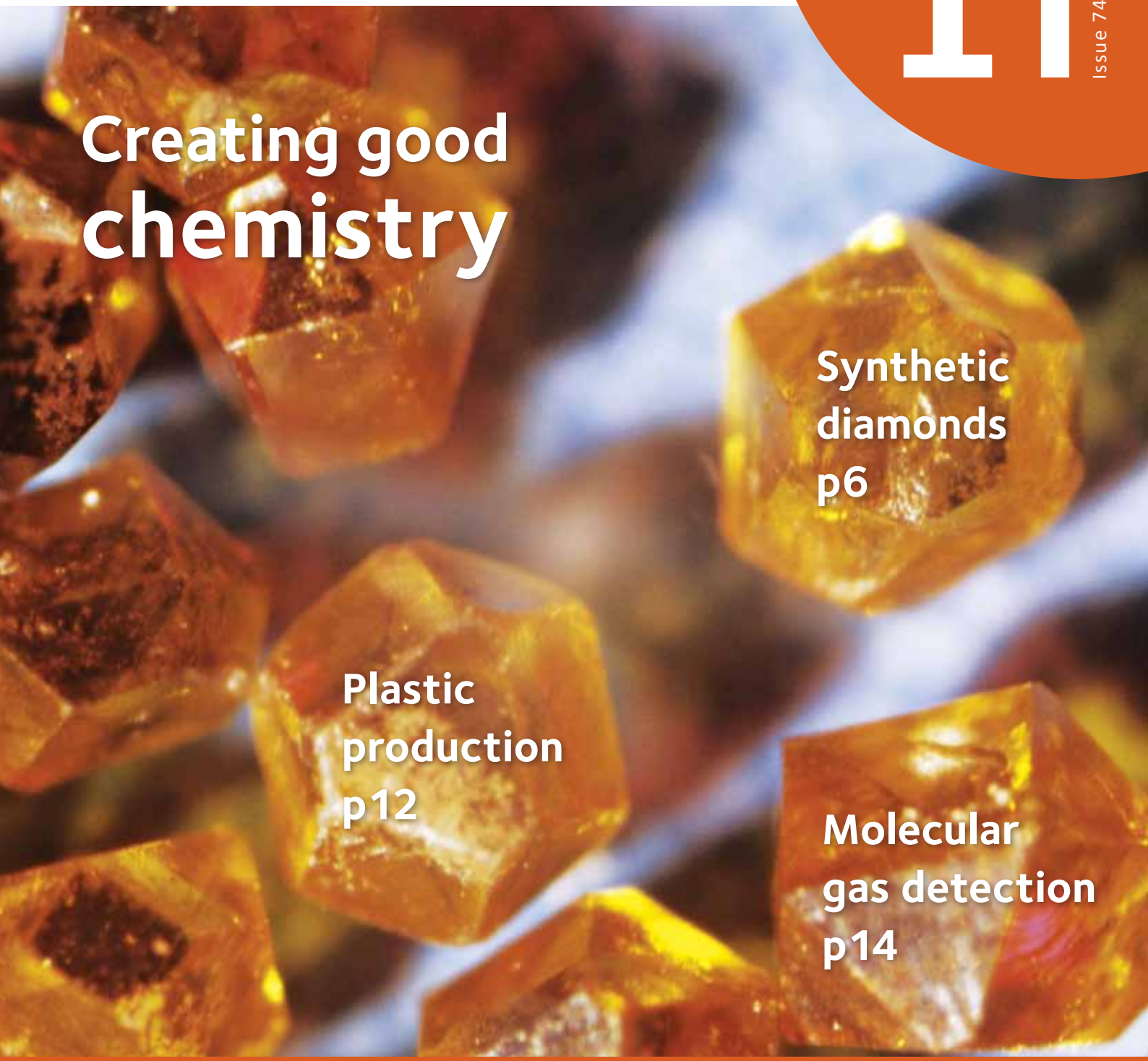
URLs beginning www.isis-innovation.com/... are automatically redirected to our new domain, www.innovation.ox.ac.uk/...

Phone numbers and email addresses for individual members of staff are unchanged

Email : enquiries@innovation.ox.ac.uk

Isis insights

Issue 74 Winter 2013



Creating good chemistry

The latest innovations, collaborations and technology transfer

UNIVERSITY OF OXFORD

ISIS INNOVATION

Issue 74
Winter 2013

Creating good chemistry

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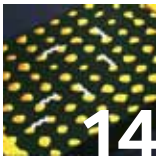

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Sensing technology for license

Information

Innovation

Invention

Inspiration

Ii is produced by Isis Innovation Ltd, the technology transfer company owned by the University of Oxford. To receive your free copy of Ii, email innovation@isis.ox.ac.uk
www.isis-innovation.com

Isis is a research and technology commercialisation company owned by the University of Oxford.

NEWS

Record year for Isis

Isis Innovation's Annual Report to March 2013 has now been published. Activities during the year resulted in a total of 395 new licensing, consulting and spin-out transactions, with £5.6m transferred to the University, Departments and researchers, against an investment of £2.5m from the University to invest in protecting University intellectual property. Total income for the year was a record £11.5m. Please request a copy of the report if you have not already received one.

Witty Report – "use universities to drive economic growth"

"Encouraging a British Invention Revolution : Sir Andrew Witty's Review of Universities and Growth" was published in October. UK universities, Sir Andrew writes, have "an extraordinary wealth of ideas, technology and human energy - much of which is world-leading and capable of seeding not just new companies but whole industries". He urges government to simplify funding streams, and commit to spending £1 billion over the next parliament on "Arrow Projects", joint ventures in clusters between universities and business, including Local Enterprise Partnerships. Isis welcomes the report's call for universities to partner with innovative local Small and Medium Enterprises (SMEs), something that we are already pioneering through the SME Smart IP (SSIP) scheme, http://www.isis-innovation.com/licensing/SMESmartIPScheme.html.

100 companies created

Following Isis' 25th anniversary (Isis Insights 72), this summer we passed another milestone. More than 100 new companies – including both spin-outs with University IP and start-ups from the Isis Software Incubator - have now been formed by Isis, since 1988. Isis is proud to have made this contribution to the impact that Oxford University has across the world, creating sustainable economic growth locally, nationally, and internationally.

New Business Incubator in China

Companies looking to establish themselves in China can now benefit from the Jinhui International Technology Transfer Centre, a business incubator that will provide industrial design and product prototyping facilities that are unique in China. Up to 100 high technology companies working in fields such as automotive components, materials, agriculture, industrial automation and software can be accommodated in the incubator, which is managed by a joint venture formed in June. The incubator is based in Liuzhou, which is home to 3,000 companies including a number of joint ventures created by industrial giants such as General Motors, Nissan and Renault.

Enterprising Consultancy

News from Isis Enterprise and Oxford University Consulting

Closing the gap

Oxford University Consulting (OUC) draws upon the depth and breadth of Oxford's world-class multidisciplinary research base to provide answers to many of the challenges faced by organisations and society today. Recently, it has been working with academic consultants from Oxford's Department of Education, who are studying options for addressing the 'attainment gap' between advantaged and disadvantaged school pupils.

The National College for Teaching and Leadership has helped establish a scheme that will allow schools and teachers to participate in research, grant-funded, that will both improve the evidence-base for the observed gap and also support development in schools.

Part of the programme – Closing the Gap: Test and Learn – has the Department of Education working with Durham University, the education trust CfBT, and evidence in education experts CUREE. The partnership will run a programme of training and support for all schools taking part in the scheme.

The National College for Teaching and Leadership and CUREE consulted, last spring, to identify interventions to be tested and collated over 200 responses in total.

Over 750 schools, representing 190 teaching school alliances, will participate in the intervention research over the next two years. Upon expressing a preference for delivering a specific intervention, the participating school will deliver an intervention according to an agreed protocol, with training beginning in the autumn term. The progress of pupils at schools delivering the intervention will be compared against that of their counterparts in schools that are not using that intervention to determine its effect.

Oxford University Consulting supported the University of Oxford's Department of Education with the contract and administration associated with the project.

Web link

www.education.gov.uk/nationalcollege/index/about-us/national-college-role/national-college-consultations/testandlearn.htm
.

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Czech consultancy

Bespoke consultancy services are offered by Isis Enterprise (IE) to interested individuals and organisations globally.

IE is currently providing training and secondments for staff from the International Clinical Research Centre (ICRC) at St. Anne's Hospital in Brno, the Czech Republic's second city. ICRC is a science and research centre with a focus on finding new methods, technologies and medicines for the effective prevention, early diagnosis and treatment of cardiovascular and neurological diseases.

IE consultants are imparting information on topics including IP identification, evaluation, protection and marketing. The clients are also learning about commercialisation via several routes to market including licensing and spin-out formation.

In addition to receiving a two-day training course delivered at ICRC, the technology transfer staff are taking two week secondments at Isis in Oxford. During their internships they enjoy a series of workshops, as well as gaining insights into the structuring of technology transfer offices and defining appropriate Key Performance Indicators (KPIs) to monitor progress and impact. The training also covers internal and external technology transfer marketing.

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The portfolio

The latest **spin-out** and **investment** news

OxCept: Safeguarding mobile payment security

OxCept is an Oxford University spin-out company seeking capital to develop the world's most secure peer-to-peer mobile payment solution. OxCept will license US and EU patents based on technologies invented at the University's Computer Science Department. The technologies enable secure communications between two parties for financial transactions.

The technology

OxCept's technology is 100 percent software. People can initiate secure financial transactions with each other using a mobile device. There are no cords, machines or phone-swipe attachments. There is no swiping, scanning or card reading. No pass codes, account information or credit card details are disclosed and there is no network connection between the devices. The application is immediately easy to use. Both parties simply download the app and the payer then authenticates the payee and authorises a payment. The payee does not authenticate the payer.

OxCept's technology is immune to many advanced security attack techniques and has been peer reviewed and tested over the past seven years by some of the world's leading universities. The technology is in the prototype stage and the security protocols have been successfully tested by the UK Ministry of Defence.

Seed capital

The company now requires £800,000 of seed capital to fund product development and to gain early market validation of the peer-to-peer transaction functionality. Additional capital requirements will be assessed after 18 months.

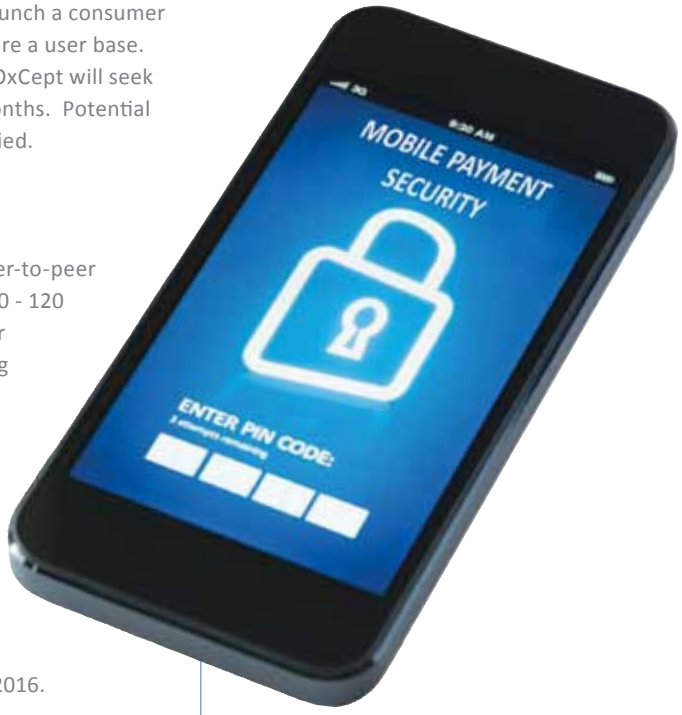
OxCept's strategy is to launch a consumer product in 2014 and secure a user base. After market validation, OxCept will seek a trade sale within 36 months. Potential buyers have been identified.

The market

The global market for peer-to-peer transactions will total $80 - 120 billion, with the figure for mobile payments growing to more than $50 billion by 2017. In the US, in 2011, peer-to-peer transactions totalled an estimated $22 billion. In the UK, the number of peer-to-peer mobile transactions taking place is expected to treble by 2016.

The team

Headquartered in the UK, with a development facility in Silicon Valley, OxCept's management team is endowed with deep knowledge and expertise in finance, technology, operations and security. With over 20 years' experience deploying marketable products, the management team features the current Head of Oxford's Computer Science Department and individuals with Oxford MBAs and PhDs.



"People can initiate secure financial transactions with each other using a mobile device. There are no cords, machines or phone-swipe attachments"

OxCEPT
start 'OxCepting' payment!

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elementsix™

With the synthetic diamond company now embedded in Oxfordshire, Element Six's Chris Wort profiles the OIS member company he represents and describes the role supermaterials have to play in an eclectic range of industries.

Element Six, a member of the De Beers Group, is the world leader in the design, development and production of synthetic diamond supermaterials. Currently establishing a research and development facility in Oxfordshire, Element Six's head office is registered in Luxembourg, with primary manufacturing facilities based in China, Germany, Ireland, Sweden, South Africa, US and the UK.

For over 50 years, the core business has remained the synthesis and processing of synthetic diamond supermaterials, an entity which includes manufactured synthetic diamond and other supermaterials such as cubic boron nitride (CBN), tungsten carbide and silicon cemented diamond. Synthetic diamond is well known as the planet's hardest known material, possessing unique properties. It is from the sixth element of the periodic table, carbon, that the business takes its name.

Element Six is made up of two businesses: Technologies, which is 100 percent owned by the De Beers Group, and Abrasives, which is 60 percent owned by the De Beers Group, with Umicore, a major global materials group, owning the remaining 40 percent.

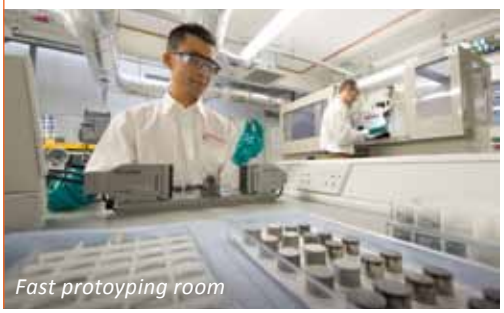
The Abrasives business encompasses our Oil & Gas, Advanced Materials and Hard Materials Divisions. Abrasives uses high pressure, high temperature (HPHT) synthesis to manufacture synthetic diamond and cubic boron nitride (CBN) and high temperature sintering to produce tungsten carbide products.

The ultimate engineering materials

Supermaterials can open the door to progress in a staggering range of applications. We have a successful track record of working with companies in many different sectors to provide built-for-purpose extreme performance supermaterial solutions. Our collaborative and flexible approach has seen both start-ups and multinationals successfully partnering with Element Six to harness the power of supermaterials. Some of the applications that we have been involved with include synthetic diamond tweeters in high-end loudspeakers, synthetic diamond sensors in radiation therapy, synthetic diamond cutters for oil and gas drilling, and synthetic diamond semi-conductors in the Large Hadron Collider.

Synthetic diamond's unique properties

The unique properties of synthetic diamond stem from its rigid lattice structure. Carbon atoms linked together in a dense tetrahedral arrangement make it incredibly strong and give it greater hardness than all other materials. The exceptional hardness of synthetic diamond has inherent advantages in



Fast protoyping room

"With synthetic diamond, machinery keeps working at peak performance, delivering unwavering build accuracy and precision throughout its life cycle"

mechanical and abrasive applications. Extending tool life reduces downtime and drives down operating costs and carbon footprints. Machinery keeps working at peak performance, delivering unwavering build accuracy and precision throughout its life cycle.

However, synthetic diamond has many other extreme properties, including the broadest optical transmission spectrum, the highest known thermal conductivity, a wide electronic band gap, the highest known resistance to thermal shock and many others.

Not surprisingly, the use of specialist technology is required for the manufacture and processing of synthetic diamond. For example, when synthetic diamond is created using high pressure, high temperature synthesis, over 55,000 atmospheres of pressure are delivered – equivalent to stacking approximately 5,000 saloon cars on a jar of peanut butter, at temperatures that would melt steel.

Pipeline

There's a lot more in the Element Six innovation pipeline. Synthetic diamond is undisputedly one of the ultimate supermaterials, but it's not the only one. Through the experience and creativity of our people, we design, develop and manufacture supermaterials products based on cubic boron nitride, tungsten carbide and silicon cemented diamond, all of which bring their own unique and extreme performance properties to the development table.

Synthetic diamond synthesis reactor room

In addition to those four supermaterials, we continue to research and develop new classes of material and applications with the potential to transform performance and deliver economic advantage in industry and science.

From improving carbon footprints to generating increased manufacturing efficiencies, and from new electronic solutions to healthcare advances, Element Six and our partners are helping to bring the power of supermaterials to the world.

Border image: Synthetic diamond windows deliver outstanding technical benefits in high power laser optics

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Remote sensing

Speaking at the September Oxford Innovation Society meeting, **Professor Lionel Tarassenko, CBE FREng FMedSci,** outlined the future of vital sign monitoring.

The best way to assess the physiological well-being of an individual is to measure their vital signs: temperature, heart rate, blood pressure, respiratory rate and oxygen saturation. This is routinely done every few hours by nursing staff on hospital wards, with a view to identifying physiological deterioration as early as possible. Early intervention leads to improved patient outcomes.

The management of chronic diseases such as diabetes, hypertension, heart failure or Chronic Obstructive Pulmonary Disease (COPD) accounts for 80 percent of the growth in healthcare spending in the developed world in the last 50 years. 30 percent of COPD patients and 25 percent of heart failure patients admitted to hospital in the UK in any given year for treatment are re-admitted at least once within the year. There is now a concerted effort to reduce unplanned hospital admissions through early detection of deterioration enabled by patient self-monitoring at home. However, elderly patients with chronic diseases often find that monitoring their vital signs presents a considerable challenge for them.

What is the optimal technology for low-cost, reliable and unobtrusive vital sign monitoring in the home? The first generation of technology has been the “telehealth box” produced by several manufacturers. However, these devices rely on a “one-size-fits-all” approach, often with poor ergonomics, and they are a symbol of illness rather than well-being. Second-generation technology based on computer tablets and Bluetooth-enabled sensors is more successful, but still requires patients to make the measurements. The ideal vital-sign monitoring technology would be unobtrusive (passive monitoring) and generate meaningful data for more than a few seconds each day. A number of third-generation devices, wearable sensors often known as “digital plasters”, are beginning to appear on the market. My research group and I have chosen instead to adopt a radically different approach: remote sensing using webcams.

By measuring and analysing the ambient light reflected from a region of interest on an individual’s face (for example, the forehead) using a webcam positioned up to 2 m way, they are able to derive real-time values of the cardio-respiratory vital signs (heart rate, respiratory rate and changes in oxygen saturation levels). They have invented a novel method of cancelling out the aliased frequency components caused by artificial light flicker, based on a mathematical technique called auto-regressive modelling. This means that non-contact vital sign measurements can be obtained for a wide range of lighting conditions. My group has also been able to construct accurate maps of the spatial distribution of heart rate and respiratory rate data from the coefficients of their

"Changes in oxygen saturation can be tracked by processing the changes in reflectance at two wavelengths"

mathematical model. As a result, the optimal locations in the image for extracting cardiac and respiratory information can be reliably identified.

In clinical studies in the Oxford Kidney Unit, the algorithms have been shown to give accurate values of heart rate and respiratory rate during continuous monitoring of patients for several hours. The accuracy has been established by comparing the webcam-derived estimates with the values obtained from the conventional monitors attached to the patients during these clinical studies. Finally, preliminary results have established that changes in oxygen saturation can be tracked by processing the changes in reflectance at two wavelengths (typically, the red and blue wavelengths from the webcam).

Following the successful completion of these clinical studies, a new company, Oxehealth, was spun out in September 2012 from my research group in the Institute of Biomedical Engineering. The initial funding, from the IP Group, is for Oxehealth to exploit Oxford's disruptive technology across a broad range of applications, from the consumer market to clinical monitoring in the home and the hospital. The intellectual property has been protected by patent applications, and the company is working with the research group on the remote monitoring of babies and of elderly patients at risk of stroke.

"Accuracy has been established by comparing the webcam-derived estimates with values obtained from conventional monitors attached to patients"

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Benefit through partnership

OIS speaker **Professor Keith Channon**, Director of Research and Development at the Oxford University Hospitals NHS Trust, describes how commercial and patient benefits are derived from clinical research.

Enshrined in the NHS constitution is a "commitment to innovation and to the promotion, conduct and use of research to improve the current and future health and care of the population". This is one of the values guiding the NHS and within it the National Institute for Health Research's 11 Biomedical Research Centres (BRCs) and 20 Biomedical Research Units (BRUs), spread nationwide, backed by investment of £800million over five years.

Oxford's own BRC, the University of Oxford and the Oxford University Hospitals NHS Trust are together realising significant commercial and patient benefits from clinical research undertaken in the city. The partnership engine – consisting of these three connected parties – delivers an outstanding quality of translational and clinical research on a large scale.

Clinical research facilities in areas including gastroenterology, immunology, cognitive health, genomics, and neuroscience are all clinically embedded. Clinical Trials Units are aligned and UKCRC-accredited. The Oxford University Hospitals NHS Trust - Oxford University partnership itself, meanwhile, is underpinned by a statutory agreement and in physical form, brings together administrators from both institutions in a joint research office at the Churchill Hospital site. In this office a dedicated team of contracts, legal and business development specialists works closely with Isis Innovation Ltd to manage the translation of IP generated by Trust employees from initial disclosures into technologies and applications which will have demonstrable clinical impact. This process may be achieved via different channels depending on the technology in question, including licensing and new company formation.

Company formation

Several spin-out companies have been formed following clinical research undertaken 'within' the NHS in Oxford. The imaging software developed by Intelligent Ultrasound, spun-out through Isis in 2012, will save the NHS £40million per year in cardiology diagnostics alone, according to CEO Andy Hill. The company's financial backers include the Oxford Invention Fund, the firm's founders, and the NHS National Innovation Centre. The Centre – which accelerates the development of innovative technologies likely to deliver significant benefits to patients and the NHS – contributed a development award to Intelligent Ultrasound.

Software commercialised by Run3D, another relatively new company formed via Isis, is being used by runners assessed at Oxford's Nuffield Orthopaedic Centre and beyond. The technology enables

"Several spin-out companies have been formed following clinical research undertaken 'within' the NHS in Oxford"

assessment of 3D gait biomechanics, muscular strength, flexibility and alignment, interpreting how these factors contribute to running and walking overuse injuries.

A non-invasive liver scan developed by a team from the Radcliffe Department of Medicine was commercialised by the Oxford University Hospitals NHS Trust and Isis, culminating in the formation of another new company, Perspectum Diagnostics, earlier this year. Fellow spin-out Oxehealth *[covered in the article by Professor Lionel Tarassenko on page eight]* promises tremendous benefit to patients through remote monitoring of those at risk of stroke and other life-threatening conditions.

Oxford BioEscalator

This year has seen development of the Oxford BioEscalator concept, an initiative which will serve to further realise the potential of the world class clinical and research expertise and assets in Oxford and the surrounding region. Once complete, the BioEscalator will represent a leading international centre for the commercial exploitation of bioscience and medical research and innovation.

The new model of bioscience business growth will reduce risks associated with early stage energy firms, stimulate new funding and management mechanisms, and create resilient, sustainable companies.

Not all clinical research needs to be commercialised to create benefit, of course. Through partnership we will continue to build research capability for both commercial and patient advantage.

OIS talk summary by Barney Cullum

Isis is responsible for the management and commercial exploitation both of jointly owned IP and IP solely owned by the Trust.

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Low-cost catalyst

Dr Jamie Ferguson presents a single site polymerisation catalyst that represents a low cost and simplified process for the production of polyethylene, the world's most familiar plastic.

Single site catalyst

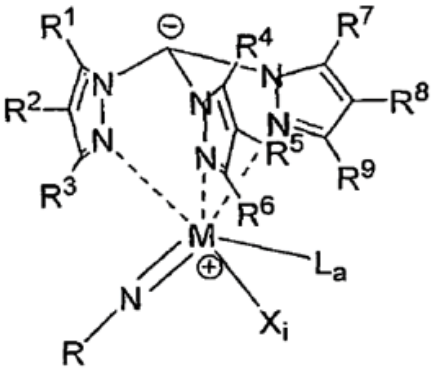
Researchers at Oxford, along with industrial collaborators, have developed a process to produce polyethylene (PE) homopolymer using a single site catalyst system. The system does not incorporate boron or fluorine atoms and has been shown to be a homopolymerisation catalyst for ethylene.

Polyethylene

PE is the most common plastic in existence, with annual production measuring approximately 80 million tonnes. The main use of PE is for packaging such as bags, films, membranes and bottles. PE produced via polymerisation of solely ethylene monomers is called homopolymer; when other monomers are also used, it is termed a co-polymer. Many types of polyethylene are known, with most having the chemical formula $(C_2H_4)_nH_2$. Small changes in structure, molecular weight and density lead to PE's wide variety of properties and uses.

Advantages of Oxford's approach

The proposed system combines the catalyst with the activator in one compound i.e. the cation and anion are within the structure. This represents a single site catalyst and avoids the need to carry out expensive and elaborate synthesis to make the separate zwitter ions. Polymerisation can be carried out without any activator present as this is built-in to the catalyst system.



As shown in the structure, M is a Group IV or V metal, L_a is a coordinating ligand that is a Lewis base, and X_i is an anionic ligand.

Moving forward

The underlying technology is the subject of granted European patent EP1781716B1. Companies interested in progressing the commercial opportunities are invited to contact Isis.

Supporting data

Please refer to: "A remarkable inversion of structure-activity dependence on imido N-substituents with varying co-ligand topology and the synthesis of a new borate-free zwitterionic polymerisation catalyst". H. R. Bigmore, S. R. Dubberley, M. Kranenburg, S. C. Lawrence, A. J. Sealey, J. D. Selby, M. Zuideveld, A. R. Cowley, and P. Mountford, Chem. Commun., 2006, 436-438. DOI: 10.1039/B514467A

Border image: Colour enhanced x-ray diffraction pattern for polyethylene crystals.

"The proposed system combines the catalyst with the activator in one compound, circumventing the need to carry out expensive and elaborate synthesis to make the separate zwitter ions"

Production of Polyethylene: a timeline

Polyethylene was first made, accidently, in 1898. However, it was not until 1939 that Imperial Chemical Industries (ICI) started a process for its commercial production. Philips Petroleum launched a new low temperature and pressure process in 1951; whilst in 1953 Karl Ziegler developed a catalytic system based on titanium halides and organoaluminium compounds that worked at even milder conditions than the Phillips catalyst.

Historically, Ziegler-Natta catalysts have been widely used to make PE, but in recent years metallocene catalysts have become favoured because of their high activity and ability to selectively make desired grades of PE, including grades to replace aramid fibres in high strength applications. Producers of PE tend to use or in-licence proprietary catalytic processes.

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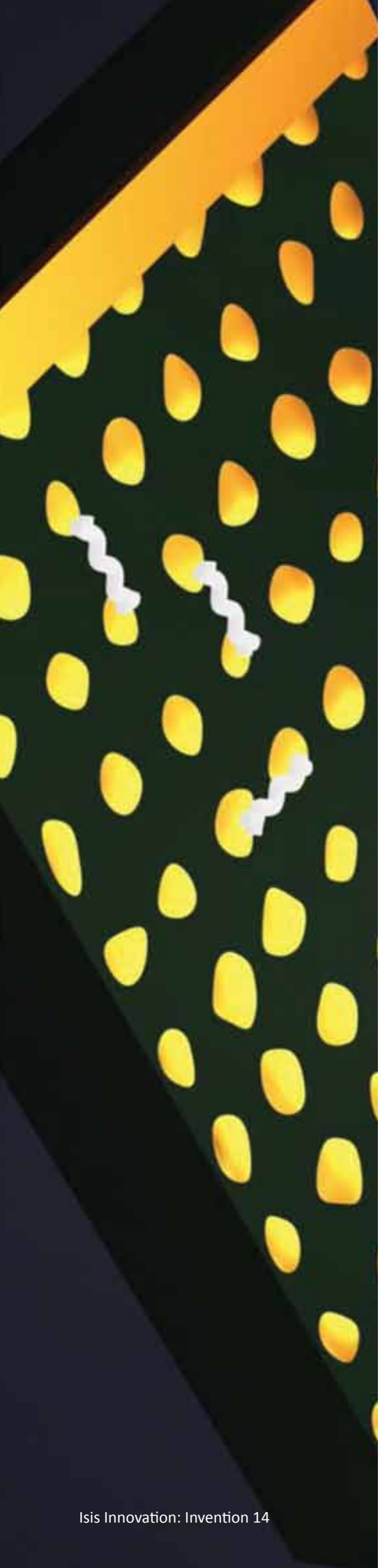

Gas detection

Dr Jon Carr profiles sensing technology that allows low concentration, ultra-sensitive detection of a range of molecular gases.

The ability to detect very low concentrations of gases in the atmosphere is desirable throughout the industrial, security and medical sectors. In warehouses containing chemical storage tanks and at security posts in airports, for example, gas detectors are already routinely used. The high sensitivity gas sensors currently in use are often based on optical absorption or spectrometry but the drawback with these detectors is that they are large, expensive and can lack robustness. Electrochemical gas sensors, in contrast, are supplied as robust and relatively cheap, but they lack the necessary sensitivity below the parts per million thresholds while the range of molecular gases that they are capable of detecting is limited.

Oxford's approach

Researchers from Oxford's Materials Department have been investigating and measuring nanostructures through Scanning Electron Microscope and Tunnelling Electron Microscope techniques for over two decades. The researchers have now managed to develop a different nanostructure sensing method to allow ultra-sensitive gas detection. They first create a 2D array of metal nanoparticles on an insulating substrate. The array is manufactured to create an insulating substrate decorated with metal nanoparticles with average spacing of just a few nanometres. By measuring the conductivity while this nanoparticle network is actually manufactured they found that the process can be finely controlled to create whatever spacing is desired.

The next step is to form 'bridges' between the nanoparticles with conducting connector molecules. These connector molecules can be engineered to have a binding site specific to a particular molecular gas, which will significantly influence the electrical conductivity of the connector molecule. With the help of the Department of Chemistry, the team are investigating a whole range of different connectors to allow different molecular gases to be detected.

During production the number of connector molecules can again be controlled and repeated. As the proportion of connections is increased, the probability increases that a conducting pathway is formed. A critical point is reached when the number of connections is sufficient to provide a conducting pathway in half the random configurations and this point is called the percolation threshold. Working in the region of the percolation threshold results in the distinctive advantage of maximum sensitivity when a gas interacts with the connector molecule. The presence of even very low concentrations of the target gas will disrupt the conductivity

Material	Advantages	Disadvantages	Application Fields
Metal Oxide Superconductor	Wide range of industrial gases, low cost, quick response time	Sensitivity, high energy use	Industrial
Calorimetric	Low cost, stable	Cross sensitivity, sensor poisoning	Combustible gases
Polymer	Low cost, low energy, quick response time, good sensitivity	Poor selectivity and stability	Industrial/Indoor air monitoring
Optical	Excellent sensitivity, selectivity and stability	High cost, large size	Gas leak detection/ Air quality
Gas Chromatograph	Excellent sensitivity and selectivity	High cost, large size	Lab analysis
Moisture Absorbing	Low cost	Poor repeatability	Humidity measurement

Summary of current gas sensing methods

significantly, and the disruption can then be detected with the appropriate electronics.

The group is now looking to produce prototype sensors that can be measured against the key criteria for efficient gas sensing systems: high sensitivity and selectivity; fast response time and recovery time; temperature independence; stability; measurement concentration range.

Applications

Widespread applications exist in industry, space exploration, biomedicine, and pharmaceutics. Immediate applications for this invention could be found in the environmental monitoring of gases, with the team having already shown proof of concept results for moisture and alcohol. Long-term, the technology could be used for the ultra-sensitive detection of landmines, human breath monitoring for low concentrations of biomarkers, and real-time detections of toxic or pathogenic gases within the medical industry.

Patent protection

This technology is now the subject of an international patent application, and Isis would like to discuss with interested companies the development and licensing of the technology.

Border image: Schematic representation of the insulating substrate decorated with the gold metal nanoparticles and 'white' conducting connector molecules

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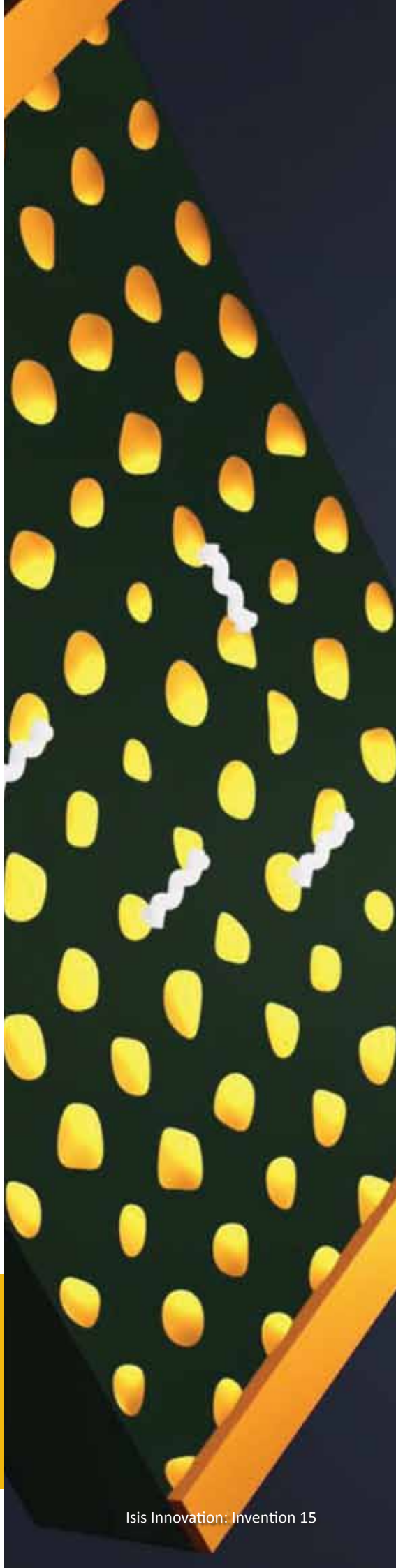


Faster, brighter scintillators

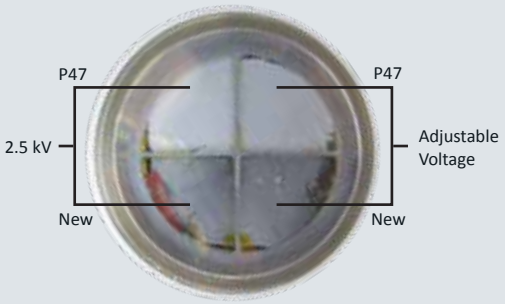
Dr Andy Robertson introduces a new class of materials that provide faster and more efficient conversion of an electron or ion signal into light, delivering performance benefits in a range of applications.

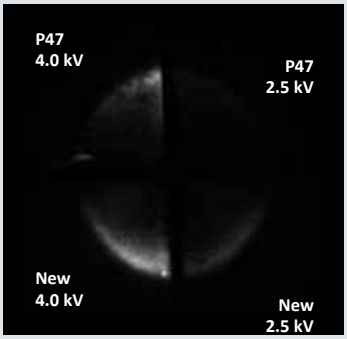
Scintillators and scintillator screens are in widespread use in a range of applications, including night vision devices and mass spectrometry. When using a scintillator to generate light in response to the detection of an electron or ion, critical performance considerations are the intensity and speed of that response. Speed, in this case, is defined by the time taken for the scintillator intensity to recover so it can record the next event, since this determines the temporal resolution of the measurement. We use the symbol τ to represent the lifetime of this intensity decay; shorter lifetimes mean improved time resolution. For time-of-flight (TOF) mass spectrometry this relates directly to improved mass resolution, which is a key performance characteristic.

Performance improvements demonstrated

Researchers at Oxford University have discovered a new range of scintillators and scintillator screens have been prepared from the new materials. Their performance has been compared to those of standard scintillators currently used in TOF imaging applications e.g. P47 (Y_2SiO_5:Ce) and P43 (Gd_2O_2S:Tb) phosphors. P47 is particularly favoured due to its faster decay lifetime, so this material was chosen as the benchmark for direct comparisons between the new scintillators and current phosphors. By preparing composite scintillator screens containing two different scintillators in two or four sections, comparative performance measures were made under identical experimental conditions. The results demonstrate that the new materials offer a number of advantages:

- **Faster intensity decay time:** A number of the new scintillators were tested and found to have decay lifetimes, τ, in the range 3-10 nanoseconds (ns) compared with the measured value of 53 ns for P47. This effectively represents an order of magnitude improvement.
- **Brighter:** Tests looked at the relative brightness of emission from the new materials compared to P47. Improved brightness yields improved detection efficiency and improved signal-to-noise ratio, typically leading to a considerable reduction in data acquisition times. The test results (see image) show significantly higher signal intensity for the new materials relative to P47 when detecting electrons of a given kinetic energy (x1.6 better at 2.5kV with larger gains at higher voltages). For applications in which scintillator screens are used as optical readouts for position-sensitive microchannel plate (MCP) detectors, the improved brightness allows lower operating potentials to be employed, increasing MCP lifetime.





Left: Quadrant detector assembly used for the relative brightness measurements.

Right: Representative images obtained using a quadrant detector employing the new scintillator and P47, at two different sets of acceleration potentials.

"Evidence from day-to-day use over several months suggests there are unlikely to be issues with product life"

Additional benefits

Along with improved time resolution and brightness, testing has demonstrated that the new scintillators are vacuum stable and offer good reliability. A 47-hour endurance test showed no degradation in signal. Evidence from day-to-day use over several months suggests there are unlikely to be issues with product life.

The inventors have also tested performance in photofragment ion imaging applications, for which spatial resolution is a further key performance parameter. Ion images produced in these tests are in close agreement with those produced using P47, and analysis of photofragment velocity distributions extracted from the images even indicates a modest improvement in the spatial resolution of the detector when using the new scintillators.

Backwards compatibility and future-proofing

Together with these performance enhancements the new scintillators also benefit from having similar emission spectra to existing materials, such as P47. As a result, screens manufactured with the new materials are compatible with existing CCD and CMOS image sensors.

Finally, the new scintillators can also be used in the emerging SPAD or photomultiplier-based direct ion detection configurations (see, for example, **Isis Project 7908 on the Isis website**), where the materials offer faster signal decay times than currently preferred scintillators such as LYSO crystal (τ = 3-10ns vs. LYSO's ~40ns).

Commercial opportunities

In addition to night vision devices and imaging mass spectrometry, scintillators are employed in a range of detection applications including PET scanners and neutron imaging. Companies designing and manufacturing detectors in a range of industries will have an interest in this project and are invited to contact Isis. The underlying technology is the subject of a UK patent application.

Border image: mass spectrometer

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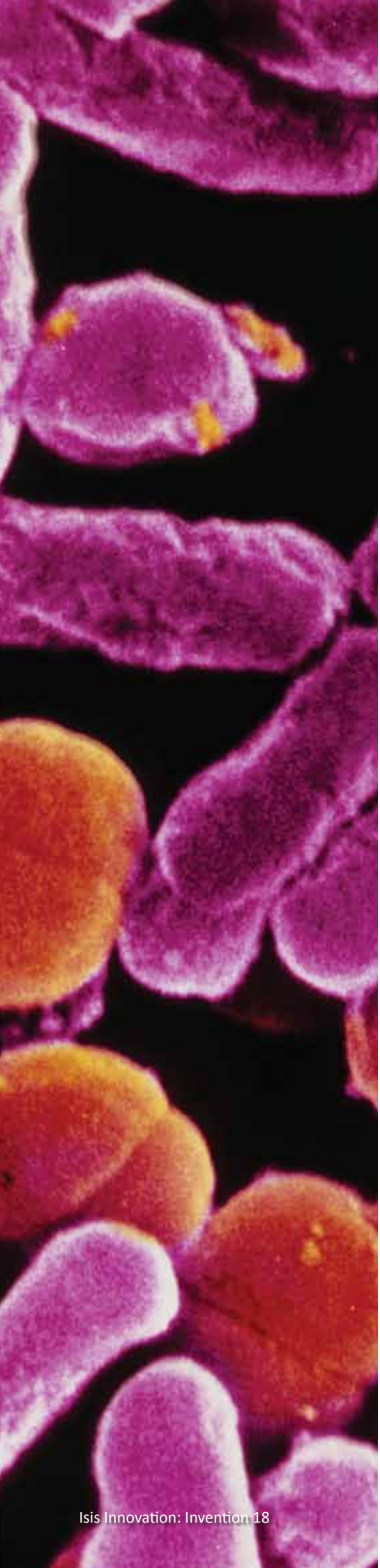

Antibiotics

Dr Mark Gostock discusses an approach for treating Gram-negative bacterial infections based on non-toxic carbohydrate drug candidates that disrupt bacterial growth. The approach allows the host's immune system an opportunity to clear the infection, replacing the need for traditional antibiotic treatments.

Resistance

Antibiotic resistance is a serious and growing threat in contemporary medicine and has emerged as one of the pre-eminent public health concerns of the 21st century. In 2004, over 70 percent of pathogenic bacteria had generated resistance to at least one commercially available antibiotic. Some 125,000 people across Europe and the USA die every year due to bacterial infections resistant to antibiotic treatments. Within these regions, drug-resistant bacteria inflict an additional financial burden on healthcare systems through exaggerated medical costs of up to $35 billion.

Despite the looming crisis, the pharmaceutical industry has been slow to develop new antibiotics, with the pipeline of future treatments described by the World Health Organisation as "virtually dry". A critical demand therefore exists for new antibiotic treatments that are active against resistant bacteria.

Cell-wall disruption

Capsular polysaccharides (CPS) comprise the first and most important protective layer for bacteria against extracellular attacks. The high-molecular-weight CPS surrounds the surface of bacteria, providing high water solubility and protection from various attacks from the immediate environment, for example attacks from the host immune system.

Based on expertise developed under the broad headings of chemistry, chemical biology and biotechnology of carbohydrates and proteins, researchers at Oxford have exemplified a new approach to treatment of bacterial infections based on non-toxic carbohydrates. This library of candidates has been shown to weaken bacteria by specifically damaging their

Oxford antibacterials: key advantages over traditional treatments

- Accessible to the target located on the outer membrane of bacteria from the extracellular environment (no cell penetration)
- Specific to the transporter of the component of the outermost protective layer (CPS) of Gram-negative bacteria (novel target)
- Action of these compounds allows subsequent clearance of infection by the host's immune system (less reliance on traditional antibiotic treatments)
- Non-toxic to probiotics within the host

"Compounds with similar structures to the Oxford blockers are stable and safe in humans, making the carbohydrate based leads very promising drug candidates"

outer cell wall from the extracellular environment without entering the cell. Bacteria exposed to such compounds are thus made vulnerable to attack by the host's own immune system. These drug candidates also offer much greater flexibility for modulation of their functional groups when compared to existing antibiotics. Furthermore, such drugs that target processes which are essential for bacterial survival in the host environment, such as transport, are less prone to resistance.

This novel mode of action, general target protein family and greater structural flexibilityprovide clear strategic advantages and dramatically decrease the possibility of acquired resistance. Compounds with similar structures to the Oxford blockers are stable and safe in humans, making the carbohydrate based leads very promising drug candidates.

Application

The Oxford compounds can advantageously be used in combination with other antibacterial or antimicrobial agents. In this way, exposure of the bacterium via weakening of the CPS layer of the cell can be used to improve the performance of other antibacterial agents.

These candidates are active as antibacterial agents not only as therapeutic agents, but also for use *in vitro*. For example, the compounds may be incorporated into cleaning agents such as soaps, detergents and deodorisers, or to provide antibacterial fabrics for use in sportswear, seat coverings and materials used in medical dressings or plasters. Use of such materials may be extended to polymers and plastics used in food preparation such as chopping boards and storage containers, as well as antibacterial surfaces in hospitals and for medical devices.

Opportunity

The underlying technology is the subject of a PCT patent application and Isis welcomes contact from parties interested in developing this opportunity.

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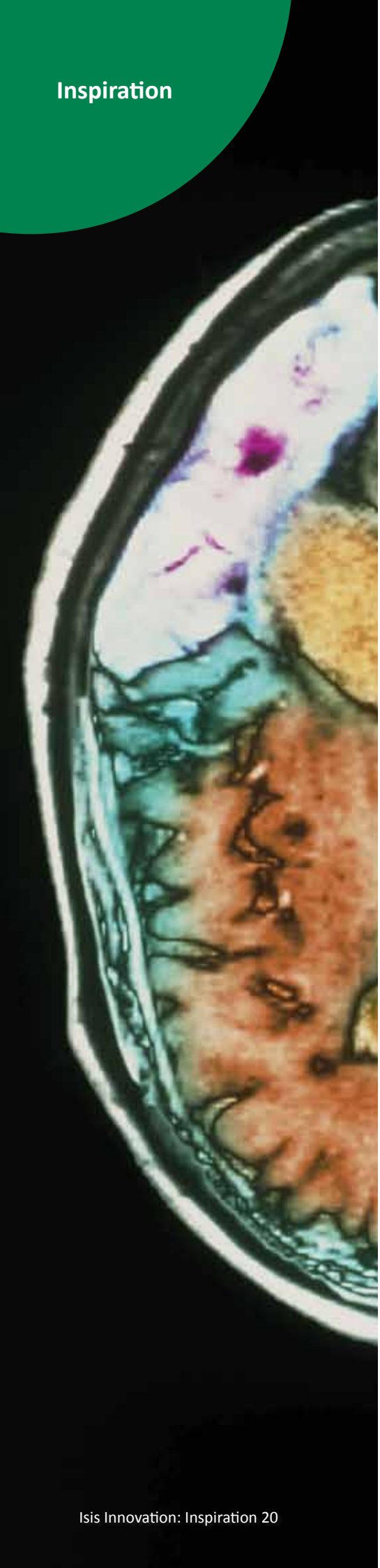

Brain power

Dr Josef Walker charts the progress of Brainomix, in a story exemplifying how academic consulting can contribute to the successful progress of a fledgling company while also highlighting the value and impact such interactions can create.

The Alberta Stroke Program Early CT Score (ASPECTS) system pioneered by Alastair Buchan, Professor of Stroke Medicine and Head of the Medical Sciences Division at the University of Oxford, has been in use for over 12 years. It applies a standardised scoring system to assess a brain CT scan, but needs to be performed by an expert. Brainomix, a start-up company from Isis Innovation's Software Incubator, is now developing e-ASPECTS, a piece of software that seeks to automatically implement the ASPECTS clinical scoring methodology to CT scan images. In doing so, it removes the need for an expert and increases the options available to centres that lack such resource: the software could be used by any hospital in the world.

With individuals who have experienced an ischaemic stroke it is possible to use thrombolytic drugs to dissolve the clot and restore blood flow to minimise damage. However, it has been established that there is only a four and a half hour window from the time a stroke occurs during which a thrombolytic treatment is effective. Therefore it is critical to minimise the time from occurrence to diagnosis. Currently, the assessment of a patient's CT scan needs to be performed by an expert consultant. For those centres that lack such an expert there is the potential for a patient with an ischaemic stroke to miss the vital treatment window.

To kick-start the development of e-ASPECTS, Brainomix won funding through the first phase of the Small Business Research Initiative (SBRI) run by the UK's innovation agency, the Technology Strategy Board. Brainomix allocated some of this to the building of an economic model for understanding whether the use of e-ASPECTS represented value for money to the UK National Health Service. In order to build the economic model, Dr Michalis Papadakis, Managing Director and Co-founder of Brainomix, approached Oxford University Consulting (OUC) with a request for expertise and OUC introduced them to Dr Oliver Rivero-Arias, a Senior Researcher from the Health Economics Research Centre at the University of Oxford. Through a consultancy agreement arranged by OUC he advised Brainomix on constructing the model.

"In order to produce a robust model to demonstrate health economic value, it is critical that the underlying assumptions are based on the best available information from the most reliable sources, otherwise any subsequent conclusion you come to that your technology will deliver value will be difficult to defend," Dr Rivero-Arias

"It is critical to minimise the time from stroke occurrence to diagnosis"

says. "Helping Brainomix to build their model was very rewarding and led to an extremely satisfactory outcome."

Working together, they built an economics model for e-ASPECTS and this was submitted by Brainomix as part of their bid for additional funding from the SBRI, this time for a much larger sum that would enable the company to make significant progress with developing e-ASPECTS. In September 2013, Brainomix was awarded £819,000, a sum that will be used to help the company develop the software, carry out validation studies and ensure compliance with European regulations.

"Getting the economics model right was fundamental in our application for additional funding and working with Oliver was a very positive experience," Dr Papadakis says. "His objective advice was invaluable. With the additional funding we can now take e-ASPECTS forward to the next stage and build on our solid rationale to drive significant clinical and economic benefits for effective stroke diagnosis and treatment."

"Helping Brainomix to build their model was very rewarding and led to an extremely satisfactory outcome"

Dr Oliver Rivero-Arias

Brainomix

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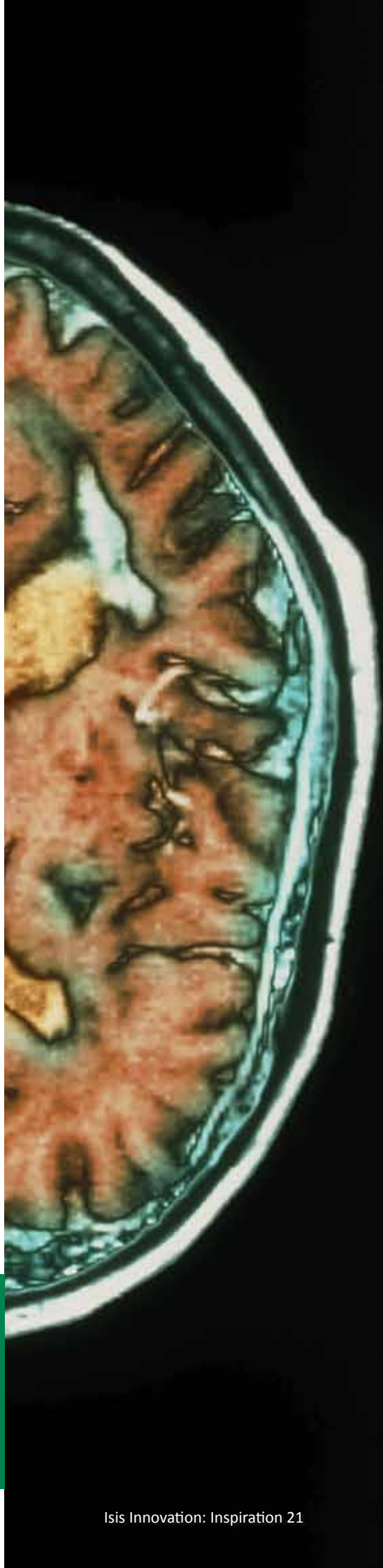

South American spotlight

Dr Mireya McKee and Dr Chris Moody discuss how Isis Enterprise is promoting science and technology innovation in South America.

For 25 years Isis Innovation has been assisting researchers from Oxford University who wish to commercialise the results of their research, harnessing a successful model for the management of the University's patent portfolio, licensing of technologies, and formation of spin-outs.

In addition to the services related to the University of Oxford, Isis also offers consulting advice in technology transfer and innovation management, through its Isis Enterprise division, to clients from the public and private sectors in the UK and internationally. Isis Enterprise's role is to facilitate the flow of new, disruptive technologies from technology providers such as universities, institutes and early stage companies to technology seekers such as mature companies looking to create ground-breaking products and new business divisions.

Isis Enterprise has worked with a wide range of clients in over 50 countries, and is currently strengthening its alliances with organisations in Latin America who wish to promote innovation and entrepreneurship.

Isis aims to provide support to its partners across the innovation ecosystem through activities such as developing Intellectual Property (IP) policies, studying innovation ecosystems, procuring and commercialising technologies and patents, and technology transfer training. Isis is currently participating in several projects to promote science, technology and innovation (STI) programmes in Colombia and Chile.

Innovation in South America

South America is currently experiencing very positive changes in its innovation ecosystem, and a number of countries are committed to increasing their budgets for innovation activities. For instance, Brazil's innovation agency, FINEP, has just put forward a request for over US$18 billion to support initiatives in STI, and Chile will dedicate US$1 billion from its annual

Participants on the Isis Enterprise Commercial Evaluation of Technology Training Programme workshop held in Bogota in July show off their certificates of training, signed by Isis, COLCIENCIAS and the British Embassy. Dr Mireya McKee is on the far left of the picture, with Dr Chris Moody centre.

"Santiago was recently dubbed 'Chilecon Valley' by *The Economist*"

national budget for innovation. Colombia is dedicating 10 percent of the royalties from mineral extraction in the country to research and innovation programmes.

Many countries are also experiencing a positive cultural change towards innovation. Last March, the city of Medellin in Colombia was voted the most innovative city in the world by Citigroup and the Urban Land Institute. Santiago, Chile was recently dubbed "Chilecon Valley" by *The Economist* and the Chilean government declared 2013 to be its Year of Innovation. These changes are playing an important role in driving economic development in the continent and making these countries important actors worldwide.

Isis activities in Colombia

Isis is currently working on a programme to assist the Colombian Department of Science, Technology and Innovation (COLCIENCIAS) in the development of biotechnology capacity in Colombia. The work is funded in part by a British Embassy Prosperity Fund programme and is focused on developing strong skills and procedures for selection of promising biotechnology projects and finding sources of investment; establishing links for international commercialisation of biofuel and other biotechnologies; and creating an environment to support the development of Colombia's Biotechnology industry by addressing the key barriers to growth and promoting sustainable technologies.

Isis is also assisting Corporación Ruta N and TECNNOVA in the City of Medellin in the implementation of a Seed Fund programme to select and later support the commercialisation of research projects with potential market applications in Colombia and other parts of the world.

Other programmes in Colombia include work with the National Agency for the Business Innovation and Entrepreneurship (iNNpulsa) such as a technology transfer strengthening partnership with Javeriana University.

Isis activities in Chile

Isis is working on a programme funded by the Chilean Economic Development Agency (CORFO) to strengthen the technology transfer and innovation management capabilities of seven Chilean Universities: Universidad de Chile, Universidad Católica, Universidad Católica de la Santísima Concepción, Universidad Mayor, Universidad de los Andes, Universidad Diego Portales, and Universidad de Concepción. Isis has also worked with Innova Bio Bio, the agency responsible for supporting innovation in the Bio Bio region in central Chile.

Isis is delighted to be a part of the innovation development process in these rapidly evolving technology hubs and looks forward to continuing the strong partnerships we have developed in South America.

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Oxford Innovation Society

Forthcoming meetings of the Oxford Innovation Society will be held on the following dates:

- Thursday 5 December 2013
- Thursday 20th March 2014
- Thursday 18 September 2014

Meetings are held in Oxford for OIS members and invited guests, and are followed by a formal reception and dinner in an Oxford college hall.

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