

UltraWire 2020

**Workshop on commercialisation of nano-carbon and metal based
conductive composite materials**

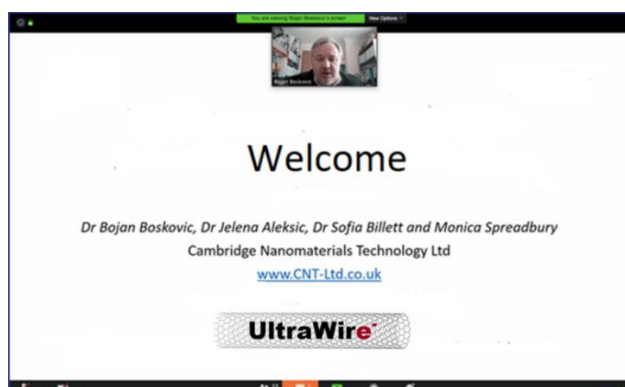
www.ultrawire.eu

Preliminary Agenda, Speakers and Participating organisations

Date: 2nd July 2020

Meeting Venue: ZOOM Online Platform

Time: 09:30 – 16:00 (UK – BST)



Organiser: Cambridge Nanomaterials Technology Ltd
14 Orchard Way, Lower Cambourne
Cambridge, CB23 5BN, UK
www.cnt-ltd.co.uk

UltraWire Workshop 2020

The *UltraWire Workshop 2020* “**Commercialisation of Ultra-Conductive Composite Technologies**”. (<http://ultrawire.eu/workshops/>), is taking place on 2nd July 2020. Due to the Covid-19 pandemic, **this workshop has been rescheduled to be online** and will be delivered using the **ZOOM digital platform**, which would enable a wider participation.

The **UltraWire Workshop 2020** is organised in order to support commercialisation of ultra-conductive materials including nano-carbon and metal-based composites technologies for a number of applications, such as; electrical energy transmission and transport by bringing together technology development leaders and industrial end-users. The UltraWire 2020 Workshop would be an opportunity to follow and learn about progress in the development of technologies using nanomaterials for improving electrical conductivity properties. It would also be a platform to exchange experience for all technology developers in industry and researchers in academia. This is also an opportunity to link the workshop with other activities related to the use of nano-materials and metal composites in additive manufacturing, and other applications.

Members of the Nano-Carbon Enhanced Materials (NCEM) private consortium, that has been running for 7 years and it is led by Cambridge Nanomaterials Technology (CNT) will also be attending the workshop.

Preliminary agenda

Please note that the times shown in the agenda are UK Time..

09:30 *Arrival, Welcome & individual Introduction of the participants*

Bojan Boskovic, CEO, Cambridge Nanomaterials Technology Ltd, UK

10:30 **Andrew Barron**, Energy Safety Research Institute, Swansea University, UK

Title: Copper-carbon nanotube hybrid wire for electrical conduction

A new approach to the formation of carbon nanotube reinforced copper nano hybrid wires is presented that involves the electrodeposition of copper into a preformed CNT fiber or fabric. The reaction in acid or anodization followed by electrolysis of a copper salt from aqueous solution enables full infiltration of the CNT fiber resulting in a wire with a lower weight than pure copper, and a specific conductivity close to that of copper.

10:50 **Atif Aziz**, The Nanoscience Centre, University of Cambridge, UK:

Title: Commercial-scale production of carbon nanotubes conductors

Carbon-based electronics is a growing field that spans power cables, printable electronics, energy storage devices, and bio-sensors. The commercialization of these carbon-based

technologies requires a scalable production of high conductivity carbon dispersions. Super acids have been used to achieve high concentration CNT inks however for commercial adoption, a scalable, safe, and acid-free process is required. In this talk, I will discuss water-based high concentration CNT dispersion which has been used to make high conductivity, flexible carbon conductors. Conductivity and sheet resistance of these conductors are $3.6 \pm 0.2 \times 10^5$ S/m and $0.11 \Omega/\square/\text{mil}$ respectively. Freestanding CNT film of thickness about $1 \mu\text{m}$ has also been created which has an areal density of 1.2 g/m^2 . A $10 \mu\text{m}$ thick film has an EMI shielding efficiency of -60dB and the thermal conductivity is $43 \pm 4 \text{ W/m/K}$. These CNT films also show very good resilience to mechanical deformation and can easily be spray-coated for making thin films. From a commercialization perspective, we can create these dispersions in a very large quantity (100s of liters) and they have a viscosity of more than $1 \text{ Pa}\cdot\text{s}$. Furthermore, due to high concentration, continuous wet spun fibres can be created using the CNT dispersion and be integrated with copper for making CNT/Cu composite wires.

11:20 *coffee break – networking*

11:30 **Zlatka Stoeva**, Managing Director, DZP Technologies Ltd, UK

Title: Novel conductive materials for emerging electronics

Today's electronics industry is evolving rapidly, driven by ever increasing demands for power in electric vehicles and energy networks, and requirements for ultimate mobility, connectivity, and convenience of consumer and healthcare electronics.

Existing processes and materials cannot always meet these rapidly changing industry needs. DZP Technologies is leading the way in inventing new, sustainable, and high-performance conductive materials, to accelerate the development of competitive electronics of novel form factors and designs. This presentation will outline the findings from recent R&D projects, and introduce new products developed by the company in two specific areas – power electronics and smart textiles.

11:50 **Thomas Greeves**, Haydale, UK

Title: Commercial Applications of Functionalised Nanomaterials

This presentation will provide an update to activities at Haydale that exploit the patented functionalisation technology that it has developed to improve the interaction of nanomaterials when dispersed in polymer systems. This will be followed by an overview of some of the key applications that Haydale are currently focused on to support the commercialisation of nanomaterials. A number of case studies will be presented to demonstrate some of the significant steps forward that have been made over the past few years, with highlights including R&D activities in diverse markets such as composites, elastomers and inks; where functionalised nanomaterials have been incorporated with a range of benefits

12:10 **Elena Polyakova**, Senior Research Fellow, National University of Singapore, Singapore.
CEO, Graphene Laboratories, Inc (Graphene Supermarket), USA

Title: Critical Overview of Performance of 2D Materials and Composites

There is a frenzy of commercialisation efforts surrounding graphene and other 2D Materials. Many "graphene" products have been recently introduced. In many cases, there is no clear evidence that the addition of graphene to the polymers results in meaningful improvement of the performance of the composite. This presentation will provide a comprehensive overview of the current state of graphene research and give a clear comparison of graphene composites with commercially available materials. Further, the potential advantages of graphene composites for 3D Printing will be discussed.

12:30 *Lunch break & networking*

13:30 Anna Boczowska, TMBK Partners Sp. z o.o, Poland

Title: CNT-doped thermoplastic veils for the improvement of electrical and mechanical properties of CFRP

The up-scaling production of carbon nanotube-doped thermoplastic veils and related pilot line will be presented.

13:50 Stephen Bennington, Q5D Technologies Limited, UK

Title: Robotic manufacture of functional components

Q5D has developed a robotic platform that combines: FFF additive manufacture, laser sintered printed electronics and embedded wiring to automate the manufacture of functionalised components. In this brief talk I will describe the technology and illustrate its use in two case studies: first and business class airline seats and car bumpers.

14:10 Dimitrios Fakis Brunel Composites Centre (BCC), UK

Title: Molecular modelling of the Graphosite sensors and brief introduction to Brunel Composites Centre.

14:30 Chris Worrall, TWI Ltd, UK

Title: SurFlow™: Data transmission through composites

A breakthrough at TWI has led to the creation of a data transfer technology that can be seamlessly incorporated into composite materials to create a high-capacity, resilient data transfer network. SurFlow™ technology uses electromagnetic surface waves to transmit data directly through composite structures. Described as 'the future of composite data highways', SurFlow™ removes the need for wires or fibre optics, while also eliminating the remote interception risks associated with conventional 'wi-fi' wireless data transfer. SurFlow™ is patented in the UK (GB2522344), the US (US10090715B2) and is awaiting issue of the EU patent. It also won a 2018 Industry Award for Innovation in Composite Design.

14:50 Chris Wiseman, Corporate Sector Manager and **Fokion Oikonomidis** TWI Ltd, UK

Title: Introduction to TWI Technology Engineering

15:10 Discussion

Facilitated by **Bojan Boskovic**, CEO, Cambridge Nanomaterials Technology Ltd

Note It is planned that all presentations would be followed by Q&A discussion. The organisers reserve the right to change the programme, speakers or venue should circumstances require. *For any further enquires please do not hesitate to contact directly Dr Bojan Boskovic on Bojan.Boskovic@CNT-Ltd.co.uk or on his mobile phone +447780874335.*

UltraWire 2020 Workshop – Speakers



Prof. Dr. Andrew R Barron (*Speaker*)
Director
Energy Safety Research Institute (ESRI)
Swansea University Bay Campus
Fabian Way, Swansea, SA1 8EP, Wales, UK

Professor Dr. Andrew Barron is the Sêr Cymru Chair of Low Carbon Energy and Environment and Professor Emeritus of Chemistry, Materials Science and nano engineering at Rice University. Research in the Barron Group is currently aimed at the development of rational molecular design approach to materials synthesis, with an emphasis on the leap from synthesis to application of nano-based materials. In 2013 he Founded the Energy safety Research Institute at Swansea University. Areas being investigated include: carbon capture, utilisation and sequestration, green energy and power transmission. He pioneered the catalytic approach for the amplification of SWNTs that may be likened to the polymerase chain reaction for DNA and he has recently developed techniques for the measurement of electrical properties of both individual CNTs and their bundles. Professor Barron created the first educational programs at Rice to span the Schools of Science, Engineering and Management, and is a co-director of the Rice Alliance for Entrepreneurship. He is also actively involved with educational programs in collaboration with the Rice section of the Society of Automotive Engineers.



Dr Atif Aziz (*Speaker*)
Senior Research Associate
The Nanoscience Centre
University of Cambridge
UK

Dr Atif Aziz is a senior research associate at the Nanoscience Centre, University of Cambridge. His area of research is studying the physical, electrical and mechanical properties of nano materials and nanoscale devices. At present he is working on Carbon Nanotubes and metal composites in particular copper and functional nanofibers. He did his PhD from Cavendish Lab, University of Cambridge and had been working as a research associate at the Materials Science Department, University of Cambridge. Before his current job, he was an experimental office at the Lancaster University, where he setup a nanofabrication facility for Quantum Technology Centre and had been a manager of the Cambridge Graphene Centre.



Dr Zlatka Stoeva (*Speaker*)
DZP Technologies Ltd.
Future Business Centre
Kings Hedges Rd.
Cambridge CB4 2HY
UK

Dr Zlatka Stoeva is a Managing Director and a co-founder of DZP Technologies Ltd. Zlatka started her career as a scientist, following the completion of PhD degree at the University of St Andrews in 2001, where she worked on polymer electrolytes for lithium ion batteries. She then held post-doctoral research positions at the University of Aberdeen (2002) and the University of Nottingham (2002-2005) working on lithium ion conductors and other energy storage materials. In 2006, Zlatka moved on to a business-focussed role at the technology transfer office at the University of Cambridge. She spent several years in this role, working on the commercialisation, patenting, and licensing of technologies arising from university science. Since moving full-time to DZP Technologies in 2011, Zlatka initiated several R&D programmes

and collaborative projects in which the company developed advanced materials for emerging applications, such as flexible and stretchable electronics, wearable technology, and sensors for the Internet-of-Things.



Thomas Greaves (Speaker)
Haydale Composite Solutions Ltd.
Unit 10, Charnwood Business Park,
North Road, Loughborough, LE11 1QJ
UK

Thomas Greaves has a BSc (Hons) in Chemistry which included a year working in industry in Manchester, UK. After completing his industry placement, Thomas was awarded the Society of Chemical Industry Prize for 2013. Thomas has since worked in the field of elastomers, composites and nanotechnology. In 2014, he spent 3 years with a large elastomer manufacturer where he was responsible for developing new elastomeric products from laboratory scale through to product launch. He was project lead on a number of high-profile projects, with projected annual revenues exceeding £1 million. Thomas joined Haydale Composite Solutions in October 2017. As Senior Project Engineer, Thomas is required to manage both commercial and grant funded projects in a wide range of speciality areas and industries. His role is focused on driving innovation in elastomers, composites and inks by demonstrating how the incorporation of nanomaterials into these systems enhances the mechanical, dynamic, electrical and thermal properties.



Dr Elena Polyakova (Speaker)
Senior Research Fellow, NUS, Singapore
CEO, Graphene 3D Lab - USA

Dr. Elena Polyakova is Senior Research Fellow at the National University of Singapore. She also serves as Co-Chief Executive Officer at Graphene 3D Lab. Previously Dr. Polyakova had served for two and a half years as the company's Chief Operating Officer. She was instrumental in bringing the first graphene filament to market. Dr. Polyakova is also the co-founder of Graphene Laboratories, Inc. where she has served as the Chief Executive Officer and President since 2009. The company pioneered the commercial graphene production market. Dr. Polyakova has grown the company's client base substantially in the past six years. Her expertise in 2D materials has been covered by prestigious news publishers such as BBC and Bloomberg. Dr. Polyakova has co-authored papers with Nobel and Kavli prize winners, as well as members of the National Academy of Sciences. She previously was one of the first graphene researchers in the Flynn Group at Columbia University. She received a Ph.D. in Physical Chemistry from the University of Southern California and a Master's degree in Physical Chemistry from Moscow Institute of Physics and Technology.



Prof. Anna Boczkowska (Speaker)
Scientific Director
TMBK Partners Sp. z o.o.
Poland

Prof. Anna Boczkowska has almost 30 years' academic and research experience. She graduated from the Warsaw University of Technology, Faculty of Materials Science and Engineering, and received her PhD in 2000, D.Sc. in 2011, both at the same Faculty. Since 2018 professor of technical sciences. Her professional experience is related to material sciences, especially composite materials, polymers, nanocomposites and smart materials. With TMBK Partners since 2013 as scientific director in several EU-funded projects on aeronautics and materials engineering performed under EU FP7 (ELECTRICAL, SARISTU), EU H2020 (PLATFORM, OASIS). Key competences: research and development of new materials, project management, extensive technical knowledge, international collaboration.



Dr Stephen Bennington, *(Speaker)*

Q5D
UK

Dr Stephen Bennington have been a CEO of a high-tech start-up and I am an experienced leader of high functioning and innovative teams in the public and private sectors. Currently I am the director of a consultancy that performs IP and technology assessment, business and financial modelling, market analysis and assists with fund-raising, primarily for University and early stage tech companies. I am also a well-respected materials physicist with deep knowledge of the science and business of nanotechnology (including graphene), hydrogen and the hydrogen economy and batteries and novel battery chemistries.

Dimitrios Fakis *(Speaker)*

Brunel Composites Centre
Brunel University
UK

Dimitrios Fakis was born in Larisa, Greece, in 1991. Received Diploma in Electrical and Computer Engineering from the Aristotle University of Thessaloniki, Greece, having chosen to specialise on Electrical Power and High Voltage Engineering. Subsequently employed as a Simulation and Consulting Engineer for two years, working on the development, testing and use of electromagnetic simulation software. Currently full-time PhD Student with Brunel University London, College of Engineering, Design and Physical Sciences. My research is focused on the excitation and propagation of electromagnetic surface waves on composite, fibre-reinforced structural parts.



Dr Chris Worrall *(Speaker)*

Consultant
TWI Ltd.
UK

Dr Chris Worrall is currently a Consultant at TWI working on composites joining, design, manufacture and testing. He is an Imperial College (London) metallurgy and materials scientist graduate, with a PhD in the impact of composite sandwich materials from the Impact Research Centre at Liverpool University. He has spent 10 years in Japan working in the automotive, aerospace, renewable energy and rail transport industries. Before leaving the UK he worked in a research laboratory on novel thermoplastic composite materials, improving the toughness of composites, and developing test methods for composite materials. He has managed a mechanical testing laboratory and carried out a wide range of tests on carbon, aramid and glass fibre composites, both short and continuous fibre. My areas of interest cover microstructure characterisation, testing, finite element analysis, welding of thermoplastic composites, and design and manufacture using advanced composite materials.



Chris Wiseman *(Speaker)*

Corporate Sector Manager
TWI Ltd.
UK

Chris Wiseman is Corporate Sector Manager at TWI Ltd, for both the Aerospace and Equipment, Consumables & Materials sectors. He also has a specific geographic responsibility for TWI Industrial Members in India and in supporting TWI's exciting growth there. As a Materials Scientist, over many

years, he has contributed to a number of technologies, including, corrosion prevention, thermo-mechanical forming, novel testing, process optimisation, joining and surface treatments. Today his role is focused on developing technical and commercial opportunities for TWI and its Industrial Members around the World.



Dr Fokion Oikonomidis (*Speaker*)
TWI Ltd.
UK

Dr Fokion Oikonomidis joined TWI in 2012 and has since developed expertise in small and large scale fracture toughness testing in air, seawater, and sour environments. Fokion is the quality advisor of the Materials and Structural Integrity group in Cambridge since 2014. Fokion has supervised postgraduate students in National Structural Integrity Research Centre. During the six years before joining TWI, he worked in the area of Fracture Mechanics both in a research centre in Belgium and during his 1st PhD at the University of Bristol. Fokion is a chartered mechanical engineer with work experience in the fields of water and wastewater treatment, building services, health and safety and business process management in the aerospace industry. Fokion has served in the Hellenic Air Force and has an MBA degree in general business administration from the University of Hull. Fokion recently obtained his 2nd PhD in Management at the University of Newcastle upon Tyne.



Dr Bojan Boskovic (*Speaker and Organiser*)
CEO, Cambridge Nanomaterials Technology
14 Orchard Way
Lower Cambourne
Cambridge CB23 5BN
UK

Dr Bojan Boskovic is the Founder, Managing Director and Principal Consultant of the company. He has more than 20 years of hands-on experience with carbon nanomaterials and composites from industry and academia in the UK and Europe. Previously, he worked as a R&D Manager at Nanocyl, one of leading carbon nanotube manufacturing companies in Europe. He also worked on carbon nanotube synthesis and applications as a Principal Engineer-Carbon Scientist at Meggitt Aircraft Braking Systems, as a Research Associate at the University of Cambridge, and as a Senior Specialist at Morgan Advanced Materials. During his PhD studies at the University of Surrey he invented low temperature synthesis method for production of carbon nanomaterials that has been used as a foundation patent for the start-up company Surrey Nanosystems. He was a member of the Steering and Review Group for the Mini-IGT in Nanotechnology that advised the UK Government on the first nanotechnology strategy policy document. Dr Boskovic was working as an advisor for the European Commission (EC) on Engineering and Upscaling Clustering and on setting up of the European Pilot Production Network (EPPN) and European Materials Characterisation Cluster (EMCC). He has experience in exploitation and dissemination management on a number of FP7 and H2020 European projects, including UltraWire, NanoLeap, OYSTER, M3DLoC, Genesis and nTRACK. Also in UK Government InnovateUK funded projects, such as UltraMAT and GRAPHOSITE He is also a leader of two private membership based consortiums: Nano-Carbon Enhanced Materials (NCEM) and Advanced Materials for Additive Manufacturing (AMAM).

UltraWire 2019 Workshop - Speaker & Delegate Organisations

AIRBUS Defence and Space AIRBUS Group



Web: www.airbus-group.com

Airbus Group is a European industrial flagship which unites the capabilities of three market leaders: Airbus, Airbus Defence and Space and Airbus Helicopters. EADS has been rebranded as Airbus Group from January 2014. Airbus Military, Astrium and Cassidian are in formation to merge as Airbus Defence and Space. This broad range of products turns the new Division into a top-10 world player in defence and space. **Astrium** is Europe's No. 1 space company and is ranked third worldwide. Part of the international EADS Group and now Airbus Group, they are the only European space company that covers the entire space business, from civil and defence systems to services and applications. Their design, manufacturing and test facilities are among the most advanced in the world. They have unrivalled expertise in the techniques and key technologies required for developing and delivering major space systems. The 18,000-plus employees of Astrium are all driven by the same ambition: to make space technology work for everybody. Their skills, energy and entrepreneurial spirit have contributed to the success of many of the most important projects in space, including Ariane, the International Space Station, ATV, Herschel, Spot & Pléiades constellation, Mars Express and Skynet 5.

Prysmian Group



<http://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.

Whirlpool Corporation



<http://whirlpoolcorp.com/>

Whirlpool Corporation (NYSE: WHR) is the world's leading major home appliance company, with approximately \$20 billion in annual sales, 77,000 employees and 59 manufacturing and technology research centers in 2019. The company markets Whirlpool, KitchenAid, Maytag, Consul, Brastemp, Amana, Bauknecht, JennAir, Indesit and other major brand names in nearly every country throughout the world.

The Nanoscience Centre



Cambridge University nanofabrication and characterisation facility

Web: <https://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.

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%).

Energy Safety Research Institute (ESRI)

Web: www.esri-swansea.org/en



The Energy Safety Research Institute building at Swansea University's Bay Campus forms part of the College of Engineering. The Energy Safety Research Institute concentrates the College of Engineering's strength in the energy sector.

The Energy Safety Research Institute is supported by industry sponsors. It focuses on the safety issues surrounding the development and expansion of existing energy processes, as well as the safe deployment and integration of new 'green' energy technologies.

The design and construction of a new 3,800m² building enables the University to develop the quality and scale of its research efforts in the areas of energy and safety.

The vision of the Energy Research Safety Institute (ESRI) and Swansea University is "building the bridge to a sustainable, affordable and secure energy future."

DZP Technologies

Web: www.dzptechnologies.com/



DZP Technologies is a leading developer of specialty materials, formulations, and technologies for emerging industries. We work closely with our customers to create innovative materials for a range of markets, from consumer electronics and wearables, to 3D-printing and renewable energy. Founded in 2008, we work with forward-thinking businesses and enterprises to fast-track scientific discoveries and create advanced technologies for a wide range of markets. We are happy to take on the toughest technical challenges, using our expertise to help our customers develop innovative, sustainable products which offer a true differentiator in competitive markets.

Haydale Composite Solutions Ltd

Web: www.haydale.com



HAYDALE Composite Solutions is an independent research and development company based in Loughborough, UK specialising in the development of advanced composites and nanomaterial enhanced composites and their applications. The company employs highly qualified engineers with mechanical engineering and material science backgrounds. The company has extensive knowledge of both thermosetting and thermoplastic based composites, manufacturing processes, structural design

and applications across a broad range of industries. The company utilise the latest in computer aided design systems and have access to its own prototyping workshops. We are a global technology solutions company passionate about creating the next generation of advanced materials. We bring together cutting-edge technology with engineering know-how to enhance the performance of products and materials thus delivering business value for our customers.

Coatema® Coating Machinery GmbH



Web: www.coatema.de/en

Coatema Coating Machinery GmbH offers a full range of equipment and R&D for coating, printing and laminating plants for Roll-to-Roll and Sheet-to-Sheet applications.

Our second generation family owned business has over 40 years of experience in the textile, foil and paper markets and offers lab, pilot and production lines for these sectors.

Coatema has been the market leader for 15 years in the pilot line sector with innovative technologies for batteries, fuel cells and printed electronics.

A focus on high tech markets, world class service support and one of the most versatile R&D center in the world for coating, printing and laminating enables Coatema to offer complete laboratory to fabrication (Lab-to-Fab) technologies.

In addition to the established sectors of vertically integrated machine engineering, Coatema is continuously active in German and European research projects and organizes an international coating symposium every year in Dormagen.

As a global acting SME Coatema has a worldwide distribution network and serves all growth markets with their products.

SENERGY



Web: www.senergyinnovations.co.uk

With a background spanning almost 20 years in the commercial roofing industry, **Senergy** are a Belfast based enterprise that design and manufacture SMART Solar Thermal Panels. By combining our roofing expertise with that of global leading engineers, we have developed the Senergy solar thermal panels. Unlike current solar thermal panels that are made from glass, copper and aluminium, Senergy panels are manufactured using advanced nanocomposite plastics.

Being aware of the sun's potential to deliver limitless amounts of solar energy, Senergy was inspired to design an architecturally attractive solution that would reduce the upfront cost of a solar heating system making it affordable to harness the sun's renewable energy.

Brunel Composite Centre



Web: www.twi-innovation-network.com/innovation-centres/brunel-composites-innovation-centre

Brunel Composite Centre is part of the Institute of Materials and Manufacturing of Brunel University. The principal mission of BCC is to establish a world class research centre offering high quality research in phenomena that take place at the interface of composites to other materials. The physicochemical processes studies include processing of composites, embedding of smart structures in composites and joining of composites with other materials. BCC operates with the aim of developing a financially sustainable research facility, drawing on Brunel University's existing strengths, to complement and underpin the applied research and development activities of TWI.

TWI

Web: www.twi-global.com



TWI is one of the world's foremost independent research and technology organisations, with expertise in materials joining and engineering processes as applied in industry. TWI specialises in innovation, knowledge transfer and in solving problems across all aspects of manufacturing, fabrication and whole-life integrity management. Established in Cambridge, UK in 1946, the organisation has gained a first-class reputation for service through its teams of respected consultants, scientists, engineers and support staff. With around 800 employees, it works with over 1800 Industrial Member companies in over 70 countries. TWI currently operates from 54,000 square metres (581,000 square feet) of manufacturing, testing and training space; five UK and 13 overseas facilities serve both its Industrial Membership and its training and examination needs. A successful international Training and Examinations programme sees around 25,000 students trained each year in welding and inspection technologies.

Q5D Technologies Limited

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.

TMBK Partners Sp. z o.o.

Web: www.tmbk.pl



TMBK Partners is an SME that specialises in the manufacturing of innovative products and provision of services in the area of materials engineering. TMBK Partners mainly specialises in the production of thermoplastic CNT-doped veils and strips. The services offered by TMBK Partners primarily involve issues relating to integration of nano-enabled products with customers' materials and technologies in order to give the final products the desired features and characteristics.

Graphene 3D Lab

Web: www.graphene3dlab.com/s/home.asp



Graphene 3D Lab, Inc. is capitalizing on groundbreaking properties of graphene and other advanced materials. The company is offering high-tech solutions in several areas including:

Blockchain and Cryptocurrency Mining: The Company is developing innovative hardware for harvesting the heat generated by the cryptocurrency mining computational hardware and converting it into heating and/or refrigeration solutions.

R&D Materials: These diverse materials have a wide spectrum of commercial, research, and military applications. The Company's wholly-owned subsidiary, Graphene Laboratories Inc., currently offers over 100 graphene and related products to a client list comprised of more than 14,000 customers worldwide, including nearly every Fortune 500 tech company and major research university. Some notable clients are NASA, Ford Motor Co., GE, Apple, Xerox, Samsung, Harvard University, IBM, and Stanford University. The Company's suite of products is available online at the company's e-commerce platform Graphene Supermarket (www.graphene-supermarket.com).

3D Printing: The 3D printing division of the Company offers a portfolio of 3D printable filaments. These materials can be purchased through multiple distribution networks worldwide or directly from the web-store www.blackmagic3D.com.

High-Performance Epoxies: Adhesive materials produced by the company are distributed under the G6-Epoxy trade name.

Argonne National Laboratory

Web: www.anl.gov



Argonne National Laboratory, one of the U.S. Department of Energy's national laboratories for science and engineering research, employs 3,400 employees, including 1,400 scientists and engineers, three-quarters of whom hold doctoral degrees. Argonne's annual operating budget of around \$760 million supports upwards of 200 research projects. Since 1990, Argonne has worked with more than 600 companies and numerous federal agencies and other organizations.

Argonne's mission is to apply a unique mix of world-class science, engineering and user facilities to deliver innovative research and technologies. They create new knowledge that addresses the most important scientific and societal needs of our nation. They also actively seek opportunities to work with industry to transfer our technologies to the marketplace through licensing, joint research and many other collaborative relationships.

Argonne is managed by UChicago Argonne, LLC, for the U.S. Department of Energy's Office of Science. They are located on 1,500 acres (6.9 sq. km) in southwest DuPage County, Illinois 25 miles (40 km) southwest of Chicago. The site is completely encircled by the beautiful Waterfall Glen Forest Preserve.

European Copper Institute

Web: www.copperalliance.org
copperalliance.eu



The Copper Alliance® represents a network of regional copper centers and their industry-leading members, led by the International Copper Association (ICA). ICA aims to bring together the global copper industry to develop and defend markets for copper and to make a positive contribution to society's sustainable-development goals.

The European Copper Institute represents the world's leading mining companies, custom smelters and semi-fabricators (represented by the International Copper Association, Ltd.) and the European Copper Industry. The European Copper Institute is part of an international network of industry associations – funded by the copper industry – whose common mission is to defend and grow markets for copper, based on its superior technical performance and contribution to a higher quality of life. This network is unified by a common brand and visual identity: Copper Alliance.

SHWire

Web: www.sh-wire.de/en



Since its foundation **SHWire** has developed into an acknowledged quality leader within its industry. The product range encompasses all enamelled copper and aluminium wires demanded by the winding wire industry on a global basis. In addition to the standard types required, SHWire develops and produces new types of enamelled wires, including the innovative low friction SHTherm® 210 GLIDE and the „shaped“ wire, which provides superior mechanical properties way above current industry standards.

UltraConductive Copper Company

Web: www.ultraccc.com



UltraConductive Copper Company Inc. (UC3) is a venture focused on the manufacturing scale-up of a new room-temperature conductive material: ultraconductive copper (UCC). UC3 works with the electric vehicle components industry, who are attracted by the potential for lighter and more efficient

UCC wires to increase electric vehicle range. UC3 was spun-out from the International Copper Association in 2017 and institutionally-funded in June 2018. Company management is always open to discussing commercial possibilities with new potential partners and investors.

Furukawa Electric Institute of Technology Ltd.

Web: www.feti.hu



Furukawa Electric Institute of Technology Ltd. is a wholly owned subsidiary of the Furukawa Electric Company (FEC) of Japan and was established in Budapest in 1991. Furukawa Electric is committed to research & development and has throughout its history been in the forefront of technological innovation.

Cambridge Nanomaterials Technology Ltd (CNT)

Web: www.cnt-ltd.co.uk



The **Cambridge Nanomaterials Technology Ltd (CNT Ltd)** is an innovation management and nanotechnology consulting company based in Cambridge. The CNT Ltd helps companies, academic and government institutions to develop world-class innovative solutions for nanomaterials related R&D and IPR strategy, partnership, products, technologies, funding and markets. CNT Ltd is specialised in carbon nanomaterials R&D consulting and collaborative R&D project management, including exploitation and dissemination management, consortium and supply chain building. CNT has done a number of patent landscaping and market research analysis studies regarding production and use of various nanomaterials helping to link inventors and technology developers with end-users and investors. The CNT Ltd is a leader of two private membership-based consortiums: Nano-Carbon Enhanced Materials (NCEM) and the new Advanced Materials for Additive Manufacturing (AMAM) with members coming from leading multinational companies and research institutions.