POSTER ABSTRACTS

HarwellXPS

Title: X-Ray Photoelectron Spectroscopy and its Application to Understanding Surface Chemistry

Authors: Shaoliang Guan, Philip R. Davies, David Lennon, David J. Morgan, Giovanni Rossi, David J. Willock

X-ray Photoelectron spectroscopy (XPS) is a tool facilitating the determination of the elemental and chemical state of a surface. Its importance as an analytical tool is highlighted by EPSRC's commitment to providing a national facility for such measurements. Recent advancements in spectrometer design and the introduction of argon cluster sources for controlled erosion of organics and inorganics, has increased the application of XPS to a more extensive application range. In the poster, we demonstrate the applicability and importance of XPS to the study of how the surface of industrial catalyst changes undergoing a chemical reaction.

Juiced Energy Hub (UCL Department of Chemistry)

Title: High Throughput Nanomaterials Discovery and Scale-up

Authors: Alexandria Groves, Prof Jawwad A. Darr

Continuous hydrothermal flow synthesis (CHFS) systems for the controlled synthesis of inorganic nanoparticles (diameter <100 nm), have many potential commercial applications from catalysts to sunscreens and battery materials to fuel cell components. CHFS systems offer many advantages over batch processes; CHFS is a green technology (using supercritical water as the reagent at >374°C and 22.1 MPa), that uses inexpensive precursors (e.g. metal nitrate salts). In CHFS, process parameters such as T, P, etc. can be controlled independently for the synthesis of high-quality, technologically important functional nanomaterials in a single step (or fewer steps than conventionally used).

Title: The JUICED Energy Materials Hub

Authors: Ian Johnson and Prof Jawwad A. Darr

The "JUICED" Hub will focus on accelerating the development of energy materials for a variety of applications. The use of high throughput synthesis and computational methods will rapidly screen materials properties and highlight lead materials for each application area. The best performing samples will then be produced at laboratory scale and characterised to understand how they can be improved and optimised for devices. Selected materials will then be produced at pilot scale, leading to testing on pre-commercial demonstrator devices.

Loughborough Materials Characterisation Centre

Title: Water droplet erosion of low pressure steam turbine blades

Authors: Lorenzo Tinari, Dr Mark Jepson, Professor Rachel Thomson

Water droplet erosion (WDE) occurs when the high speed impingement of water particles causes the removal of material from the surface of the affected part. In the context of steam turbines, WDE occurs in the final, low pressure (LP) stages, where the low pressure causes part of the vapour to condense back into

water. The collision of water droplets with the rotating blades leads to loss of turbine efficiency, damage of the turbine components and catastrophic failure of the unit. This project aims to better understand the evolution of damage resulting from WDE of common LP steam turbine blade materials.

Title: Structure and mechanical performance characterisation of zirconium nitride after heavy ion irradiation

Authors: Stuart Robertson, Scott Doak, Dr Houzheng Wu

For improved efficiency the next and future generations of nuclear reactors require components capable of operating at higher temperatures (up to 1000 ºC). Zirconium nitride (ZrN) is of interest for high temperature and high dose nuclear applications. In this poster we will explore the effects of 4 MeV 400 dpa gold ion damage on hot pressed ZrN. SEM, HREBSD, TEM, nano indentation and micro bend testing have been used to explore the effects of ion damage on ZrN. It was observed that the mechanical properties of ZrN and Zr2ON2 its second phase is resistant to high dose ion irradiation.

Loughborough University Department of Materials

Title: Molecular Design of Nanomaterials for Bio-Imaging: Novel Magnetic Resonance Imaging Contrast Agents

Authors: Thomas Berki, Dr Helen Willcock, Dr Stephen Butler

Here, we propose innovative strategies to enhance resolution/contrast in Magnetic Resonance Imaging (MRI), which is a major medical imaging technique used in disease diagnosis. Through the molecular design and synthesis polymerisable gadolinium complexes, and their integration in polymeric nanoscale systems, contrast agents (CAs) with superior properties over commercially available products were obtained. Biocompatible CAs with higher relaxivities and longer bio-circulation times were obtained, using controlled radical polymerisation to produce polymeric nanostructures. In the future, by designing more complex polymeric scaffolds, we hope to achieve multimodal imaging nanoscale probes with both responsive and theranostic capabilities.

Title: Strategies for the Attainment of Dismantleable Adhesion

Authors: Constantine J Marlas

Dismantleable structural adhesion is required to facilitate the recycling and re-use of critical materials and to enable flexible manufacturing. Currently there are a number of ways to achieve dismantleable adhesion, either through the incorporation of fillers or joint design. These approaches have shown >90% reduction in initial adhesion levels but have limitations in terms of their applicability in industrially-useful bonding systems. Several novel methods for achieving this effect have been developed, enabling initial adhesion levels of >15MPa to be reduced to zero joint strength after triggering, or alternatively, failure in static low load tests within a few seconds.

Nottingham Trent University

Title: A wearable optical sensor yarn

Authors: Achala Satharasinghe, Theodore Hughes-Riley, Tilak Dias

A wearable optical sensing yarn has been prototyped by embedding a photodiode into a textile yarn structure, offering new possibilities for a number of application such as for monitoring body vitals including heart rate, blood oxygen level and skin temperature. The yarn can be readily converted to a fabric, using a weaving technique. The photodiode is soldered to copper wires; it is then encapsulated within an optically clear resin micro-pod for protection, before being covered in a fibrous structure to provide softness and normalcy to the yarn. The resultant optical sensing yarns generated comparable opto-electronic output to the non-embedded photodiode.

Photocentric

Title: UltraFlex - Photocentric's Brand New Flexible 3D Printable Photopolymer

Authors: Photocentric

Ultraflex is Photocentric's amazing new flexible 3D printable photopolymer • Made using a radically different type of chemistry for constructing photocurable polymers • Novel technology developed in-house by Photocentric chemists • Long lasting product durability • Extreme toughness combined with high flexibility • Available resins at 355nm, 380nm, 405nm and 460nm Typical printed properties: Elongation = 100% +/- 20% Tensile Strength = 2.5MPa +/- 0.5MPa Applications: Soft, flexible and durable structures Objects that have to compress, deflect bend and return Parts with high tear resistance, low tensile shear properties and high elongation

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QinetiQ

Title: High Throughput Materials Discovery of Nanomaterials

Authors: Charles Footer and Shahid Hussain

Continuous Hydrothermal Flow Synthesis is a scalable and versatile method for rapid nanomaterial manufacture. Simple precursors are mixed in flow with supercritical water in a patented mixer causing nanoparticle formation. This novel technique is the foundation for an ambitious materials discovery methodology, and enables the exploration of novel candidate materials for use in electromagnetic applications. The project involves materials synthesis, process engineering, chemical/ physical characterisation, mass data collection, storage and mining and macro analysis. This methodology has allowed a new level of understanding of the relationship between structure and electromagnetic response to be developed.

Title: Graphene Modified CFRP for Improved Mechanical Performance

Authors: C. Nagi and A. Foreman

The toughness limitations of laminated carbon fibre reinforced polymer (CFRP) composites is well established. Current work at QinetiQ and the University of Surrey is developing a novel approach to this problem, involving the modification of CFRP using graphene. Our method relies on the modification of a polymer which is combined with the host matrix to improve toughness. The approach allows for the delivery of accurate, precise and repeatable graphene loading in CFRP. The subsequent CFRP / Graphene coupons have been mechanically tested under mode-I and mode-II conditions with the subsequent fracture surfaces characterised by scanning electron microscopy.

University of Liverpool

Title: Synthesis of Branched Poly(oligo-(ethylene glycol) methyl ether methacrylate) for application in nanomedicine

Authors: Heba Elkateb, Sean Flynn, Mona K. Omir, Tom McDonald and Steven P. Rannard

Surfactants play a crucial role in the formation and stabilisation of drug delivery systems. Here we focus on oligo-(ethylene glycol) methyl ether methacrylate (OEGMA) polymers as stabilisers for nanoparticles to enhance the drug delivery of poorly water-soluble drugs and as an approach for potentially attaching active targeting of drugs by attaching of specific ligands to the end groups of the polymers.1 A series of linear and branched polymers have been produced by Atom Transfer Radical Polymerisation (ATRP), which allows the formation of polymers with similar molecular weights and narrow molecular weight distribution.2 Polymers with different degrees of polymerisation (DPn) within the primary chains were targeted, also different ratios of initiator to branchers were used in the copolymerisation of OEGMA with ethylene glycol methacrylate (EGDMA) to produce branched copolymers with different degrees of branching. To produce polymers with varied end groups, both linear and branched P(OEGMA) polymers were prepared using 2-dodecyl-2-bromoisobutyrate and PEG17 as initiators, which might enable the encapsulation of wide range of materials in the core of nanoparticles. The produced polymers were analysed with gel permeation chromatography (GPC) and 1H NMR.

University of Nottingham

Title: Wondrous Nanocarbons

Authors: Andrei N. Khlobystov

Element 6 has a unique ability to form diverse structures, including the wonder-materials such as fullerenes, graphene, carbon nanofibres and nanotubes. Nanotubes, for example, possess record-breaking strength, conductivity and chemical stability, which we harness and develop in nanoscale test tubes and nano-reactors at Nottingham. We trigger and control chemical reactions of molecules entrapped in nanotubes to deliver desired products and even discover new materials, such as graphene nanoribbons or unusual polymers. Nanotubes loaded with metal nanoparticles exhibit remarkable catalytic properties that

are exploited in many reactions, including electrocatalysis in fuel cells, outperforming traditional catalysts by selectivity and durability.

University of Sheffield

Title: Modification of Titanium Foams for Biomedical Applications

Authors: Mohammed Shbeh

The problem of tooth loss is being compounded by increased life expectancy and poor nutrition. Titanium dental implants are currently a popular choice for replacing missing teeth. However, the high elastic modulus of titanium compared to the elastic modulus of the surrounding bone or tissue as well as its bio-inertness may cause problems. The aim of this study is to investigate the usage of cyclic voltammetry in Plasma Electrolytic Oxidation treatment of porous titanium parts with three different percentages of porosities with the purpose of developing biologically active ceramic coatings onto their porous structure.

University of Southampton

Title: Advancing the Applications of Chalcogenide Glass

Authors: Andrea Ravagli, Bruno Moog and Fernando Guzman

Chalcogenides, glasses based on metal alloys with sulphur, selenium and/or tellurium are an important family of materials for infrared optics. Though commercially available, poor stability and fragility of traditional chalcogenides have limited practical applications. Working in collaboration with industry, we have been developing a new family of chalcogenides, which offer significant improvement in thermal, mechanical and corrosion resistance. Typical improvements see an increase in temperature stability from 200oC to over 500oC, a reduction in thermal expansion, increased thermal conductivity and improved visible transmission, paving the way for improved performance in aerospace, sensing, laser power delivery, night vision and other applications.

University of Southampton

Title: 2D Materials: Synthesis, Characterization and Applications

Authors: N. Aspiotis, O. A. Abbas, G. Alzaidy, A.H. Lewis, L. McDonnell

2D layered materials, synthesized down to one atom thickness, have led to unprecedented applications and performance, albeit with many remaining challenges. We present our research on synthesizing and fabricating these materials as well as understanding their optical and electronic properties. Our team has developed improved wafer scale processes for their deposition, including atomic layer deposition and chemical vapour deposition techniques. Applications we are developing include wafer scale fabrication of 2D heterostructures for optoelectronics, photovoltaic applications, integration of 2D materials into hollow core

optical fibres for all fibre electro-optics, devices for energy harvesting and fundamental studies of light - matter interactions.

University of Surrey

Title: Cellular Material with High Cutting Resistance

Authors: Rene Vogel, Florian Bittner, Hans-Josef Endres, Thomas Hipke, Stefan Szyniszewski

Physical security is essential for the society. We discovered a meta-material with extreme cutting resistance but significantly lighter than hardened steels. Embedding ceramic spheres in a cellular metal created a contrast between high stiffness of ceramics and flexibility of the lightweight cellular matrix. Such architecture vibrated under the fast-moving, rotating disc of an angle grinder. Oscillations at the interface created the ceramic powder. These abrasive particles applied localized forces, which coupled with vibration-induced strain rate effects, wore the blades completely. Our meta-material can improve safety while reducing the weight of protective systems.

Title: Study and Optimisation of the Liquid Phase Exfoliation of Graphene

Authors: Piers Turner, Mark Hodnett, Rob Dorey, David Carey

By leveraging NPL's multi-frequency sonoreactor, we have studied the fundamental mechanism, acoustic cavitation, which drives the sonication assisted liquid phase exfoliation of graphene. We have found that graphene is dependent on both the cavitation dose and the lateral size of the graphene/graphite flakes being exfoliated. Graphene yields of up to 18% by mass were produced when utilising high cavitation doses. This knowledge will help develop advanced exfoliation strategies to overcome the production challenges limiting the industrial viability of 2D Van der Waals bonded nanomaterials such as graphene.

University of Warwick

Title: Characterisation of Bigger and Better Synthetic Diamonds

Authors: P. L. Diggle, B. L. Green and M. E. Newton

Today it is possible to produce synthetic diamonds with exceptional purity and very low concentrations of structural defects. This opens up a range of new applications for synthetic diamond materials, including optical components where low absorption, low birefringence and high thermal conductivity are key performance parameters. Furthermore, a pure diamond crystal lattice forms a low noise environment so that fragile quantum properties of "defects" are not lost and can be exploited in a range of quantum technologies. We report hereon the investigation of impurity and defect incorporation in high quality single crystal diamond grown at high temperatures and pressures.

Title: Functionalised boron doped diamond electrodes for pH sensing in extreme environments

Authors: S. J. Cobb, Z. J. Ayres, M. E. Newton and J. V. Macpherson

Laser micromachining systems are commonly used to cut diamond, at Warwick these have been employed to manufacture all diamond electrochemical devices, including disk electrodes, band electrodes and ring disk electrodes. The machining process can also produce non-diamond (sp2) carbon, which has been found to have a significant effect on the electrochemistry observed, activating the diamond towards a variety of different analytes. For example, we have shown how spatial location of (oxidised) sp2 sites on a conducting diamond surface makes the material pH sensitive. Such electrodes are found to be very stable, and capable of outperforming conventional glass electrode, pH technology.

University of Exeter

Title: Chiral 2D Material Liquid Crystal Nanocomposites for Optoelectronic and Photonic Devices

Authors: Ben Hogan, Monica Craciun and Anna Baldycheva.

In the modern age, silicon structures at the nanoscale are the driving force behind almost all computing globally. However, as we approach the achievable limits of silicon-based devices, new technological paradigms are required to keep pace with Moore's law. One nascent technology of huge potential is optoelectronic devices capable of interacting with and controlling the propagation of light. Chiral 2D material liquid crystals (2DLC) hold great promise as drivers of a revolution in the development of optoelectronic and photonic devices. Here, we develop and characterise a number of different 2DLC materials with wide-ranging and exciting properties.

Title: Auxetic Enhancement of Vibration Energy Harvesting

Authors: William Ferguson[1], Yang Kaung[1], Ken Evans[1], Christopher Smith[1], Meiling Zhu[1]

We have developed an auxetic strain-energy piezoelectric harvester to increase the power output available from tensile excitations (<300 με at 1–20 Hz). We found that this gained ~11 times more power than an equivalent plain harvester under the same excitation (up to 191 μW from auxetic sample, compared to 13 μW from plain, each subjected to 10 Hz, 250 με excitation). This gain is constant under any excitation. The auxetic component increases stress in the piezo, increasing its power output[1]. W anticipate applications in harvesting from low-strain environments, ideal for powering structural health monitoring i buildings and infrastructure[2,3].

University of Swansea

Title: Brand Protection for Steel Packaging Products

In recent years the underground market of counterfeit products has grown into a global network posing an increasing threat to modern societies. The raised concern of the general public regarding this illicit trade has initiated a series of reforms in governmental regulations and policies worldwide. CMD's strong links with the packaging industry place it right at the centre of these developments. By combining multiple technologies each providing different levels of security, CMD's aim through this project is the development of an anti-counterfeiting feature intended to address different audiences throughout the entire supply chain, including the final product authentication by the consumer.