



REPORT

IUK File Reference: 104266

GRAPHOSITE

A Graphene Sensor for Defect Detection and Predictive Maintenance in Composite Materials

Open Day 2019 Workshop

Date: 20 November 2019

Meeting Venue: Crausaz Wordsworth Building
Robinson College
Adams Road
Cambridge
CB3 9AD

Organisers: Cambridge Nanomaterials Technology Ltd



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1. Introduction

The GRAPHOSITE Open Day 2019 was held on 20th November 2019, at the Plenary Suite at Crausaz Wordsworth Building - Robinson College, Cambridge. This college was chosen due to its attractive location, excellent room for the meeting and for its large exhibition space in the foyer of the building, where coffee breaks and lunch took place.

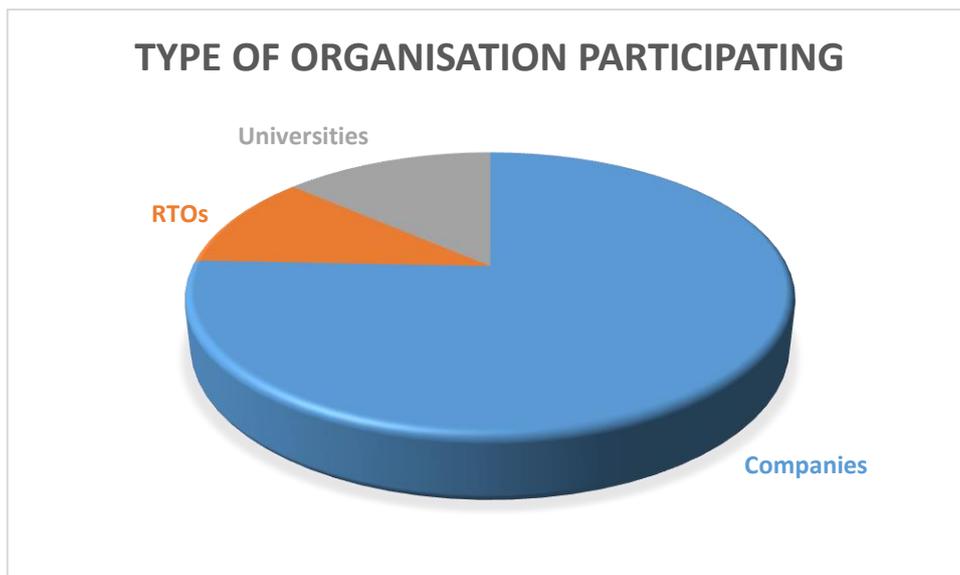


Fig.1 Plenary Suite



Fig.2 Foyer

Around 45 external people confirmed their participation to the Open Day coming from 34 organisations. Confirmed participants include representatives from: BAE Systems, BT, Lucideon, GoodFellow Cambridge Ltd., ARUP, Bitrez Limited, BSI Group, Nanoscience Centre - University of Cambridge, Schlumberger Cambridge Research, Versarien plc., MBDA UK Ltd., University of Surrey, University College London, Rolls Royce, EMPA, Prysmian Group, Bridon Bekaert Ropes Group, Q5D, Innovative Technology & Science Ltd (InnoTecUK), E.G.O. Elektro-Gerätebau GmbH, Innovia Technology, University of Cambridge, Exemplas Ltd -EEN East of England and ANSYS Granta, Reflex Imaging, National Composites Centre, Non-metallic Innovation Centre (NIC), Printed Electronics Ltd, Teledyne CML Compo-sites, Brunel Innovation Centre, AMRC With Boeing, Marshall Aerospace and Defence Group and Uniper Technologies Ltd.



2. Agenda

GRAPHOSITE Open Day
Meeting Venue: Crausaz Wordsworth Building
Robinson College
Cambridge

10:00 Arrival and registration



10:15 Welcome and GRAPHOSITE Open Day Introduction

Dr Bojan Boskovic, Managing Director, Cambridge Nanomaterials Technology Ltd (CNT)
GRAPHOSITE Project Exploitation and Dissemination & Open Day 2019 Organisation



10:30 Overview of GRAPHOSITE Project

Dr Sofia Sampehai, Senior Project Leader, TWI, GRAPHOSITE Project Coordination and Management



11:00 Coffee Break – exhibition

11:30 Dr Sofia Sampehai, Senior Project Leader, TWI

Title: TWI and role in the GRAPHOSITE Project



11:45 Dr Evelyne El Masri, Project Leader, Non-metallic Innovation Centre (NIC) – *Guest speaker.*

Title: NIC: Non-metallics and beyond



12:00 Thomas Greaves, Haydale Graphene Industries PLC
Title: Commercial applications for functionalised nanomaterials



12:30 Dr Nithin Amirth Jayasree, Research Fellow, Brunel Composites Centre and **Dimitrios Faki**, Research Fellow at National Structural Integrity Research Centre (NSIRC).
Title: Molecular modelling of the GRAPHOSITE sensors



13:00 Lunch & exhibition

14:00 Dr Zlatka Stoeva Managing Director, DZP Technologies Ltd.
Title: Introduction to DZP Technologies Ltd



14:30 Dr George Maistros, Managing Director at ADVISE-DETA
Title: In-process sensors for quality control and optimisation of composites manufacturing processes



15:00 *coffee break & exhibition*

15:30 Dr Sofia Billett, Senior Innovation Consultant, Cambridge Nanomaterials Technology Ltd.
Title: Exploitation and Dissemination activities of the GRAPHOSITE project



Guest presentations

16:00 Dr. Cem Selcuk, Head of Business Development, TWI Innovation Network-TWIIN, TWI Ltd.
Title: TWIIN - Innovation Accelerators / Technology Acceleration Programme TAP



16:30 Tadej Bregar, Project Manager, InnoTecUK.
Title: Introduction to InnoTecUK and its role in the UltraMAT project (www.ultrammat.co.uk): Power ultrasound as a generic tool for micro/nanoscale processing of metals



17:00 *Closing remarks*

3. Exhibition and Networking

All GRAPHOSITE partners were given the opportunity to have an exhibition desk. The Innovate UK funded project UltraMAT (one of the guest speakers), was invited to also have its own exhibition desk, as CNT is also part of this project.

3.1 TWI



3.2 Haydale Graphene Industries PLC



3.3 Brunel Composites Centre – BCC



3.4 DZP Technologies Ltd.



3.5 ADVISE-DETA



3.6 Cambridge Nanomaterials Technology Ltd - CNT Ltd



3.7 UltraMAT (Guest exhibitor – InnoTecUK)



4. External participating organisations

BAE Systems



Web: www.baesystems.com

BAE Systems is a global defence, aerospace and security company employing around 83,100 people worldwide. Our wide-ranging products and services cover air, land and naval forces, as well as advanced electronics, security, information technology, and support services.

British Telecom



Web: www.btplc.com/index.htm

BT Group plc is a British multinational telecommunications holding company headquartered in London, United Kingdom. It has operations in around 180 countries and is the largest provider of fixed-line, broadband and mobile services in the UK, and also provides subscription television and IT

Rolls-Royce plc.



Web: www.rolls-royce.com

Employing over 40,000 people worldwide, **Rolls-Royce** is a global company providing highly-efficient integrated power and propulsion solutions. Our power systems are predominantly used in aerospace, marine, energy and off-highway applications.

We are one of the world's leading producers of aero engines for large civil aircraft and corporate jets. We are the second largest provider of Defence aero engines in the world. Rolls-Royce is well established in the marine sector where we design vessels and integrate power systems. We have a growing presence in civil nuclear power, drawing on our skills and experience of over 50 years in powering nuclear submarines. Our MTU brand is world-renowned in high-speed diesel engines powering applications as diverse as rail locomotives and luxury yachts.⁷

Schlumberger Cambridge Research



Web: www.cambridgetrust.org/partners/schlumberger-gould-research-centre

The **Schlumberger Gould Research** facility houses more than 930 m² of laboratory space and offices for more than 100 scientists and technicians.

Research focuses on drilling, chemistry, fluid mechanics, and seismics. In each domain, SGR combines three strands of research: theory, experiment, and computational simulation. Research teams are multidisciplinary, embracing physics, chemistry, materials science, mathematics, statistics, earth sciences, solid and fluid mechanics, computer science, and instrumentation.

Schlumberger works with the Cambridge Trust to offer the Schlumberger Cambridge International Scholarship, available to PhD applicants in subjects relevant to the work of the Schlumberger Gould Research Centre.

Prysmian Group



Web: www.prysmiangroup.com

Prysmian Group is world leader in the energy and telecom cables and systems industry. With nearly 140 years of experience, sales of over €7.5 billion in 2016, 21,000 employees across 50 countries and 82 plants, the Group is strongly positioned in high-tech markets and offers the widest possible range of products, services, technologies and know-how. It operates in the businesses of underground and submarine cables and systems for power transmission and distribution, of special cables for applications in many different industries and of medium and low voltage cables for the construction and infrastructure sectors. For the telecommunications industry, the Group manufactures cables and

accessories for voice, video and data transmission, offering a comprehensive range of optical fibres, optical and copper cables and connectivity systems. Prysmian is a public company, listed on the Italian Stock Exchange in the FTSE MIB index.

MBDA

Web: www.mbda-systems.com



MBDA is the only European group capable of designing and producing missiles and missile systems to meet the whole range of current and future needs of the three armed forces. A multi-national group with 10,000 employees working together across France, Germany, Italy, Spain and the United Kingdom. Offices also set up in USA. Jointly held by 3 prestigious shareholders: AIRBUS (37.5%), BAE Systems (37.5%) and Leonardo (25%).

ARUP

Web: www.arup.com



ARUP is a multi-disciplinary engineering firm, offering a variety of services across the built environment from planning to environmental consultancy and traditional SMEP engineering to specialist materials consulting. Operating with over 15,000 staff in 95 offices across 36 countries. We have had input to many landmark projects over the years including historically the Sydney Opera House or more recently Heathrow Terminal 5 to name but two.

GoodFellow

Web: www.goodfellow.com



Goodfellow is a leading global supplier of metals, alloys, ceramics, glasses, polymers, compounds, composites and other materials to meet the research, development and specialist production requirements of science and industry. With over 6000 customers supported by a worldwide network of offices, agents and distributors Goodfellow also offers a comprehensive range of bespoke processing services, effectively operating as an extension of the production team in order to develop custom fabricated components in any quantity required. Our in-house team is comprised of fellow scientists and engineers with extensive knowledge of materials and processing – through their technical expertise and a supporting range of specification tools the company has built an unrivalled reputation for helping to find solutions to even the most challenging of research problems. All of our products are also underpinned by the ISO 9001 quality accreditation.

BITREZ

Web: www.bitrez.com



Bitrez is a resin manufacturer that holds the UK's coveted Queen's Award for Enterprise in Innovation. We offer an extensive range of highly innovative materials developed for a broad range of markets. We work with a high standard of customer service and flexibility with controlled design, development and implementation programmes to give our customers the right solutions for their resin requirements. Founded in 1982, we have developed a reputation for providing quality products with exceptional service. We recognise that all requirements are unique and our team works hard to ensure that an outstanding package is provided. We endeavour for constant improvement, achieving this through training, integration and investing in our technology and staff.

EMPA

Web: www.empa.ch



As an interdisciplinary research institute, **EMPA**, the **Swiss Federal Laboratories for Materials Science and Technology**, conducts cutting-edge materials and technology research. Its activities

focus on the requirements of industry and the needs of society, and thus link applications-oriented research to the practical implementation of new ideas. Through an efficient technology transfer EMPA is turning research results into marketable innovations.

Lucideon

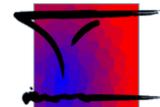
www.lucideon.com



Lucideon is a world leader in the field of Industrial Materials Sciences & Technology. Its business covers consultancy, contract R&D and testing & analysis. It is a well-known consultancy company with over 60 years history and employs over 200 professional scientists and engineers to serve worldwide clients with speed and simplicity to improve profitability and competitive position. Six major services are: Aerospace, ceramics, construction, healthcare, nuclear, power generation.

The Nanoscience Centre University of Cambridge

Cambridge University nanofabrication and characterisation facility
Web: www.nanoscience.cam.ac.uk



The **Nanoscience Centre** is an 1800m² research facility completed in January 2003 and located at the north east corner of the University's West Cambridge Site. The Centre provides open access to over 300 researchers from a variety of University Departments to the nanofabrication and characterisation facilities housed in a combination of Clean Rooms and low noise laboratories. Office space is primarily home to the Department of Engineering's Nanoscience Group, technical and administrative staff and members of other research groups who require long term access to facilities.

University of Cambridge Department of Materials Science & Metallurgy

Web: www.msm.cam.ac.uk



The Department of Materials Science & Metallurgy has a large and vigorous research school, with about 100 research fellows, postdoctoral scientists and visiting scientists, and more than 140 research students studying for the postgraduate degrees. The growth in our research activities over the past twenty years has been almost exponential, with a current research income of more than £10 million per year. Although our research has always been closely linked with industrial needs and supported in large part by industry as well as government, recent trends have seen the development of larger-scale working relationships with major research sponsors. Similarly, our wide range of international contacts which bring visiting researchers to Cambridge has been extended through formal collaboration agreements with institutions from around the world.

University College London Department of Physics and Astronomy

Web: www.ucl.ac.uk/physics-astronomy



UCL is a world-leading university situated in the heart of London, UK. UCL was 1st in the UK for research strength at the last UK university research assessment (UK REF 2014). ~40,000 undergrad+post grad students, ~7,000 Staff. The Physics and Astronomy Department at UCL is located in the heart of the historical area of Bloomsbury. Scientific research and study has been a strong feature of UCL since its inception in 1826 and the Department is one of the top rated Physics departments in the country and the world.

**University of Surrey
Advanced Technology Institute**



Web: www.surrey.ac.uk
www.surrey.ac.uk/ati/about

The Advanced Technology Institute at the University of Surrey is an interdisciplinary research centre dedicated to advancing next-generation electronic and photonic device technologies. Our strategy is based on having selective and focussed programmes of research, each of critical mass, which embrace in their investigations the full spectrum of fundamental science through to applied engineering. From our contributions to the design of the first strain layer laser in the mid 80's to rapid thermal annealing and production of SIMOX for semiconductors in the 90's to nano-materials and nano-technologies in the last decade; our researchers have been at the forefront in helping to solve some of the most challenging problems in industry today. We are also examining such issues as the fabrication of cheap renewable energy sources, and work with industry to deliver high quality output wherever it is required. Presently, there are some 160 researchers working in the AT

Bridon-Bekaert Ropes Group



Web: www.bridon-bekaert.com

Bridon Bekaert Ropes Group is a world leading manufacturer and service provider of wires, cords, steel ropes and synthetic fibre ropes. Headquartered in Doncaster with 2,500 employees and ~20 manufacturing factories and service sites worldwide, Bridon Bekaert Ropes Group has three technology centres with the largest one based in Doncaster UK.

E.G.O. Elektro-Gerätebau GmbH



Web: www.egoproducts.com/en/home

E.G.O. is an international high-tech company and one of the leading global manufacturers of domestic appliance technology, components and products. Other industries, ranging from medical technology through building services to automotive technology, benefit from our pioneering spirit, our experience and our expertise. Ever since the company was founded in 1931 we have been inventing sophisticated technology that makes people's day-to-day lives easier. Carrying on this tradition is what drives us on each and every day.

Versarien™ plc (Headquarters)



Web: www.versarien.com

We utilise proprietary materials technology to create innovative engineering solutions that are capable of having game-changing impact in a broad variety of industry sectors. Founded in 2010, we have continued to develop advanced materials and processes to satisfy customer-specific applications whilst expanding our portfolio of intellectual property through acquisition. Our product offerings are capable of having a game-changing impact in a broad variety of industry sectors.

Innovia Technology



Web: www.innoviatech.com

We are an innovation consultancy specialising in the front end of innovation, working with the best companies in the world to create opportunities for growth.

InnoTecUK



Web: www.innotecuk.com

InnotecUK is a dynamic, fast growing and progressive robotics and automation solution provider, specialising in development of innovative and novel robotic systems to overcome complex sensing, measurement, control, automation and inspection challenges. InnotecUK has a diverse client base and has strong partnerships in Ireland, UK and Asia in sectors including conventional power generation, oil & gas, nuclear, renewable energy, chemical, food processing, and maritime. InnotecUK focuses on delivering client-led solutions to maximise life-cycle production asset values. It develops and markets novel mechatronic systems to overcome complex equipment and asset inspection challenges in hazardous and difficult to access environments. The ability to deliver value and technical excellence under harsh operating conditions has been central to success.

BSI Group

Web: www.bsigroup.com/en-GB



BSI is the business standards company that helps organizations all over the world make excellence a habit. For more than a century we have been challenging mediocrity and complacency to help embed excellence into the way people and products work. That means showing businesses how to improve performance, reduce risk and achieve sustainable growth. As a global leader in helping organizations improve, our clients range from high profile brands to small, local companies in 182 countries worldwide.

Exemplas Ltd

EEN East of England

Web: www.exemplas.com



Exemplas are pioneers of business advisory services in the UK

Exemplas help small businesses and organisations to enhance their value proposition and benefit their markets.

Q5D

Web: q5dtech.com



Q5D is an innovative technology company developing tools to automate the production of wiring harnesses for the consumer white and electronics, through to the automotive and aerospace markets.

ANSYS Granta

Web: www.grantadesign.com



Granta is the leader in materials information technology – software, information resources, and services to advance materials education, and to enable better, greener, safer products. Granta Design is a subsidiary of ANSYS Inc.

Reflex Imaging

Web: www.reflex-imaging.com



Reflex Imaging was formed in 2013 with a mission to bring to market products based on its unique technical innovations and patent portfolio. The company is based in Horsham, West Sussex in the UK. The company focuses on design and development, partnering with established suppliers for manufacturing and distribution.

National Composites Centre

Web: www.nccuk.com



The National Composites Centre is a world-class research centre, where companies of any size and across industry sectors, can access cutting-edge technology and specialist engineers, to drive innovation in the design and manufacture of composites.

Non-metallic Innovation Centre

Web: www.non-metallic.com



Saudi Aramco Technologies Company (AramcoTech), TWI and ADNOC, have come together to form the Non-metallic Innovation Centre (NIC), a private technology innovation partnership. NIC will connect AramcoTech & ADNOC with composites manufacturers, academic institutions and industrial partners wanting to make an impact on the oil and gas industry, and beyond.

As a multi-stakeholder centre based at TWI in Cambridge, NIC will conduct a research programme covering technologies with different maturity levels spread through Technology Readiness Levels (TRL) 1-9. Partners are drawn from leading academic institutions, research centres and composite material manufacturers.

Printed Electronics

Web: www.printedelectronics.com



Experts in functional printing, material deposition, inkjet and digital technologies focussing on electronic applications. We supply training, product and process development for companies, universities and research organisations all around the world.

Teledyne CML Composites

Web: www.teledynecml.com



Teledyne CML Composites based in Bromborough England provides a comprehensive manufacturing service for composite products in advanced engineering applications, including components and assemblies for aircraft structures and systems.

Teledyne CML Composites is integrated with the Marine and Aviation Manufacturing business unit of Teledyne Brown Engineering which brings with it extensive expertise and experience in design, product development and engineering support.

With a strong pedigree in manufacturing machined and fabricated metallic components for the aerospace industry since the 1940's, Teledyne CML Composites are now focused on the manufacture and supply of composite components from details through to complete sub-assemblies or kits of parts. Operating out of a brand new state of the art facility opened by HRH Prince Andrew in 2011, Teledyne CML Composites can supply the complete Turnkey package, from engineering, lay-up, curing, CNC machining, assembly, paint and NDT. With the added bonus of having metal fabrication and machining capability in-house Teledyne CML Composites can offer a "one stop shop" for the customer looking for a complete composite manufacturing solution.

Brunel Innovation Centre (BIC)

Web: Brunel.ac.uk/bic



The Brunel Innovation Centre (BIC) is a world class research and technology centre that sits between the knowledge base and industry offering high quality research in an innovative environment focused on non-destructive testing, condition and structural health monitoring, power ultrasonics and allied technologies covering a range of materials, sensors, electronics and software systems supporting partners in industry to transfer academic research into industrial application. BIC has 35 staff members. BIC pursues initiatives that span national and international platforms including Innovate UK, EPSRC and EC. The Centre has been building a strong portfolio of projects in line with its multinational interdisciplinary vision.

Core Areas: State-of-the-art power ultrasonic systems for inspection and cleaning; Smart non-destructive testing; Condition and structural health monitoring; Advanced signal and image processing algorithms including machine learning; Numerical modelling and fluid structure interaction; Novel and robust sensing for harsh environment (e.g high temp transducers up to 600 °C); Digital twin technology; IoT and data analytics.

University of Sheffield Advanced Manufacturing Research Centre (AMRC)



Web: amrc.co.uk

AMRC specialises in carrying out world-leading research into advanced machining, manufacturing and materials, which is of practical use to industry. Our 110-plus industrial partners range from global giants like Boeing, Rolls-Royce, BAE Systems and Airbus to small companies. Businesses can work with us on a one-off project, or join us as a member for long-term collaboration. The AMRC now employs over 500 highly qualified researchers and engineers from around the globe, on the Advanced Manufacturing Park and Sheffield Business Park in South Yorkshire, as well as in Broughton and Preston.

Marshall Aerospace and defence group



Web: marshalladg.com

Marshall Aerospace and defence group – 1,800 employees, £321m turnover
 Industry – Aerospace and defence incorporating Military aerospace, Land systems, Aerostructures, Advanced composites, Major projects, Aeropeople business units. Main activities – design, maintenance, manufacture, repair of complex systems for military applications e.g. auxiliary fuel management systems for aerospace, large composite marine structures, special missions aircraft platforms, deployable military shelters

Uniper Technologies Ltd.



Web: www.uniper.energy

Uniper is a power generation company comprising 14,000 employees worldwide. Uniper Technologies Ltd., based near Nottingham, provides a wide range of energy services to the industry and beyond. Services include inspection, materials analysis and failure investigations, structural assessment, condition monitoring, electrical power and networks, environmental sciences, vendor assessments, etc.

Ultra Electronics, Precision Control Systems



Web: www.ultra-pcs.com

Ultra Electronics Precision Control Systems is a division of Ultra Electronics that mainly serves the Aerospace industry with safety critical, high integrity electronic, electro-mechanical and pneumatic systems. Ultra's main technology areas include position sensing and control, ice protection and noise & vibration.

LEITAT Technological Center



Web: www.leitat.org

LEITAT is a private non-profit Technological Centre specialized in production technologies and develops R&D activities in the areas of advanced materials, environment, human and environmental health and safety, biotechnologies and renewable energies with deep knowledge and experience in technological transfers to several industrial sectors. LEITAT is recognised by the Spanish Government as a CIT (Centre of Technological Innovation). It is also a member of FEDIT (Federation of Technological Centres in Spain) and the IT Network of the Catalan Regional Government.

e-Xstream engineering



<https://www.e-xstream.com>

e-Xstream engineering is a software and engineering services company 100% focused on state-of-the-art multi-scale modelling of complex multi-phase composites materials and structures (nanocomposites,

SFRP, CFRP, SMC, MMC, CMC, Foams, Rubber, Hard Metals, etc), and materials lifecycle management.

e-Xstream engineering is part of Hexagon, a leading global provider of information technologies that drive productivity and quality across geospatial and industrial enterprise applications. Hexagon’s solutions integrate sensors, software, domain knowledge and customer workflows into intelligent information ecosystems that deliver actionable information. They are used in a broad range of vital industries. Hexagon has approximately 18,000 employees in 50 countries.

Global Chilltech- PhasLo



<https://www.phaslo.com/>

Chill Tech Global believes the PhasLo invention is worthy of such an honourable classification, based on the novel benefits and the technological advancements over other products. Now, it’s their mission to help PhasLo become the number one super cooling solution across the world. It’s a safer, sustainable and highly efficient product compared to its competitors. The company values resemble around our customers, the process of further improvements and making the world a better place. The company’s focus is on innovation, replacement/disruptor to Dry Ice based line; thermal conductivity and heat exchange based. Aviation catering and pharmaceutical logistics.