NTU DOCTORAL SCHOOL

NOTTINGHAM TRENT UNIVERSITY

"Creating future innovators and impact for education, industry, the professions and society"

Nottingham Trent University
Doctoral School
School of Science and Technology
PhD Projects – 2016

Broad area of research – Physics and Mathematics

Welcome to the Nottingham Trent University Doctoral School

The Doctoral School provides a supportive environment and a thriving research culture that encourages you to reach your full potential as a research degree student.

Valuing ideas, enriching society

We encourage new ideas and new ways of thinking across the whole University through a culture of discovery and innovation. We believe our research has the potential to impact the world we live in and change lives.

Research excellence

Our research is recognised across the world. In the most recent Research Excellence Framework (Ref 2014) most of our research was considered internationally-excellent or world-leading.

The University is committed to developing and expanding its activity to increase the scope, quality and impact of our research.

Be part of our research

With MPhil, PhD and Professional Doctorate research degree opportunities across each of our academic schools, we support students conducting research in a diverse range of areas. Our research students form an important part of our research community and make a significant contribution to our activity.

We offer full-time, part-time and distance learning research degree opportunities.

Our Professional Doctorates offer you the opportunity to contribute to research in your profession while attaining a research qualification.

A supportive community

We are committed to supporting and developing our research students.

You will have academic, administrative and personal support throughout your studies and access to dedicated workspace and exceptional facilities.

Excellent support throughout your studies

The Doctoral School aims to provide excellent personal and practical assistance for our research students creating a supportive and pro-active environment.

Support and guidance

Your main source of advice and support will be your own doctoral supervisory team, which will include a director of studies and at least one other supervisor. This team will be selected based on their experience in your chosen area of study or their background in relevant practice.

The Doctoral School Team will be available throughout your studies. Our dedicated team will offer advice and guidance for your initial enquiry and application and introduce you to the University and to your supervisory team.

Outstanding facilities

As a research student at NTU you will have access to a wealth of facilities and resources to aid and enhance your studies. The University is committed to providing the best possible facilities for all its students and we are constantly investing in new facilities and learning environments.

Dedicated study areas

All our research students are able to use study and writing areas giving you access to desks, laboratories and IT facilities when you need it.

Learning resources

Students at Nottingham Trent University have access to a wealth of library materials including over 480,000 books and 1,300 printed journals, as well as an extensive audio-visual collection of DVDs, videos and slides.

Electronic library resources are an increasingly important part of the support offered to research students, and more than 290 databases and 17,000 eJournals are accessible from any networked PC within NTU, or from your home or off-campus PC.

Our experienced and knowledgeable library staff will help guide you to the most useful sources of information.

Developing the next generation of researchers

We aim to nurture research talent and help our students thrive through their research degrees and into their future careers.

Researcher Development Programme

All research students are expected to participate in a rolling programme of professional development. You will have the opportunity to attend a range of workshops and developmental activities mapped to the Vitae Researcher Development Framework (RDF).

Our Research Development Programme empowers you – in discussion with your supervisory team – to create an individualized package of activities to support your career development as a researcher.

A range of core activities will support your journey from enrolment at NTU as a research student, through to final submission of your thesis. These activities will be complemented by a series of electives that you will choose to pursue, depending upon your developmental needs as you progress in your research work.

Developing your career

We pride ourselves on equipping our students with knowledge and skills and encouraging initiative, innovation and excellence.

Our research students are encouraged to take part in conferences, seminars and external networks. These are an excellent opportunity for you to share your work, meet other researchers and build a network of contacts.

Our own research conferences and seminars offer you the opportunity to present and discuss your work among the NTU research community.

You may also have the opportunity to teach undergraduate students or supervise laboratory work.

School of Science and Technology

Research in the School of Science and Technology is rich and diverse, with staff conducting internationally recognised and world-leading research. Research is clustered in Research Centres and units, providing a focus for different themes with their underpinning platforms:

- **Biomedical Sciences and the John Van Geest Cancer Research Centre**

Internationally excellent research environment – Our Biomedical Research is world-leading and involves staff with broad academic backgrounds, including Biochemistry, Bioinformatics and Biomathematics, Analytical/Synthetic Medicinal Chemistry, Immunology, Microbiology and Pharmacology. In the recent REF2014 assessment (http://www.ref.ac.uk/) of University research quality the Biomedical Sciences Research Unit's submission (to UoA A03) was highly rated, having 86% of overall activity at the highest 3* (internationally excellent) and 4* (world-leading) grades. This included achieving 100% of its impact at 3* and 4* levels.

- **Materials and Engineering**

Internationally excellent research environment – Our multidisciplinary Materials and Engineering Research is extremely strong in terms of high quality outputs, income generation, and international impact. In the recent REF2014 assessment of University research quality our Materials and Engineering Unit's submission (to UoA B15) was highly rated, having 84% of overall activity at the highest 3* (internationally excellent) and 4* (world-leading) grades. This included achieving a joint 7th rank out of 62 submitted UK institutions for the quality of our publications, which were judged as attaining 94.6% at 3* and 4* levels.

- **Computing and Informatics**

Internationally excellent research impact- The multi-disciplinary research is directed to address important questions and is clustered under three themes: Interactive Systems for cognitive and physical rehabilitation and mental wellbeing; Computational Intelligence and Applications for computationally intelligent methods and techniques; and Intelligent simulation, modelling and networking. In the recent REF2014 assessment of University research quality the Computing and Informatics Research Unit's submission (to UoA B11) was highly rated achieving 80% of its impact at 4* and 3* levels.

- **Sport, Health and Performance Enhancement (SHAPE) Research Centre**

Internationally excellent research outputs- In the recent REF2014 assessment (http://www.ref.ac.uk/) of University research quality the Sport Sciences Research Unit's submission (to UoA C26) was highly rated, having 94% of the outputs rated at the 3* (internationally excellent) and 2* (internationally recognised) grades. Our Sports Science research is multi-disciplinary and is clustered under a number of themes, driven by the Musculoskeletal Physiology, Sports Performance, Exercise and Health and Sport in Society Research Groups.

Research themes and areas

These research units promote the research excellence and facilities within the School, and stimulate knowledge transfer, innovation and exploitation. They provide strategic direction in research planning and portfolio development, and ensure that mechanisms are in place to nurture research.

List of available projects and a summary description of them are provided in the following research categories.

- Biomedical Sciences and the John Van Geest Cancer Research Centre
- Computing and Informatics
- Materials and Engineering
- Sport, Health and Performance Enhancement Research Centre

Or they can be searched based on the following academic Departments.

- Biomedical and Biological Sciences
- Chemistry and Forensic Sciences
- Computing and Technology
- Physics and Mathematics, and
- Sport Science

Project Titles (descriptions below)

1. Dr. Martin Bencsik - Honeybee colony response to artificial vibrational pulses

2. Prof. Carl Brown - Liquid Crystal Microfluidics

3. Dr. Christopher Castleton - Computational Pathways to Higher Efficiency Solid Oxide Fuel Cells

4. Dr. David Chappell - Modelling Dynamic Interfaces Driven by Fluid Flow

5. Prof. Nadia Chuzhanova - Making sense of single nucleotide variants in non-coding regions - a computational approach

6. Prof. Paul Evans - Computational 3D X-ray Imaging (several different PhD projects are available under this theme)

7. Dr. David Fairhurst - Self-assembled micro-structures as building-blocks for macro-scale devices

8. Dr. Demosthenes Koutsogeorgis - Photocatalysis enhancement by plasmonic nanoparticles

9. Dr. Demosthenes Koutsogeorgis - Embedding Plasmonic Nanoparticles in flexible and transparent substrates

10. Prof. Haida Liang - Multispectral Optical Coherence Tomography

11. Prof. Haida Liang - Non-invasive imaging and sensing for art history, conservation and archaeology (multiple projects)

12. Dr. Rob Morris - Low field magnetic resonance for the detection of adulteration of food oils

13. Prof. Bob Stevens - Implantable bioelectronics nerve stimulator for drug free treatment of chronic disease

14. Prof. Bob Stevens - Early warning point of care diagnostic for onset of type 2 diabetes

1.
HONEYBEE COLONY RESPONSE TO ARTIFICIAL VIBRATIONAL PULSES

In our group we have developed methods, based on the use of ultra-sensitive accelerometers, to monitor the overall vibrational activity of honeybee colonies. We have also developed numerical routines to extract, from these vibrational logs, signatures that are relevant to specific conditions of the colony, such as its intention to swarm, its ability to face the winter season, or the state of the brood in the frame under investigation.

Recently this research has led us to monitor individual honeybee vibrational pulses, on the long term. We have developed further numerical methods to extract these pulses and categorise them. We are in the process of correlating the statistics of the occurrences of these signals with more specific different conditions that the colonies are going through.

Some of the vibrational messages that we are detecting are only meaningful to honeybees if they are accompanied by further signalling routes. This is the case, for example, of the waggle dance, which includes a combination of honeybee displacement, sound, vibrations, high velocity air jets, etc.. However, there is some evidence that other signals are meaningful to the individual honeybees even as pure vibrational signals.

In this project vibrational signals of interest will be conveyed to honeybees through the honeycomb, the substrate on which they reside, with an electromagnetic shaker, and the reaction of the colony/bees will be monitored both by visual inspection and by vibrational logs.

This will allow us to further understand the possible physiological function of various vibrational signals of interest, and give new insights into the sophisticated communication mechanisms that honeybees use to make efficient group decisions.

References

- Identification of the honey bee swarming process by analysing the time course of hive vibrations, Bencsik M. et al., Computers and Electronics in Agriculture, 76, 44-50 (2011)
- Honeybee Colony Vibrational Measurements to Highlight the Brood Cycle Bencsik M. et al., PLOS ONE, 10(11): e0141926

Supervisor: Dr Martin Bencsik and Dr Martin Newton

Supervisor biogs

Dr Martin Bencsik co-invented and demonstrated a new type of MRI hardware that minimises PNS and a gradient coil that lowers acoustic noise output, which is where his interest in vibrations began. This gave him experience in monitoring acoustic noise and analysing such signals. Dr Bencsik published a pilot study successfully demonstrating a vibrational signature unique to a honeybee colony's preparation for swarming, which has been extended to monitor a range of specific honeybee colony conditions as described below.

Dr Michael Newton is Reader in Experimental Physics, a Chartered Engineer and a Fellow of the Institution of Engineering & Technology with more than 30 years of experience in instrumentation and the development of experimental equipment. He has been an investigator on 18 research council funded projects including PI on both ERSRC and BBSRC and has published over 140 refereed journal articles. He provides complementary experimental skills needed for this project.

Entry Requirements

In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Physics.**

Contact: martin.bencsik@ntu.ac.uk for informal discussions.

2.
Liquid Crystal Microfluidics

Nematic liquid crystal materials are now ubiquitous in mobile, projection and large screen home cinema displays. These materials exhibit different electrical polarisabilities, refractive indices, and viscosities along different directions. The tendency of the molecules to align with the direction of an applied electric field is exploited in LCDs to control the light transmission of each pixel using a switching waveform. This project will investigate the flow of nematic liquid crystals in and across different closed and open microfluidic confinement geometries. In a moving nematic layer the local molecular "n-director" orientation is determined by the balance of torques arising from any applied electric fields, the local flow direction, and the elastic coupling transmitted from the molecular anchoring at the confining solid surfaces. This means that the effective viscosity, and hence the flow rate, can be modulated by varying the magnitude of an applied voltage. Confinement in particular flow geometries, such as tubes and rectangular cross section channels, can additionally lead to sudden changes in the n-director orientation and regions of local melting of the nematic molecular ordering. These phenomena can potentially be tailored via novel surface patterned geometries for controlling flows in microfluidic systems.

Supervisors: Prof. Carl Brown

Supervisor biogs

The Director of Studies for the project, Carl Brown, is a Professor of Physics and the Coordinator for the Materials and Engineering Research Unit. Prof. Brown joined Nottingham Trent University in 2003 from a Departmental Lectureship in Engineering Science at Oxford University and he has previously lead supervised 7 Doctoral Research projects to successful completion. Publications resulting from these projects are amongst his 59 peer-reviewed papers, including in top prestigious archival journals such as Physical Review Letters (http://goo.gl/5UpO6B), Nature, Nature Photonics (http://goo.gl/5UpO6B, selected for Editor's highlight interview) and Nature Communications (http://goo.gl/iZG7R0). Prof. Brown's significant grant funding income of £1.4M (plus £0.7M as Co-Investigator) provides cutting edge equipment and facilities to underpin this research project. Several of his ten patented inventions on liquid are being actively commercially exploited (http://www.displaydata.com).

Entry Requirements

In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Physics, Materials Science or related discipline.**

Contact: carl.brown@ntu.ac.uk for informal discussions.

3.
COMPUTATIONAL PATHWAYS TO HIGHER EFFICIENCY SOLID OXIDE FUEL CELLS

Today's car engines explode fuel to convert its chemical energy into movement, but waste most of that energy as heat. Fuel cells convert the chemical energy directly into electricity, with much smaller losses and CO2 emissions, a little like a battery, but with continuously supplied fuel, leading to less waste and losses during recharging. However, fuel cells are not yet fully commercially competitive: further improvements in materials and techniques are needed to raise efficiency and lower cost. This project will focus specifically on Solid Oxide Fuel Cells (SOFCs), which are based on charge transport through a layer of metal oxide. The project will examining the atomic scale processes involved in their operation, in particular the fuel to electricity conversion processes in the new Cu/CeO2 based anodes, which have recently been developed to overcome problems with the current Ni/Y-ZrO2 based technology. While much improved, this new nanocomposite is susceptible to a slow build-up of sulphur from the fuel feed. The aim is to use quantum mechanical atomic scale computer simulations (specifically, Density Functional Theory, DFT,) to

- Develop a deeper understanding of sulphur, CO and hydrocarbon related processes at Cu/CeO2 interfaces in SOFC anodes and catalysis, and study key reaction pathways.
- Understand how doping and alloying of the Cu side of the interface may be used to alter and tunes the key processes and interactions.
- Computationally prototype potential solutions to current problems with Cu/CeO2 based anodes for SOFCs.
- Training a PhD student in both fuel cell materials and advanced materials modelling techniques.

References

- Oxygen Vacancies versus Fluorine at CeO2(111): A Case of Mistaken Identity? J.Kullgren et al. Phys.Rev.Lett, 112, 156102 (2014) (impact factor 7.7) https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.112.156102
- Hydrogen on III-V (110) surfaces: Charge accumulation and STM signatures.C.W.M.Castleton et al. Phys.Rev.B, 88, 045319 (2013) (impact factor 3.7) https://journals.aps.org/prb/abstract/10.1103/PhysRevB.88.045319
- Several different charge transfer and Ce3+ localization scenarios for Rh–CeO2(111). Z.Lu, et al (Dr Castleton is the corresponding author). J.Mater.Chem.A, 2, 2333 (2014) (Impact factor 6.6 as J.Mater.Chem.) http://pubs.rsc.org/EN/content/articlepdf/2014/ta/c3ta11169e
- Cu-doped ceria: Oxygen vacancy formation made easy. Z.Lu et al. Chem.Phys.Lett. 510, 60 (2011) (Impact factor 2.0)

Supervisors : Dr. Christopher Castleton

Supervisor biogs

Dr Christopher Castleton has supervised 4 PhD students (1 complete as DOS, 1 ongoing, 2 complete as second supervisor) and published numerous papers on atomic scale processes in oxides and semiconductors, including work on the materials featured in this project.

Entry Requirements
In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Mathematics, Physics or a related discipline.**

Contact: Christopher.castletion@ntu.ac.uk for informal discussions.

4. MODELLING DYNAMIC INTERFACES DRIVEN BY FLUID FLOW

An everyday example of an interface driven by fluid flow is where the sea meets the air. The evolution of liquid-air, or more generally liquid-liquid interfaces due to fluid flow is of interest for applications throughout the natural sciences including in liquid optics, chemical analysis, thin film deposition and drying. Modelling and simulation tools are not only used to verify experimental findings, but to quickly and efficiently study the fluid's behaviour beyond the limits of the experimental set-up. In this way the project will help to inform the design of future experiments and shape the direction of cutting edge science. Boundary integral approaches provide a unique advantage of reducing the fluid modelling to the interface alone, meaning that the fluid velocities driving the interface motion can be rapidly computed. A combination of numerical and asymptotic methods will be explored leading to breakthroughs in linking fluid properties, such as local variations in the surface tension, to their effects on the motion of the interface.

References

- Chappell, DJ, Boundary integral solution of potential problems arising in the modelling of electrified oil films. Journal of Integral Equations and Applications, Vol. 27, pp. 407 - 430 (2015).
- Brown, CV; Wells, GG; Newton, MI; McHale, G., Voltage-programmable liquid optical interface. Nature Photonics, Vol. 3, pp. 403-405 (2009).

Supervisors: Dr. David Chappell

Supervisor biogs

The Director of Studies for the project is David Chappell who is a researcher and Lecturer in Applied Mathematics. Dr Chappell joined Nottingham Trent University in 2012 from an research fellowship with the University of Nottingham and Jaguar Land Rover Ltd. Dr Chappell is the coordinator of the €1.94 million EU funded research project Mid-to-high frequency modelling of vehicle noise and vibration, working with an internationally leading research team within an interdisciplinary research network including partners from industry (Jaguar Land Rover Ltd., inuTech GmbH and CDH AG) and academia (University of Southampton, University of Nottingham). Dr Chappell's work has been published in internationally leading journals such as Chaos, the Journal of Computational Physics, the Journal of the Acoustical Society of America and the Proceedings of the Royal Society of London A.

Entry Requirements

In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Mathematics, Physics or a related discipline.**

Contact: david.chappell@ntu.ac.uk for informal discussions

5.

MAKING SENSE OF SINGLE NUCLEOTIDE VARIANTS IN NON-CODING REGIONS - A COMPUTATIONAL APPROACH

Increasing number of regulatory mutations is being recorded in the Human Gene Mutation Database (currently 1.9% of 156932 diseases-associated mutations) as a sole cause of disease phenotype. In addition, numerous genome-wide association studies (GWAS) have revealed that the majority (~93%) of potentially functional variants associated with human disease and/or disease susceptibility occur outside protein coding regions. While interpretation of mutations in coding regions is relatively straight forward procedure, both identification of remotely-acting regulatory elements and understanding how mutations in these elements affect the expression of their target genes are still in its infancy. The aim of this project is to develop computational approaches for predicting potential regulatory regions, not necessarily in the immediate vicinity of the specific disease gene, and to understand their role in disease developments and progression. One of the specific aims will be to suggest a novel explanation for the observed genome-wide positional distribution of the SNPs associated with neurodegenerative disorders and to establish 'missing links' between numerous non-coding mutations found by GWAS and their target genes. The results of this study will be important for improving the design of novel screening strategies, diagnostic tests and for identification of novel drug targets by extending screening beyond the immediate vicinity of the specific disease gene.

Supervisors: Prof. Nadia Chuzhanova and Dr Jonathan J Crofts

Supervisor biogs

Prof Nadia Chuzhanova has developed a strong international reputation for excellence in the field of bioinformatics of mutagenesis in pathology and evolution. To date, she has published 113 papers and book chapters in a variety of high profile journals including Nature Genetics, Nature Review Genetics, PNAS, etc. The average citation rate of her papers is 42.11 and H-index (Thomson Reuters Web of Science) is being 29. Her outputs were submitted to REF2014 and were amongst the most highly ranked within A03 whether assessed by IF, subject ranking or citation data. Prof Chuzhanova has a good track record of PhD completions. She is currently supervising one PhD student as a director of studies and four as a second supervisor.

Dr Jonathan J Crofts is a computational and applied mathematician with strong interests in computational biology. His recent work has been increasingly interdisciplinary, focussing on unravelling complexity in large biological networks.

Entry requirements

In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **mathematics, computing, engineering or related discipline. Experience of mathematical programming using Matlab, C++ or similar languages is desirable.**

Contact: nadia.chuzhanova@ntu.ac.uk for informal discussions.

6.
COMPUTATIONAL 3D X-RAY IMAGING (SEVERAL DIFFERENT PHD PROJECTS ARE AVAILABLE UNDER THIS THEME)

This project investigates sparse sampling techniques applied to a new type of material specific 3D X-ray image collection/reconstruction process (focal construct technology FCT) to increase the speed of scanning. The increased throughput and reduced X-ray dose is of great significance in practical applications of this new technology. Two distinct methodologies will be investigated under the rubric of sparse sampling. The first will concern an under sampled approach applied to FCT. In imaging applications the spatial sampling rate is often not determined by the Shannon theorem but by the desired spatial resolution. However, it is common to band limit the signal by applying an antialiasing low-pass filter before sampling. The initial work in this project will investigate the tomosynthesis of FCT images recovered from pseudo-random sampling. The second approach will investigate the possibility of applying compressive sensing to FCT. The theory of compressive sampling or compressed sensing exploits the fact that many signals are sparse or compressible in the sense that they have concise representations when expressed in the proper basis. In other words certain images can be recovered from far fewer samples than traditional sampling.

The project will provide an original contribution to knowledge at a number of different levels. An X-ray technique, which combines sparse/compressive collection of diffracted signals with corresponding X-ray absorption signals, will provide the basis for a high-speed material specific scanning modality. The characterisation of the technique will enable scalability and scope of the technique to be determined for a range of potential applications in security screening, medical diagnostics and non-destructive testing.

Supervisors: Prof. Paul Evans

Supervisor Biogs

The Director of Studies for the project is Professor Paul Evans Head of the Imaging Science Research Group. Prof Evans has previously lead supervised 17 Doctoral Research projects to successful completion at Nottingham Trent. He also supervises PhD students in collaboration with other UK Research Intensive Universities.

Prof. Evans has been awarded significant grant funding income circa £5M as Sole and Principal Investigator from the UK and US government sources. Over the years he has invented and led the development of several new 3D X-ray imaging techniques and sensor technologies, which have been exploited by international industry to form new products. His early work in 3D X-ray imaging has been widely adopted by the manufacturers of security scanners to become a de facto standard.

Entry Requirements
In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Physical Sciences, Engineering or related discipline / science.**

Contact: paul.evans@ntu.ac.uk for informal discussions.

7.
SELF-ASSEMBLED MICRO-STRUCTURES AS BUILDING-BLOCKS FOR MACRO-SCALE DEVICES

Can you paint a picture with details smaller than the brush?

The ambitious aim of this project is to do exactly this, to investigate how liquids containing self-assembling components can be used in 3D printing to create large-scale patterns with resolution finer than the size of the print-head. Currently, micron-scale resolution in 3D printing requires pico-litre droplets controlled by state-of-the-art equipment, however there are many everyday examples in which components in liquids self-assemble into micron-scale structures spontaneously: the alignment of soap molecules around oil droplets to stabilize emulsions [1]; the hexagonal arrangement of spherical silica particles to form opals [2] and the deposition of coffee grains around the edge of a dried droplet creating the familiar ring-stain pattern, for example.

This project will investigate using self-assembled structures as the basic building blocks of large composite designs, enabling high-resolution products to be built from low-resolution fabrication techniques. There are several avenues to explore in this highly innovative project, including creating interconnected conducting rings, wavelength-dependent reflectors from multi-layer concentric circles, luminescent materials and microfluidic devices. Initially, we will build on our expertise with the coffee ring-stain [3] to investigate the consequences on the self-assembled patterns when using multiple droplets. Subsequent approaches will develop previous work including: the fabrication of solid 3D structures from drying polymer droplets [4-8]; using micro-spheres to template the arrangement of nano-sized particles [9]; and the self-assembly of hollow tubes, shown in Fig 1 below, and their use in micro-fluidic devices.

Supervisors: Dr. David Fairhurst

Supervisor biogs

Dr. David Fairhurst is a Principal Lecturer at Nottingham Trent University where he has worked since 2005. Previously he held post-doctoral positions at Victoria University, New Zealand and Edinburgh University, UK. During this time he has acquired significant expertise in colloidal, surfactant and capillary self-assembly and experimental skills in imaging, microscopy and rheology. He has successfully supervised 2 PhD students, has 20 publications in top-ranking journals. He also founded and co-organized an International Workshop Series on Droplets and is a UK representative on the European network for Smart and Green Interfaces. He also has strong active links with industry including collaborative work with Angus Fire, GEA Pharma, Unilever and Devonté Drinks. He has been awarded around £250,000 of grant income.

Entry requirements
In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Physical Sciences, Engineering or a related discipline.**

Contact: david.fairhurst@ntu.ac.uk for informal discussions.

8.
PHOTOCATALYSIS ENHANCEMENT BY PLASMONIC NANOPARTICLES

Plasmonic nanoparticles are already demonstrating high optical performance in a variety of systems and devices with important social impact (e.g. photovoltaics, SERS, hydrophobicity, electronics etc). At the same time photocatalysts like TiO2 play a very important role in treatment of aqueous hazardous pollutants. Proprietary technology developed at NTU by the Director of Studies for this research project, has the ability to mass produce nanoparticles arrays atop or within thin film materials, whilst controlling their local surface plasmon resonance. This project will investigate the benefit of combining the above mentioned technologies, in order to examine the feasibility of fabricating cost effective and efficient plasmonic catalysts in thin film form.

Supervisors: Dr. Demosthenes Koutsogeorgis

Supervisor biogs

The Director of Studies, Dr. Demosthenes Koutsogeorgis, is a Reader in Photonic technologies in the School of Science and Technology and has developed a proprietary method of controlling the properties of nanoparticles via laser processing of thin metal films. He has 16 years of research experience and has supervised 11 PhD candidates. He has continually attracted research funding from the UK EPSRC, the European Commission and from Industry. Examples of high impact journal publications include Nano Letters (http://pubs.acs.org/doi/abs/10.1021/nl2034738), Journal of PhysicsD: Applied Physics (http://iopscience.iop.org/0022-3727/46/9/095305), Journal of Materials Science (http://link.springer.com/article/10.1007/s10853-014-8044-3), Nanotechnology (accepted).

Entry requirements
In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Physics, Materials Science, Optics or related discipline.**

Contact: Demosthenes.koutsogeorgis@ntu.ac.uk for informal discussions.

9.

EMBEDDING PLASMONIC NANOPARTICLES IN FLEXIBLE AND TRANSPARENT SUBSTRATES

Plasmonic nanoparticles are already demonstrating high optical performance in a variety of systems and devices with important social impact (e.g. photovoltaics, SERS, hydrophobicity, electronics etc). This project will examine the feasibility of embedding nanoparticles in flexible and transparent substrates (e.g. PET, PEN, BOPP or PolyCarbonate) at the production stage (e.g. by extrusion, drawing or injection moulding) and subsequently controlling the optical response of the nanoparticles in selected regions via laser processing. This research programme will involve extensive training in thin film fabrication, laser processing, structural and optical characterization techniques.

Supervisors: Dr. Demosthenes Koutsogeorgis

Supervisor biogs

The Director of Studies, Dr. Demosthenes Koutsogeorgis, is a Reader in Photonic technologies in the School of Science and Technology and has developed a proprietary method of controlling the properties of nanoparticles via laser processing of thin metal films. He has 16 years of research experience and has supervised 11 PhD candidates. He has continually attracted research funding from the UK EPSRC, the European Commission and from Industry. Examples of high impact journal publications include Nano Letters (http://pubs.acs.org/doi/abs/10.1021/nl2034738), Journal of PhysicsD: Applied Physics (http://iopscience.iop.org/0022-3727/46/9/095305), Journal of Materials Science (http://link.springer.com/article/10.1007/s10853-014-8044-3), Nanotechnology (accepted).

Entry requirements
In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Physics, Materials Science, Optics or related discipline.**

Contact: Demosthenes.koutsogeorgis@ntu.ac.uk for informal discussions.

10.
MULTISPECTRAL OPTICAL COHERENCE TOMOGRAPHY

Optical Coherence Tomography is based on a fast imaging Michelson interferometer capable of non-contact and non-invasive imaging of subsurface microstructure. It was invented in the 1990s for the non-invasive in vivo imaging of the interiors of the eye. It has since found applications in a variety of non-biomedical fields including industrial and archaeological applications.

OCT has mostly been used for imaging of subsurface structure, but its potential for material identification through the spectral and optical properties have not been fully explored. This project will explore methods to extract both the structure and chemical information of a material using OCT. The student will use existing OCT developed in the group to investigate methods of extracting the underlying physical/chemical properties of the material. Depending on the funding level, the student can also be involved in instrument development.

References:

- Cheung C. S., Spring M., Liang H., Ultra-high resolution Fourier domain optical coherence tomography for old master paintings, Optics Express, Vol. 23(8), 10145-10157 (2015).
- Cheung C. S., Daniel J., Tokurakawa M., Clarkson W. A., Liang H., High resolution Fourier domain optical coherence tomography in the 2 micron wavelength range using a broadband supercontinuum source, Optics Express, Vol. 23(3), 1992-2001 (2015).
- Cheung C. S., Daniel J., Tokurakawa M., Clarkson W. A., Liang H., Optical coherence tomography in the two-micron wavelength regime for paint and other high opacity material, Optics Letters, Vol. 39, 6509-6512 (2014)

Supervisors: Prof. Haida Liang

Supervisor biogs

The director of studies for the project is Prof.Haida Liang who has a wide range of experience in research from astrophysics to imaging & optics instrumentation and the application of advanced imaging techniques to archaeology and art conservation science. She currently leads the research in advanced optical imaging and remote sensing, imaging and sensing for art conservation and archaeology at Nottingham Trent University.

She has lead over 20 projects as principal investigator from UK research councils, the Royal Society, charities and industry. Her research benefits from collaborations with industry and various museums and heritage organisations. She has published in a variety of journals including Optics Express, Optics Letters, ISPRS Journal of Photogrammetry & Remote Sensing, Astrophysical Journal and MNRAS. She has previously supervised 6 PhD students to successful completion.

Entry requirements:
In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st

Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in Physics, Engineering, Chemistry or related discipline.

Contact: haida.liang@ntu.ac.uk for informal discussions.

11.
NON-INVASIVE IMAGING AND SENSING FOR ART HISTORY, CONSERVATION AND ARCHAEOLOGY (MULTIPLE PROJECTS)

The Imaging & Sensing for Archaeology, Art history and Conservation (ISAAC) group is engaged in developing novel imaging and sensing techniques as well as developing applications for heritage science. Material identification and characterisation are particularly challenging in this field, since cultural heritage encompasses a wide range materials and non-invasive investigations is often the only means of examination.

The current trend is to employ a variety of imaging modality and sensing techniques that complement each other for material analysis. Projects in this category involves collaborating with heritage organisations to apply imaging and sensing techniques to solve problems in archaeology, art history and conservation.

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- Liang et al., Remote spectral imaging with simultaneous extraction of 3D topography for historical wall paintings, ISPRS Journal of Photogrammetry and Remote Sensing, 95, 13-22 (2014)
- Liang et al., Optical Coherence Tomography for the non-invasive investigation of the microstructure of ancient Egyptian faience, Journal of Archaeological Science, 39, 3683-3690 (2012)
- Liang H., Advances in multispectral and hyperspectral imaging for archaeology and art conservation, Appl. Phys. A, 106(2), 309-323 (2012)

Supervisors: Prof. Haida Liang

Supervisor biogs

The director of studies for the project is Prof.Haida Liang who has a wide range of experience in research from astrophysics to imaging & optics instrumentation and the application of advanced imaging techniques to archaeology and art conservation science. She currently leads the research in advanced optical imaging and remote sensing, imaging and sensing for art conservation and archaeology at Nottingham Trent University.

She has lead over 20 projects as principal investigator from UK research councils, the Royal Society, charities and industry. Her research benefits from collaborations with industry and various museums and heritage organisations. She has published in a variety of journals including Optics Express, Optics Letters, ISPRS Journal of Photogrammetry & Remote Sensing, Astrophysical Journal and MNRAS. She has previously supervised 6 PhD students to successful completion.

Entry requirements
In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Physical Science, Conservation science, archaeometry.**

Contact: haida.liang@ntu.ac.uk for informal discussions.

12.
LOW FIELD MAGNETIC RESONANCE FOR THE DETECTION OF ADULTERATION OF FOOD OILS

The detection of adulteration of food products and in particular high priced olive oils is a concern in the food industry. Adulteration of extra virgin olive oil with other cheaper oils, for example, can lead to significant profits for the unscrupulous dealer. Laboratory based methods have been developed for the monitoring of adulteration of edible oils but this project will investigate/develop a low field magnetic resonance technique for operation 'in the field' and without the need for the oils to be taken out of their original bottles which can remain sealed. A preliminary study has shown that the physical basis of this work is sound (Sensors 2014 doi:10.3390/s140202028) and represents a feasible and exciting PhD project. The work undertaken by the PhD student will not only investigate the basic science, the relationship of magnetic resonance relaxation times and diffusion to the properties of the oils, but also engineer a practical monitoring system.

Supervisors: Dr. Rob Morris

Supervisor biogs

Dr Rob Morris, is a reader in physics with a strong background in magnetic resonance imaging and low field magnetic resonance based sensors. Since 2013 he has been principal investigator on an EU FP7 project (ARBI-EU.com) developing magnetic resonance sensors for the clogging of constructed wetlands based on preliminary work carried out at NTU. In 2013 Dr Morris was invited to be a guest editor for a special issue of the journal Sensors (mdpi) on the topic of magnetic resonance sensors (ISSN 1424-8220). The second supervisor is Dr Michael Newton who is Reader in Experimental Physics. He has nearly 30 years research experience on sensors and measurement systems. He has published more than 140 refereed journal articles, including an invited review that has become the most cited article ever published in the journal Soft Matter (2008 doi:10.1039/b712575p) with more than 650 citations. He has been an investigator on 17 UK research council funded projects and two EU FP7 funded projects.

Entry requirements
In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **bioscience or biomedical discipline.**

Contact: rob.morris@ntu.ac.uk for informal discussions.

13.
IMPLANTABLE BIOELECTRONICS NERVE STIMULATOR FOR DRUG FREE TREATMENT OF CHRONIC DISEASE

A wireless hybrid bioelectronic medical implant device will be developed which provides pulsed electrical and optical stimulation of peripheral nerves. Design concepts will be developed which are compatible with large area electronic manufacturing techniques, such as printing and coating. Ultra-thin silicon microelectronics III-V light emitting devices and printed sensors will be assembled on flexible low modulus substrates which are suitable for long term implant in the body. Devices will be tested on in vitro cell models of the nervous system.

Supervisors: Prof. Bob Stevens

Supervisor biogs

The Director of Studies for the project, Bob Stevens, is a Professor of Smart Materials and Devices as well as a serial entrepreneur. He co-founded www.oxsensis.com based on intellectual property for high performance fibre optic sensors and www.electrospinning.co.uk which manufactures 3D nanofibre platforms for the biotech industry. He is a director of Nano Products Ltd which is commercialising offset litho printed flexible electronics and Audition Therapeutics which is creating micro-engineered system to treat conditions of the middle ear. He is DoS for two active PhD studentship, who are establishing new and improved technologies for Parkinson's disease research and spinal cord repair. Bob established the 'Neuron Special Interest Group' at NTU which is a multi-disciplinary team of experts determined to establish new knowledge, techniques and tools to impact science and healthcare of neuro related diseases and therapies.

Entry requirements
In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Master's degree.**

Contact: bob.stevens@ntu.ac.uk for informal discussions.

14.
EARLY WARNING POINT OF CARE DIAGNOSTIC FOR ONSET OF TYPE 2 DIABETES

Significant progress has been made to develop a novel point of care diagnostic technology which is based on electrospun nanofibre materials and established assembly techniques. Research is required to develop the microfluidic and hybrid printed electronic circuits of a low cost,compact and disposable test strip which demonstrates high specificity and sensitivity with high signal to noise ratio.

Supervisors: Prof. Bob Stevens

Supervisor biogs

The Director of Studies for the project, Bob Stevens, is a Professor of Smart Materials and Devices as well as a serial entrepreneur. He co-founded www.oxsensis.com based on intellectual property for high performance fibre optic sensors and www.electrospinning.co.uk which manufactures 3D nanofibre platforms for the biotech industry. He is a director of Nano Products Ltd which is commercialising offset litho printed flexible electronics and Audition Therapeutics which is creating micro-engineered system to treat conditions of the middle ear. He has won research funds in collaboration with Professor Ian weeks at Cardiff University to develop materials and techniques to create microsensing devices which can be assembled into microfluidic strips. The PhD will address all aspects of producing and testing a prototype diagnostic.

Entry requirements
In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Masters degree.**

Contact bob.stevens@ntu.ac.uk for informal discussions.