

Ultra**MAT**

Ultramaterial Innovations

Power ultrasound as a generic tool for
micro/nanoscale processing of metals

Project Partners and Services Booklet

www.ultrammat.co.uk

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TISICS
Titanium Composites



nquiringminds

This project is supported by Innovate UK
UltraMAT Project Ref. 102802

Innovate UK

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Introduction

UltraMAT is a project funded by **Innovate UK** (Ref. No. 102802) with the objective to develop a novel generic technology for materials processing of fluid and semi fluid phases that are widespread in manufacturing including welding and adhesive joining components and manufacturing of bulk composite components with nanomaterials additives such as carbon nanotubes and graphene.

UltraMAT project partners are: Innovative Technology & Science Ltd (InnoTecUK), Brunel Innovation Centre (BIC), TISICS Ltd, KW Special Projects Ltd, NquiringMinds Ltd, Carrs Welding Technologies Ltd, Cambridge Nanomaterials Technology Ltd and Cedar Metals Ltd.

OBJECTIVES:

- To enable production of manufactured components with step improvements in specific strength (yield/ fatigue/ impact) and modulus, fatigue life and thus light weighting.
- To reduce energy consumption and emissions in manufacture and transport.
- To homogeneously produce distributed and shaped nanoscale particulates, fibres or grains.

OVERVIEW:

- Manufacturing processes selection :
- Suitable for fluid phase ultrasonic processing
 - LASER Welding
- Laminated composites manufacturing (with and without nanoparticles)
- Literature review: studying current state-of-the-art on power ultrasonic assisted manufacturing processes.
- FEA simulations of ultrasound propagation in selected manufacturing processes
- Aluminum plates
- Laminated GLARE plates
- Experimental validations: 3D- Laser Doppler Vibrometry tests
- Building an UltraMAT system: Power amplifier, transducers, software ...
- Manufacturing and testing of Ultrasonic processed samples

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Brunel Innovation Centre (BIC)

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Brunel Innovation Center (BIC) is part of the Institute of Materials and Manufacturing of Brunel University.

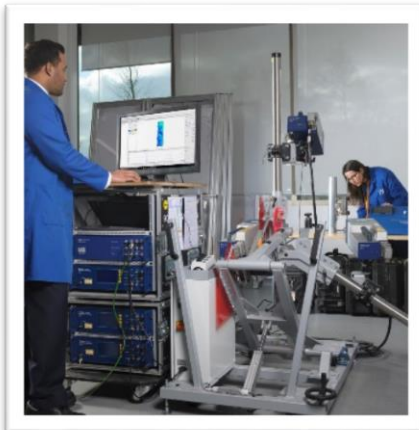
BIC was founded in 2009 in collaboration between Brunel University London and TWI, and is based in Granta Park, Cambridge.

The research carried out at BIC is predominantly in the field of NDT, CM, SHM, Power Ultrasonic and related areas, including:

- SHM / CM (Acoustic emission & ultrasonic guided waves)
- Ultrasonic Cleaning / De-icing / Material Processing
- Smart NDT (automation, wireless, IMUs)
- Sensors and transducers (aggressive environments; high temperature)
- Signal / Image Processing/Machine learning
- Systems (hardware-software) integration



Our mission



To establish a world class research centre offering high quality research in an innovative environment, with the focus on non-destructive testing, condition and structural health monitoring, power ultrasonic and allied technologies covering a range of materials, sensors, electronics and software systems.

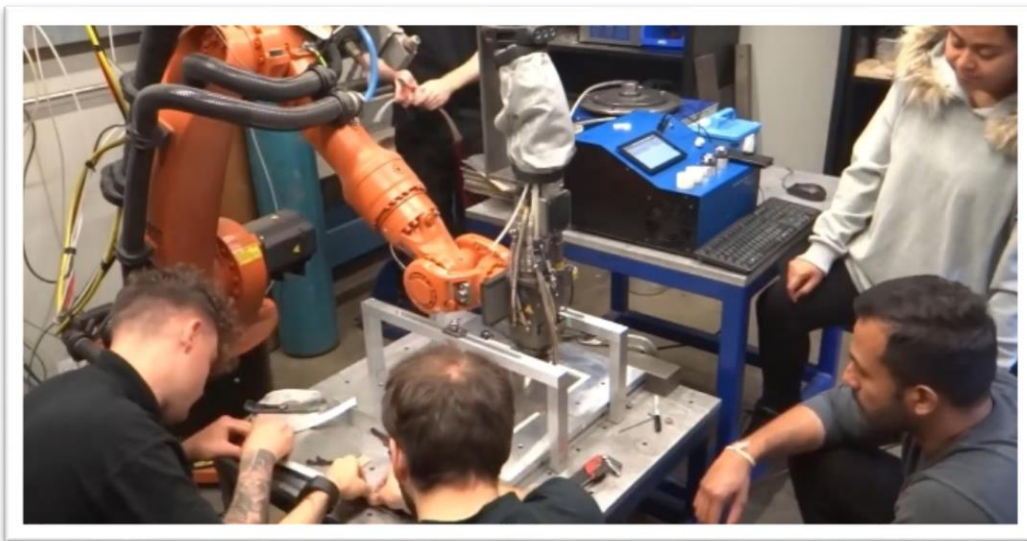
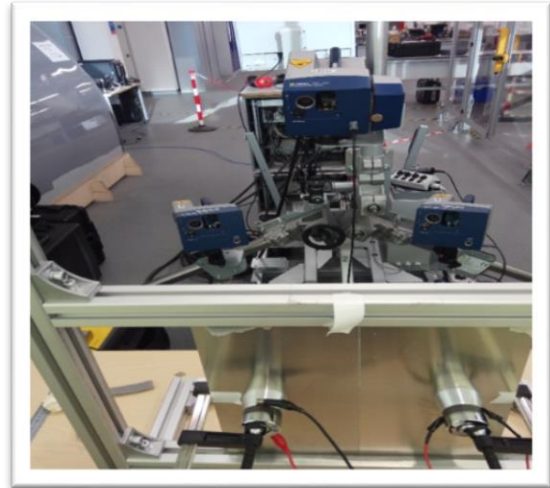
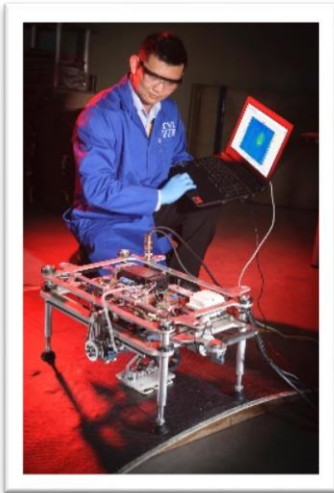
BIC Benefits of the access to the latest technologies at TWI's state-of-the-art facilities, close industrial collaborations with an academic dimension, research and development for advanced process and product development, achieving excellence in science, plus continuous professional development for staff and students.. BIC has built an outstanding portfolio of projects in line with its multinational interdisciplinary vision.

Products and services

- Power ultrasonic systems for inspection, cleaning and material processing
- Smart Non-Destructive Testing
- Condition and Structural Health Monitoring
- Advanced signal and image processing algorithms



- Numerical modelling and fluid structure interaction
- Novel and robust sensing for harsh environment (eg high temperature transducers up to 600°C)
- Machine learning and data analytics for process and asset monitoring
- IoT sensing
- Computer Vision
- Digital Twin technology



Role in UltraMAT Project

BIC has been involved in the characterisation of power ultrasonic technology to assist laser welding processing and metal composite manufacturing process.

KW Special Projects Ltd (KWSP)

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KWSP is a high-performance engineering team that uses the capabilities and technologies of the motorsport industry to provide turnkey engineering programme delivery, from concept to manufacturing & assembly to multiple sectors. Key to KWSP's approach is the use of digital manufacturing techniques such as Additive Manufacturing ('3D Printing') that facilitate bespoke solutions to engineering challenges. KWSP's core capabilities include lightweight structures & composites, powertrain integration, control systems & automation and full system integration, with clients across Automotive &

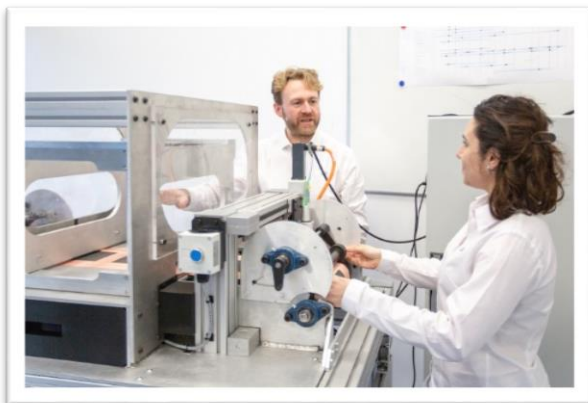
Mobility, Performance Sport and Manufacturing.

Much of our work is in the R&D sphere either on behalf of clients or for our own development. We invest in our own R&D projects often as part of a consortium. We have been involved in and led a number of Innovate UK projects as well as Horizon 2020 funded projects.

Products and services

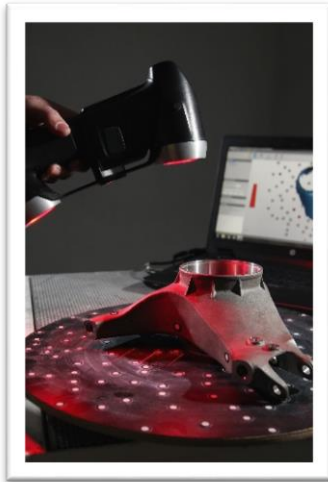
KW Special Projects uses the speed and agility of the motorsport industry alongside the latest in digital manufacturing & engineering capabilities to deliver complete engineered solutions, from concept to production.

Capabilities:



Our skill set spans mechanical, electrical and controls & automation engineering disciplines to support clients with:

High Performance Mechanical Engineering: Precision engineering of mechanical assemblies.
Lightweight Structures & Composites: Motorsport-bred lightweight design, and process expertise applied across sectors.
Additive Manufacturing: Applying digital manufacturing to make low-volume production possible.



System Design, Integration & Automation: Design and delivery of special purpose machines and systems.

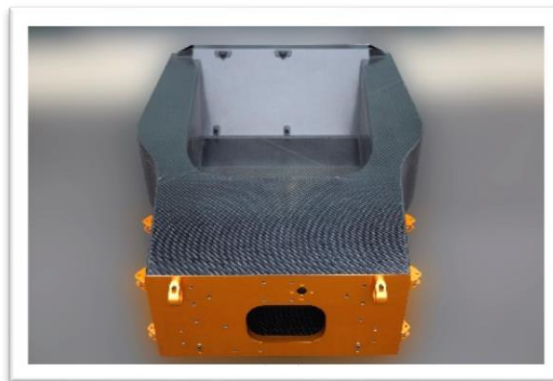
Sectors & Applications:

We are sector agnostic and see this diversity as a strength. Just some examples of where we work include:

Transport & Mobility: Delivering engineered solutions to high-performance and niche vehicle markets, and R&D services to mass-market OEMs.

Sports Technology: We leverage our motorsport pedigree to help other sports teams and equipment manufacturers excel in competition, from cycling to winter sports.

Digital Manufacturing: Supporting organisations' adoption of Industry 4.0 through development of bespoke digital manufacturing systems.



Role in UltraMAT Project

KWSP leads the work on the outline of the functional design of the UltraMAT tool and experiments.

TISICS

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TISICS
Titanium Composites

www.tisics.co.uk

TISICS develops light weight ceramic fibre reinforced Titanium and Aluminium alloys for high performance systems where strength, mass, corrosion resistance and temperature properties can be exploited , with partners in the space, aerospace, defence, automotive and energy sectors.

40%

Weight savings with substitution of conventional geometry components

70%

Weight savings with designs optimised for composite properties and net shape manufacturing

TECHNOLOGY

METAL MATRIX COMPOSITES

Titanium and aluminium alloys are selectively reinforced with ceramic fibre to form metal composite components . The technology benefits from the low density of the metal matrix while delivering the performance of high strength steels with significant mass reduction.

CERAMIC FIBRE

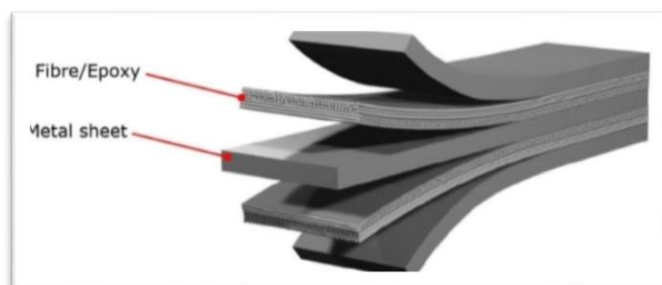
TISICS manufacture continuous silicon carbide mono filaments at its Farnborough plant . Continuous fibre offers considerable benefits through high mechanical and thermal performance, enabling MMCs to operate at higher loads and temperatures with lower creep and CTE than the base metal.

NET SHAPE MANUFACTURE

Net shape fabrication significantly reduces waste compared with conventional forming and machining techniques. This additive manufacture incorporates integral features with reduced final machining and assembly operations.

Products and services

 <p>Reinforced pressure vessel for Satellite propulsion system. 6 Month development from drawings to tested parts.</p>	 <p>Novel use of diffusion bonding to build single piece near net shape pressurised propellant system. Diffusion bonding enables additive manufacture of complex parts to reduce system assembly mass and time.</p>
 <p>Near Net Shape Titanium Matrix composite (TMC) Manufacture</p>	 <p>Aluminium composite wing trailing edge rib development. Integral attachment points. Compression strength enabled lightening compared to machined aluminium.</p>
 <p>TISICS LARAD Programme TMC robotic arm demonstrator . In collaboration with Airbus Defence and Space Innovate UK programme</p>	 <p>Full size landing gear side stay for Airbus A320. 35% lighter than aluminium standard part. Net shape manufacture of tube and clevises to avoid welds.</p>



Role in UltraMAT Project

TISICS is leading development of a novel laminated composite to metal joint methodology which can potentially exploit both our in house MMC technology and the capabilities of the UltraMAT system. Further involvement includes composite sample manufacture and characterisation via mechanical testing

Carrs Welding Technologies

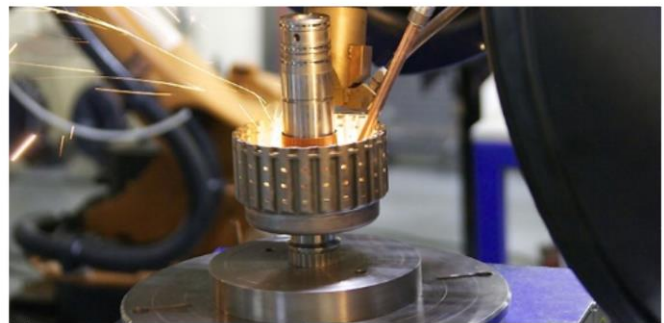
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carrswelding.co.uk/

Carrs Welding Technologies Ltd (CWT) was started by Phil Carr in the early 90's carrying out Selective Electro Plating of injection mould tooling. Through continuous investment in new technology, CWT has grown into one of the market leaders in 'Precision Laser Welding'. From the early days of just serving the tooling industry, the company has now grown and reaches a customer base of more than 350, ranging from one-man engineering companies to international aerospace manufacturers while still supporting the tooling industry.



Currently, CWT has 11 Laser Welding systems available for all types of work from R&D to medium batch production. Combined with an open honest approach and wide skill base, covering all aspects of Laser Welding, Carrs provides the ideal partner for future projects or current applications.

Providing continuous investment in staff and equipment over the last 26 years has enabled CWT to provide tailored welding solutions for each enquiry whilst also performing a 'While U Wait' tooling repair services alongside the everyday demands of ongoing production orders.

CWT achieved the ISO 9001 quality standard in 2001 and is now accredited to the latest version ISO 9001:2015 (since January in 2018) allowing us to continue to serve all our customers to the level they have come to expect from us long into the future.

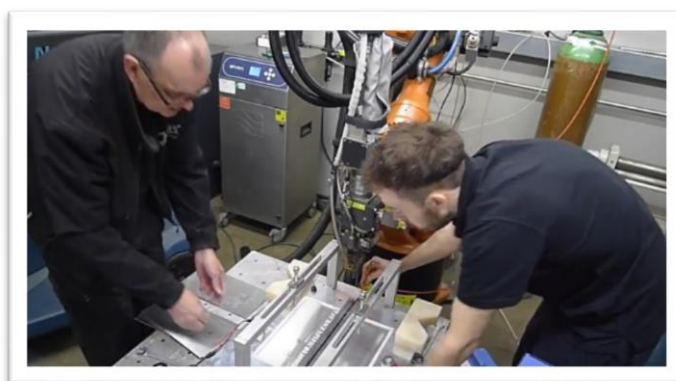
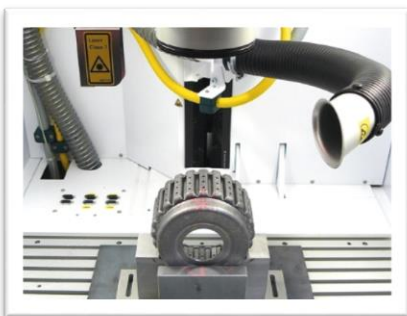
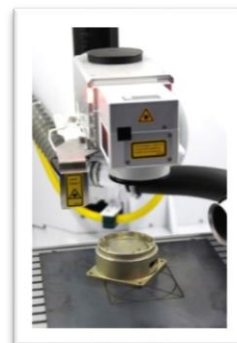


CWT benefits from an ideal location off the A14 on the border of East Anglia and the Midlands. Situated an hour from the nearest International Airport and easily accessible by road. With our wide range of equipment and a highly skilled but flexible workforce, we pride ourselves on the ability to turn work around exceedingly quickly. In today's market we are conscious of the need for keen prices. Carrs' laser welding technology enables material and process savings not possible with conventional welding. Waste is minimal, and our lean and efficient operation also contributes to keeping process costs down. We trust you will find our rates better than fair.

Products and services

Carrs specialise in laser welding and are considered to be the UK market leaders in this field. We now have a total of eleven laser welding systems available to serve you, principally from the world's outstanding manufacturers Alpha, Trumpf and Rofin:

- 1 Rofin system
- 5 Trumpf lasers
- 5 Alpha laser welders
- amongst other services



Role in UltraMAT Project

Carrs is involved in the testing on samples with comparison of ultrasonically processed samples with benchmark samples prepared without ultrasound.

Innovative Technology & Science Ltd. (InnoTecUK)

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InnoTecUK is an experienced, dynamic and progressive provider of robotic and automation solutions. We are committed to consistently developing high-value and high-quality technical robotic platforms and automation solutions. InnoTecUK has been massively involved in and has successfully delivered 50+ hi tech, complex collaborative projects, addressing the unmet needs and challenges in industries such as Oil & Gas, Renewable Energy, Offshore, Rail, Manufacturing, Aerospace and Transport, among others. This has enabled us to build a team of in-house engineers with cutting edge research and commercial expertise. InnoTecUK also internationally provides Technical Innovation Consultancy Services in areas of Research, Technology development and Innovation to both organisations and individuals. Our services are managed directly by high-level and world class trainers and innovation consultants.

We accompany our clients in securing funding through bespoke trainings on specific funding programmes and by supporting them from the initial stage of grant writing to proposal submission and project management. We have expanded in Ireland and continuing to establish collaborations abroad..

Products and services

We developed a number of prototypes and robotic platform solutions in overcoming complex challenges for components, infrastructure and high value assets. This is evident from our acclaimed work.

iFROG

iFROG is an amphibious multi robot solution for inspection and predictive maintenance of offshore wind assets. It involves the development of homogenous robotic platforms that will perform the deployment of NDT sensors (Non-Destructive Testing) in a hazardous environment, such as the internals of offshore monopile foundations. The data collected will be post processed by a Risk Based Inspection (RBI) system to assess the integrity of the structures and for developing an effective maintenance strategy of wind farms. Two robotic crawlers have been developed to perform the tasks of biofouling inspection and cleaning, and the inspection of corrosion levels and integrity of weld lines.



Figure 1: iFROG robot – Robot 1 (cleaning and corrosion mapper)

InnoTecUK participates in this project with Brunel University London (BIC), TWI Ltd and Offshore Renewable Energy Catapult (OREC) Ltd. The project is co-funded by the UK's innovation agency, Innovate UK.

TrainNDT

TrainNDT was a two-year project, co-funded by Innovate UK, in which InnoTecUK participated with Uniper Technologies GmbH, TWI Ltd, Eastpoint Software Ltd and Applied Inspection Ltd. A novel non-destructive testing training system based on wireless probe tracking has been developed. TrainNDT is a training aid for ultrasonic weld inspectors.

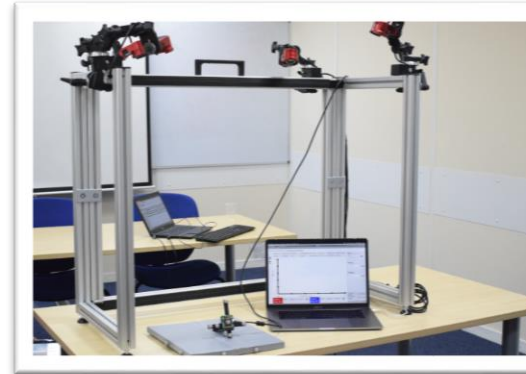


Figure 2: Developed TrainNDT system

RoBFMSII



Figure 3: RoBFMS Phase 1 robot

RoBFMSII is a project, co-funded by Innovate UK, developing an autonomous, robotic and AI enabled biofouling monitoring, cleaning and management system for offshore wind turbine monopile foundations. InnoTecUK participates in the project with Brunel University London and The European Marine Energy Centre Ltd (EMEC). Following from the successful Phase 1 project, the Phase 2 project is developing an automated fouling management system for offshore wind turbine monopile foundations in the form of a multi-functional robot having a survey function in addition to cleaning functions.

COSCR

COSCR is a project, co-funded by Innovate UK, aiming to develop a collaborative, on-site construction robot, based on a rugged mobile platform equipped with a robotic arm that can deliver a range of common, otherwise labour-intensive activities on a construction site. COSCR is a 2nd phase project, following on from the CAMERA project (Construction and Manufacturing Enabled by a mobile Robotic Arm). The partners of the project include InnoTecUK Ltd, HAL Robotics Ltd, Building Research Establishment Ltd (BRE), SKANSKA Technology Ltd and ABB Ltd.



Figure 4: Robot developed in the CAMERA project (Phase 1)

TankRob



Figure 5: TankRob robot

TankRob was a two-year project, co-funded by the Horizon 2020 programme of the European Union, that developed an application specific robotic Non-Destructive Testing (NDT) solution for the inspection of in-service Above Storage Tank (AST) floors using PAUT NDT techniques. This includes a robotic platform (crawler and its control), sonar hardware and NDT hardware, and suitable control and navigation software for satisfying the inspection requirements. InnoTecUK was in partnership with Technic-Control from Poland, TWI Ltd, London South Bank University and Integrity NDT from Turkey.



Figure 6: Developed UltraMAT systems

Role in UltraMAT Project

InnoTecUK is the Project Coordinator. It is working, along with NQM and BIC in the integration of the hardware/software of the project.

nquiringminds

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www.nqminds.com

nquiringminds are experts in AI, IOT and CyberSecurity. We have two core products:

- TDX Cloud (Trusted Data Exchange) cloud based, state of the art data sharing and AI powered data analytics platform, built from the ground up for security and scale.
- TDX Edge: developed for small IOT devices, supports real IOT security from hardware through to a PKI certificate-based application layer. Based on a peer to peer cryptographic model, it also includes autonomous AI for intelligent distributed (edge) data processing.

Our technology helps our customers deliver AI driven digital transformation
nquiringminds is seven years old, organically grown and owns all the core IP. We have real world customers in sectors as diverse as SmartCities, Industry 4.0, Defence, Agriculture, Telecoms and Health and Social Care. Our award winning software has been endorsed by the likes of UK Cabinet Office, UK Prime Minister, NHS, Ministry of Defence, Indian Government, Cisco and many UK Cities.

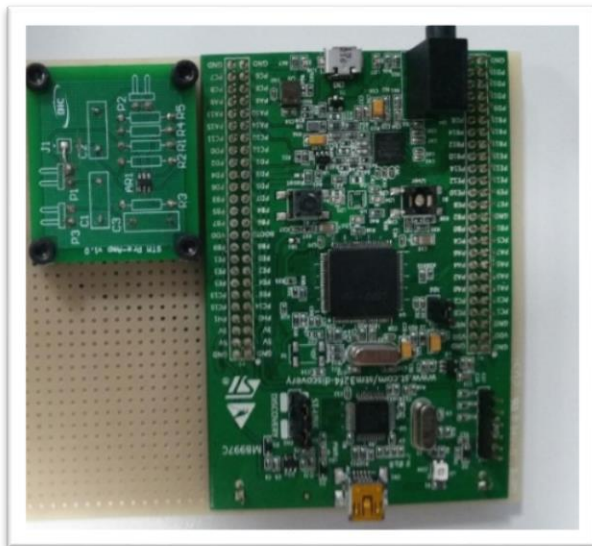
Products and services

 tdx cloud	Cloud based data sharing and AI analytics		SmartCities
 tdx edge	Secure edge processing technology		Health
			AgriTech
			Industry 4.0
			Cyber

Awards:



Customers:



Role in UltraMAT Project

NquiringMinds is developing the tool operating software for the project.

Cambridge Nanomaterials Technology Ltd (CNT)

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CAMBRIDGE
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The Cambridge Nanomaterials Technology Ltd (CNT Ltd) is a nanomaterials innovation management and nanotechnology consulting company based in Cambridge, England.

The CNT Ltd helps companies, academic and government institutions to develop world-class innovative solutions for nanomaterials related to R&D and IPR strategy, partnership, products, technologies, funding, business development and markets. CNT Ltd is specialised in nanomaterials R&D consulting and collaborative R&D project management, such as H2020 project proposal preparation, innovation, exploitation and dissemination management, and consortium and supply chain building. The CNT Ltd provides expert advice and experts for your team. 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.



Products and services

The summary of our services is:

- Consulting and an expert advice related to carbon nanomaterials (graphene, carbon nanotubes, carbon nanofibres, etc.) and other nanomaterials regarding their production, composites, applications, key players, funding and market.
- Management in collaborative R&D projects, such as EU Horizon 2020 projects: EPPN project (www.eppn.eu); n-TRACK (www.n-track.eu); Oyster (www.oyster-project.eu); M3DLoC (www.m3dloc.eu); Genesis (www.genesis-h2020.eu); Repair3D



(<http://www.repair3d.eu>) as well as UK projects: UltraMAT (www.ultrammat.co.uk) and GRAPHOSITE (www.graphosite.co.uk).

- Innovation management and technology transfer support related to R&D of novel nanomaterials and composites.
- Advice and support related to development of Intellectual Property (IP) Strategy – patent landscaping reports, due diligence, invention and protection.
- Market Research and Strategy - market research reports, consulting and advice about innovation, new product strategy and development, proof-of-concept, market and funding.
- Organisation of nanomaterials and nanotechnology application related conferences, workshops and customised training, seminars and support multinational companies and research institutions.



Role in UltraMAT Project

CNT is leading exploitation and dissemination activities of the UltraMAT project. CNT is in charge of the project website (www.ultrammat.co.uk), leaflets, workshops, Intellectual Property (IP) strategy, and preparation of patent landscaping reports. We are also involved in market research, business development and exploitation strategy of the project.

Cedar Metals Limited

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We are a limited company specialising in data and patent literature searches and provide confidential technical assistance to various industries using knowledge and experience gained in over 40 years working in industry before forming Cedar Metals Ltd in 2004. As well as working on various InnovateUK projects based on advanced ultrasonics, our main area of expertise is the production, fabrication and uses of refractory metals and rare earths from mine to finished products for the Aerospace, Defence, Chemical, Electronic, Furnace, Nuclear and Glass Industries. Other areas of expertise are Powder Metallurgy

Processes, furnace design and friction stir welding of steel and non-ferrous materials and thixotropic processing of aluminium and magnesium alloys. We carry out telephone, on-line and on-site consultations in the UK and overseas helping our clients solve their production problems.

Our Managing Director David Rowe is also an approved assessor and interviewer for applicants applying for CEng., IEng. via IOM3 and TWI and for CSci and RSci on behalf of the Science Council and TOPRA.

David has access to a vast area of current and historic literature on his specialist subjects via online and large collection self-held literature obtained throughout his career to date. He has also published articles in a number of journals and regularly lectures to learned societies on a variety of specialist subjects. Texts of the latter are available as .pdf files on request.

Products and services

Because of the confidential nature of our work we are not able to publish lists of clients and projects worked on, but we have clients in Europe, USA, Russia and China. Details of DTI/InnovateUK projects are in the public domain and extracted from the InnovateUK website:

CLEANMINE: Ultrasonic Cleaning of Valves in Mining TSB Project 101333 We aim to provide mine operators with a rapid method of detecting and removing calcium and similar deposits from in service check valves without stopping production, thus extending the life of expensive components, reducing the cost of maintenance by 50%pa and downtime by 5%pa. In the case of cyanidation, exposure of maintenance operatives to cyanide will be reduced to zero for certain tasks, presenting obvious health benefits. The system will reduce the risk of contamination from back-flow, and could be applied to other industries where check valves (or similar) are used, eg petrochem, nuclear or hydropower generation. A novel ultrasonic cleaning method will be developed: the components themselves act as a cleaning bath so are not removed from service. A device consisting of a wave generator, amplifiers and high-power ultrasonic transducers will be clamped to accessible surfaces of the valve to remove well adhered debris effectively without chemicals.

HITClean: High Temperature Inspection & Cleaning by Advanced Ultrasonics for Effective Maintenance and Management of Oil&Gas Offshore Production subsea & topside operating pipelines and vessels. InnovateUK Project 102491. HITClean addresses a number of related safety critical, security of energy supply, production economic and maintenance challenges in the life cycle of Oil&Gas offshore production installations (e.g. platforms and FPSOs) subsea assets including pipelines and production

UltraMAT Project Partners

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