TWI

2017 Public Funded Projects Additive Manufacturing

Contents

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About TWI

TWI, formed in 1946, is a world-leading not-for-profit research and technology organisation with a turnover in 2014 of £80m. From bases in the UK, South East Asia, India, the Middle East, Central Asia and the USA, over 900 staff provide expertise in joining and fabrication, material science and structural integrity. Services include generic research; contract R&D; technical information; engineering services and advice; standards development; and training and qualification services.

TWI is internationally renowned for its ability to employ multidisciplinary, impartial teams to implement both established and advanced joining technologies, or to solve problems arising at any stage of the product life cycle

TWI is a membership-based organisation with 1,800 Industrial Member companies from 70 countries, representing every sector of the manufacturing industry. Many of the largest engineering companies in the world are amongst its diverse Industrial Membership base, including:

- Rolls-Royce, Boeing, Airbus, BAE SYSTEMS, GKN, Lockheed Martin and Honeywell from the aerospace sector
- BP, Exxon Mobil, Shell, Chevron, Petrobras, Lloyd's Register, Kawasaki Shipbuilding and Samsung Heavy Industries from the oil and gas and marine sector
- Areva, EDF, Alstom, Scottish Power, SunPower and ITER from the power sector
- Honda, Jaguar Land Rover, Yamaha, London Underground, Network Rail, Tata Steel and Hitachi from the automotive and rail sectors
- JCB, Caterpillar, Laing O'Rourke, Tata Steel, ESAB, Linde Group and BOC from the construction and fabrication sectors
- DePuy, Smith & Nephew, Siemens, Danfoss and Emerson from the medical, electronics and sensors sectors

Additive Manufacturing at TWI

TWI has been advancing additive manufacturing (AM) technology for more than 20 years, delivering innovative solutions to clients spanning multiple industry sectors and technologies. Our comprehensive AM service offering has the ability to add value at all stages of the technology readiness level (TRL) process through concept and business model generation, technology and system development, demonstration, product evaluation and validation.

TWI currently has 27 collaborative additive manufacturing projects underway, as well as substantial and confidential single client work across many industrial sectors for our Members. We have over 35 dedicated staff with combined expertise covering a comprehensive range of AM services encompassing processing technologies, automation and manufacturing systems, simulation and design, non-destructive evaluation, testing and materials characterisation. We also host an annual industrially focused AM seminar showcasing the latest developments and provide input to standards and committees from organisations including Nadcap, ASTM and the UK and EC Strategy for Additive Manufacturing.

Summary of Collaborative R&D investment in Additive Manufacturing

Over the last five years, TWI has participated in additive manufacturing R&D activity totalling over £70m, funded from UK and EU public funding bodies, joint industry projects and confidential member company projects.

twenty-seven collaborative R&D projects

£11m R&D projects supported by UK and EU public funding bodies

£70m R&D projects WON with innovation partners

AMSCI

Aerospace supply-chain initiative in Additive Manufacturing

Additive Manufacturing (AM) – 3D printing in metal – has been a research topic for the last 20 years, driven by cost-tolerant industries such as aerospace and medical implants. The technology has now moved from R&D into production, as evidenced by the recent growth in machine sales ~100 machines per year in 2006-2009, growing quickly to 198 machines sold in 2012, and 348 systems in 2013 (75 per cent growth in 12 months). However, as the technology has moved to production, it has become evident that the supply of 'standard metal powders' to these machines is currently inadequate both terms of quality and available quantity. The principal issue is that metal powders perform differently on different manufacturer's machines.

There is a clear need for a reliable range of 'clean intelligent powders' created specifically for AM that enable reliable use on multiple machine platforms.

Objectives

Our project aims to:

- Address all of these emerging gaps in the production AM supply-chain enabling the acceleration of the uptake of the manufacturing approach.
- To accelerate the adoption of AM across the UK aimed primarily at the wider aerospace supply-chain, with targeted knowledge sharing, industrial supply-chain engagement and development of qualified training courses.

Benefits

With AMSCI funding, there are several additionally benefits that will be realised, through the structure and nature of our consortium:

- Allow LPW to access the capability and machine technologies via TWI which will be critical for both test purposes on alloys and independent validation of the powders
- Ensure LPW powder complies with emerging AM standards (all of which involve TWI directly, eg ASTM F42, BSI AMT/008, etc.)
- Develop and launch a UK-based training and accreditation programme
- Engage industry with an AM targeted technology transfer programme accelerating AM adoption across the UK aerospace supply chain, initially via TWI's UK aerospace membership base (~150 UK companies).

Project budget	Confidential
Grant to TWI	£ 1,100,000

Project partners: TWI, LPW Technology Ltd, The Manufacturing Technology Centre Ltd

The AssureNet project is funded by the Advanced Manufacturing Supply Chain(AMSCI) reference number 14050

EMUSIC

Efficient manufacturing for aerospace components using additive manufacturing, net shape HIP and investment casting

In response to call for International Cooperation in Aeronautics with China, MG.1.10-2015 under Horizon 2020 in the area of enhanced additive manufacturing of metal components and resource-efficient manufacturing processes for aerospace applications. The technologies that are identified, which are all seen as offering substantial potential, are: (i) additive manufacturing; (ii) HIPping (Hot Isostatic Pressing) of Ti alloy powders to produce components to near net shape and (iii) investment casting of Ti alloys.

Objective

The overall objectives of this project are to carry out research and development on the three areas, Additive Manufacturing (AM), Near Net Shape HIPping (NNSHIP) and Investment Casting, (IC), so that demonstrator components can be produced, which meet specifications defined by end-users and for which the production costs will be defined. All demonstrator components will be manufactured and assessed within the timeframe of the project. The objectives and broad scope of the research required in these three areas are described below.

Benefits

- that manufacturing of the selected components is more environmentally friendly than current technologies
- that fuel consumption will be reduced through the use of lighter materials
- that the cost of manufacture and maintenance of components will be reduced
- that the flexibility in the design of components, will improve functionality and in many cases reduce further the weight of components
- that the production of full-sized demonstrator components will be established, making technology transfer relatively straight-forward
- that the market share for European and Chinese partners in the aircraft industry will be increased

www.birmingham.ac.uk/generic/emusic

Project budget	£ 1,827,732
Grant to TWI	£ 192,000

Project partners: University of Birmingham, ESI Software Germany GmbH, Rolls-Royce Plc, ESI Group, Centre Internacional de Metodes Numerics en Enginyeria, Airbus Group S.A.S, Industria de Turbo Propulsores S.A, Fraunhofer Gesellschaft zur Foerderung der Angewandten Forschung E.V, Goodrich Actuation Systems Ltd, Calcom Esi S.A, The Manufacturing Technology Centre Ltd LBG, TWI Ltd

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 690725.

CORSAIR

Cold spray radical solutions for aeronautic improved repairs

Objective

- Explore the real capabilities of cold spray in several practical examples of aeronautic repair applications.
- Investigate the coating and repair characteristics (mechanical, microstructural, thermal and chemical properties) in order to finely tune and define where cold spray could be further applied for maintenance and repair in aeronautics.
- Investigate the effect and the characteristics of feedstock materials.
- Give the required reliability to the coating deposition and repair processes to validate the technology for aeronautic industry.
- To surpass the actual technological limitations of line-in-sight cold spray deposition process
- To develop a new industrial portable cold spray unit.

Benefits

Cold spray is an emergent technology belonging to thermal spray techniques; its key characteristic is the low temperature deposition which avoid both the oxidation process during deposition and the occurrence of heat affected zones at the interface between the base component to be repaired and the repaired area itself. Furthermore, the low deposition temperature provides a low level of coating residual stresses developed during the post-deposition cooling down allowing the growth of well-adhered and high thickness metal-based coatings.

CORSAIR will directly target the drastic reduction of costs associated with maintenance, repair and overhaul of aerospace parts both by impacting in the reduction of waste and in the increase of the re-use of components.

www.corsair-project.eu

Project budget	£ 4,657,306
Grant to TWI	£ 340,478

Project partners: Politecnico di Milano, Veneto Nanotech SCPA, Kharkiv Aviation Institute, University Rey Juan Carlos, MetaLogic, Avio Sp.A, EADS Innovation Works, EADS – Construcciones Aeronauticas SA, LPW Technology Ltd, Impact Innovations GmbH, European Aeronautics Science Network, Iberia Lineas Aèreas de Espana SA Operadora, TWI

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 605207.

FastEBM

High productivity electron beam melting additive manufacturing development for the part production systems market

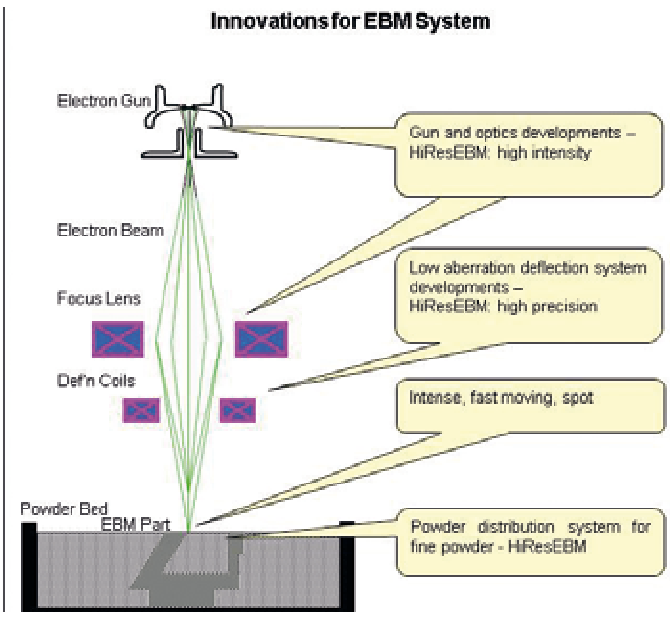
Additive manufacturing allows parts to be produced using a numbher of techniques from wire or powder very close to their final dimensions. One of these, electron beam melting (EBM), is used to produce successive layers of a part in a powder bed and offers the ability to produce components closest to their final dimensions, with good surface finish and resource efficiency. The process is faster than any technique of comparable quality, but the parts are not produced at sufficient rate to make them economically viable for any but very high value specific applications.

Objectives

- An innovative new high power electron beam gun designed for EBM that enables high productivity processing
- Knowledge surrounding the use of the high power electron beam gun, including process control, and modelled and validated understanding of beam-powder bed interaction

Benefits

- Parts that are 55 per cent cheaper than forged/machined counterparts
- Efficient use of scarce metals – saving the costs, energy and environmental impacts inherent in metal production
- Flexible manufacture allowing a wide range of parts to be addressed, and rapid response to customer needs.



Project budget	£ 1,240,221
Grant to TWI	£ 549,944

Project partners: TWI, Arcam AB, TLS Technik GmbH & Co. Spezialpulver KG, 5AXperformance GmbH, Friedrich-Alexander-Universitat Erlangen Nurnberg, Mecachrome France SAS, Materials Solutions LBG, H K Rapid Prototyping Ltd

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 286695.

Hi-StA-Part

High strength aluminium alloy parts by selective laser melting

The last ten years have seen the development of direct manufacturing (DM) technology or additive manufacturing (AM) technologies which have demonstrated their important potential in the reduction on components costs. Among the available DM techniques, selective laser melting (SLM) has been recognised as an excellent option for the direct net shape manufacturing of metallic parts.

Objective

The project aims to demonstrate the viability of producing aerospace grade aluminium parts using direct manufacture – specifically the process of SLM. The project will demonstrate that components and parts can be manufactured with a significant weight reduction, to the required mechanical properties for aerospace applications.

Benefits

- Topology optimisation of aluminium components
- Characterisation of SLM components in aluminium
- Demonstration of additive manufacturing technology for state-of-the-art high strength aluminium alloys
- Implementation of net shape manufacturing of aircraft components.

Project budget	£ 100,539
Grant to TWI	£ 65,513
Project partners:	TWI, LPW Technology

The work leading to this invention has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for the Clean Sky Joint Technology Initiative under grant agreement No 325931.

MERLIN

Development of aero engine component manufacture using laser additive manufacturing

Aircraft manufacturers are constantly looking to reduce the environmental impact of air transport while enhancing performance and decreasing costs. Manufacturing aircraft component in layers, bottom up, could diminish material waste and energy consumption while leading to lightweight parts allowing the aircraft to burn less fuel and so create fewer emissions while in service. This can be achieved using additive manufacturing (AM) techniques.

Objective

The aim of the project is to reduce the environmental impact of air transport using AM techniques in the manufacture of civil aero engines. The focus is on selective laser melting and laser metal deposition technologies.

Benefit

The development of AM techniques, at the level one stage, will allow environmental benefits including near 100 per cent material usage, no toxic chemical usage and no tooling costs, to impact the manufacture of future components (current buy-to-fly ratios result in a massive amount of waste).

All of these factors will drastically reduce emissions across the life-cycle of these parts. There will also be added in-service benefits because of the design freedom in AM. Lightweighting and the performance improvement of parts will result in reduced fuel consumption and reduce emissions.

www.merlin-project.eu

Project budget	£ 5,885,147
Grant to TWI	£ 815,083

Project partners: TWI, Rolls-Royce plc, WSK "PZL-Rzeszów" SA, ITP, MTU, LPW Technology, Turbomeca, Volvo Aero Corporation, Fraunhofer, ARMINES, Lortek Research Centre, BCT, University West, Frederick Research Centre

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 266271.

NANOTUN3D

Development of the complete workflow for producing and using a novel nano-modified Ti-based alloy for additive manufacturing in special applications

Development of the complete workflow for producing and using a novel nano-modified Ti-based alloy for additive manufacturing in special applications

The NANOTUN3D consortium is developing nano-modified materials for a complete metal additive manufacturing (AM) supply chain from initial selection of nanoparticles and raw metal powder through to completed and tested components. The main focus of the project is to develop powder with a controlled nanoparticle dispersion, as well as a route to process such powder safely and reliably by AM. The target is to produce parts demonstrating a significant improvement in mechanical property performance, while being able to be integrated quickly into industrially regulated supply chains and AM qualification efforts.

NANOTUN3D has considered an interdisciplinary approach specifically tailored to obtain a processable AM material. Nanotechnology issues (choice of NPs and core-shell developments), powder metallurgy (integration and mixing of nano-sized species into a Ti alloy matrix) AM processing (derivation of parameters and powder recycling strategies), health and safety (definition of an HSE management system for each step in the manufacturing chain) and industrialisation concepts (required post-processes to improve mechanical properties, qualification issues, quality, etc), are all being addressed in parallel in order to achieve the project objectives.

Objectives

The project objectives are to:

- produce a new powder for AM based on a nano-modified Ti6Al4V alloy with enhanced performance (15% to 40% improvement in structural properties with no weight penalty)
- develop manufacturability requirements for processing the nano-modified Ti6Al4V by selective laser melting and electron beam melting
- assess post processes needed by the AM NANOTUN3D part: machining, surface and heat treatments
- implement a health and safety management system to deal with the safety risks associated with nano powder production.

Benefits

It is anticipated that NANOTUN3D will have an impact on improving innovation capacity of manufacturing SMEs by widening the applicability scope (new material, new parts) of AM metal technologies. This project will enable SMEs working in AM to expand into additional sectors/customers through the offering of additional material options. The project will provide a completed industrial workflow on material handling and processing, which will also improve competitiveness on processing multiple materials for AM SMEs. As a direct outcome from the project the aim is to increase the market share of specialty power companies, primarily SMEs, and to enable those specialising in nanotechnology to gain access to the AM market.

Project budget	£ 2,683,340
Grant to TWI	£ 379,070

Project partners: AIDIMME, LAURENTIA TECHNOLOGIES, CEIT, UPV. Zoz, TLS, APR, VITO

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 685952.

SCAMPER

Scale-up of additive manufacturing with materials manipulation processing for higher performance and reducing waste in manufacturing and repair

The aerospace sector wastes 90 per cent of material when manufacturing a part. A solution to this is the use of additive manufacturing (AM) via laser metal deposition (LMD), an exciting new manufacturing technique, which significantly reduces material waste, and enables direct manufacture of complex components in an expanded range of metallic alloys.

Objective

To reduce material waste for production and repair applications in the aerospace sector using AM techniques. SCAMPER aims to improve LMD technology in terms of suitable materials, production rate and size of components for manufacture and repair applications.

Benefit

To allow the OEM to use this novel manufacturing method to produce (and repair) large high value-added aero engine and air frame parts using robotics at greatly reduced cost and with reduced waste.

Project budget	£ 1,081,743
Grant to TWI	£ 218,124

Project partners: TWI, Laser Optical Engineering Ltd, EADS UK Ltd, Materialise UK Ltd, Olympus Technologies Ltd, Rolls-Royce plc

Innovate UK
Technology Strategy Board

This project was co-funded by the UK's innovation agency, Innovate UK.

COLA

Coaxially laser assisted cold spray

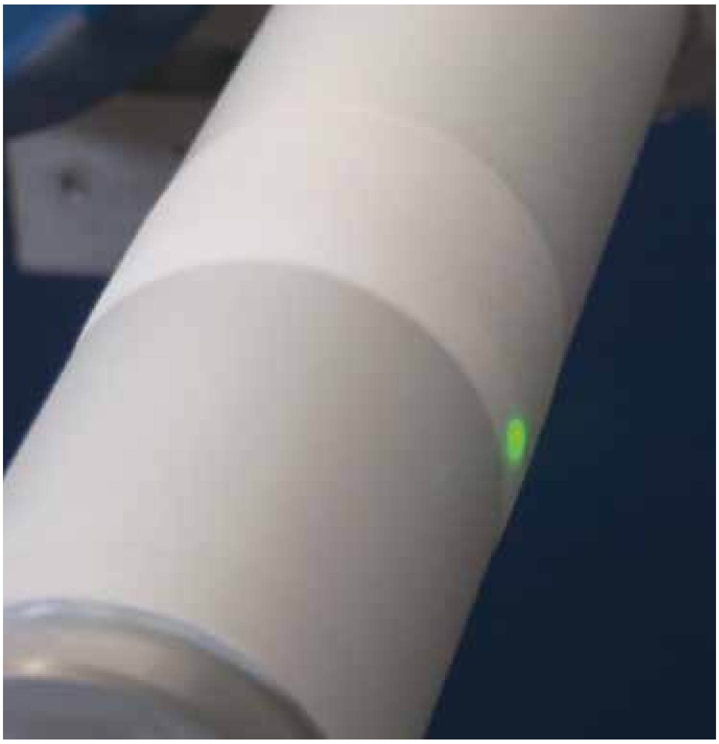
Objectives

- Design, build, test and prove proprietary laser heating equipment for coaxial laser-assisted cold spraying
- Design, build, test and prove bespoke process control equipment
- Retro-fit the laser heating and process control equipment to existing cold spray systems
- Develop laser-assisted coating parameters for different materials and preforms
- Characterise the qualities and properties of the coatings achieved.

Benefit

The COLA project has developed bespoke equipment for controlled laser heating of substrates coated using the cold spray process which can be retro-fitted. Laser heating has been confirmed to improve both coating/substrate adhesion and the cohesion within the coating, for selected coating/substrate combinations, without resorting to high spray gas temperatures or pressures, or the use of helium as a spray gas. Coating porosity contents have been proven to reduce with laser heating, whilst potential oxidation from spraying on to substrates at higher temperatures has been avoided.

www.cola-project.eu



Project budget	£ 1,263,712
Grant to TWI	£ 436,859

Project partners: TWI, Cavitar OY, Lulea Tekniska Universitet, TTY-Saatio, Metalmark Engineering Ltd, TLS Technik GmbH & Co. Spezialpulver KG, Putzier Oberflachentechnik GmbH

This project has received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration under grant agreement No 315157.

KRAKEN

Hybrid automated machine integrating concurrent manufacturing processes, increasing the production volume of functional on-demand using high multi-material deposition rates

KRAKEN concept was born after November 2015 and it is a successful finalisation of MEGAROB project, a R&D project funded under H2020 framework programme. The KRAKEN project will combine various key technologies—including 3-D printing, robotics, 7DoF real-time control, complex monitoring, advanced control algorithms, and the support of innovative CAM software in a single machine. After the end of the project, KRAKEN machine will be an affordable solution (1.5M€ estimated selling price, lower than current equipment and strategies for the production of final parts) for the customised production of large size functional parts.

Objectives

KRAKEN will develop a disruptive hybrid manufacturing concept to equip SME and large industries with affordable all-in-one machine for the customised design, production and quality control of functional parts (made in aluminium, thermoset or both material combined from 0,1m till 20m) through subtractive and novel additive technologies in vast working areas without floor space requirements. KRAKEN aims to achieve high deposition rates (10kg/h for aluminium) while assuring quality with use of advanced monitoring technology.

In addition, KRAKEN will develop and demonstrate the efficiency and sustainability of this cost-effective hybrid manufacturing solution developing and constructing a functional machine concept in industrially relevant environment for automotive and building industries

Benefits

The KRAKEN machine aims to achieve at least 40 per cent reduction in time, 30 per cent reduction in cost and 25 per cent increase in productivity when comparing to current additive and subtractive processes. It will also benefit the user with real-time path programming, geometry inspection and automated measurement control of manufacturing processes assuring increased quality. The KRAKEN machine also consists of integrated additive, milling and finishing operations which reduce the space required by 90 per cent compared to traditional methods because the KRAKEN machine does not require additional stations for each manufacturing operation. The system will use metal, resin and combination of both materials which will provide added flexibility compared to the current additive and subtractive manufacturing methods.

www.krakenproject.eu

Project budget	£ 4,956,530
Grant to TWI	£ 597,582

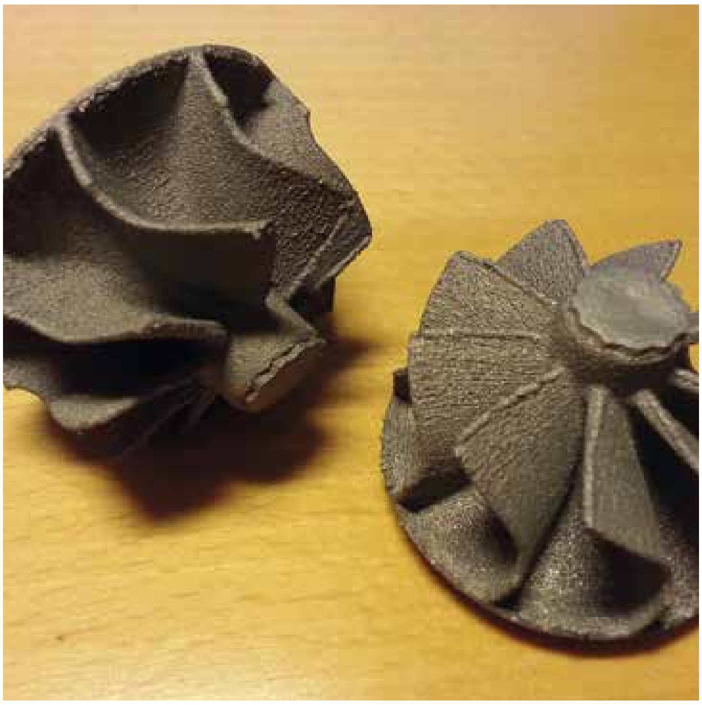
Project partners: Fundacion Aitiip, TWI, CSEM Centre Suisse d'Electronique et de Microtechnique S.A - Recherche et Developpment, Acciona Construccion sa, Centro Richerche FIAT S.C.P.A, Pininfarina SpA, Teamnet World Professional Services S.R.L, Leica Geosystems AG, Vero Software Ltd, Arasol Aragonesa de Soldadura S.L, Dimitrios Karadimas, Alchemie Ltd, Espeace 2001 S.A, Cecimo - The European Committee for the Co-Operation of the machine tools, Autonomous Systems S.R.L, Planit Software Ltd

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723759.

TiAlCHARGER

Titanium aluminide turbochargers – improved fuel economy, reduced emissions

The technologies behind our innovations are electron beam melting (EB melting) and electron beam brazing (EB brazing). The EB melting process has the potential to fabricate a turbocharger wheel from successive layers of powder allowing a hollow, lightweight, low-inertia rotor wheel to be formed. The TiAl wheel will be joined to the steel shaft using the EB brazing process, the challenge being to create a joint between dissimilar materials that is robust enough to withstand vibrations, high temperatures and rotational speeds present in a turbocharger unit. This fabrication method provides the possibility to manufacture turbocharger wheels from TiAl, which (if of the required quality) retains its strength at high temperatures, expanding the usage of turbochargers to a broad range of engine types.



Objectives

To create a cost-effective, mass-producible, low-inertia TiAl turbocharger assembly using innovations in EB melting and EB brazing.

Benefits

- Weight savings of 60 per cent and a reduction in mass moment of inertia of 36 per cent (due to the lower density of TiAl compared to currently used nickel super alloys and the hollow configuration made possible by the EBM manufacturing route)
- Expansion in the application of turbochargers to a broad range of engine types (TiAl retains its strength at high temperatures of >950°C)
- Improvement in vehicle efficiency and reduction in CO_2 emissions (due to the increased fuel to air ratios achievable as a result of the lightweight rotor).

www.tialcharger.com

Project budget	£ 1,290.180
Grant to TWI	£ 418,333

Project partners: TWI, Aquasium Technology Ltd, Cogeme Set RO SRL, TLS Technik GmbH & Co. Spezialpulver KG, Arcam AB, Josch Strahlschweisstechnik GmbH, Politecnico di Torino, IHI Charging Systems International GmbH, Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung E.V

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 315226.

Sniffles

Artificial sniffer using linear ion trap technology

As crime and terrorism continue to threaten the vision of a peaceful world, advances in technology are bringing solutions to discourage and pre-empt menacing events. One positive development in this respect is the prospect of a universal gas sensor, or artificial sniffer, to detect a variety of substances from drugs to explosives. The EU-funded project 'Artificial sniffer using linear ion trap technology' (SNIFFLES) is working on such a promising device.

Objective

The main objective of the Sniffles project is to develop a state-of-the-art miniature and portable electronic gas sensor capable of detecting hidden persons and illegal substances. The project is aiming to provide a cost-effective and scalable technology to complement the work of sniffer dogs.

Benefits

- Prevent transport of illegal substances, including biological and chemical warfare agents
- Streamline passenger traffic by quickly scanning for illegal substances, offering low alarm rates and reducing queues
- Increase security by reducing human error, with a less invasive and questionable method to detect illicit substances compared to other solutions.

www.sniffles.eu

Project budget	£ 4,144,143
Grant to TWI	£ 527,925

Project partners: TWI, University Of Liverpool, Aix-Marseille Université, Da Vinci Laboratory Solutions, Q-Technologies Ltd, SAES Getters Group, Envisiontec GbmH, XaarJet AB, Wagtail UK Ltd

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 285045

AMCOR

Additive manufacturing for wear and corrosion applications

Objectives

Develop and demonstrate a flexible and automated manufacturing process for the repair, coating and near net shape production of components composed of functionally graded materials (FGMs).

The following top level objectives have been determined to deliver the AMCOR concept:

- deposition procedure and powder development for high strength components with high corrosion and wear resistance
- tool path generation and software
- dual powder nozzle deposition head
- real-time process monitoring and control
- tomographic powder flow sensor
- demonstration components.

Benefits

The AMCOR project can make a significant contribution to some of the key policy drivers of Factories of the Future (FoF). With laser metal deposition being the core of the process, AMCOR will create a significant contribution improving the competitiveness of EU manufacturing through:

- a new European model of production systems for FoF
- ICT-based production systems and high-quality manufacturing technologies
- sustainable manufacturing tools, methodologies and processes for complex and novel materials.

It is envisaged through the outputs of the project direct economic impact on innovation and research in manufacturing, reducing process chains from raw material to finished parts, applied to many industry sectors will take place. This will initially start by applying the AMCOR developments to a number of end user components, providing demonstration of the benefits of using FGM by laser metal deposition.

www.amcor-project.eu

Project budget	£ 3,975,037
Grant to TWI	£ 358,641

Project partners: TWI, Vlaamse Instelling voor Technologisch Onderzoek, Bosch Rexroth BV, VCST Industrial Products BVBA, BCT Steuerungs- und DV-Systeme GmbH, S.K.M. Informatik GmbH, Ideko - IK4, Škoda Power s.r.o., Sirris, Olympus Technologies Ltd, Etalon Research Ltd, Danobat S. Coop., Ekin S. Coop, Denys NV, Sulzer Metco AG

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 314324.

AutoInspect

Automated inspection for sintered parts by non-destructive techniques for improved quality in production

Sintered parts obtained by the powder metallurgy (PM) process are used in several industry sectors, in particular the automotive. They are typically intricate, complex shaped parts produced in near net shape by compaction of powders into a geometry followed by sintering of the compacts for consolidation, where particles are bonded on heating. The PM process is suited to high volume production any flaws/defects in the parts can have a significant impact on the production output, as well as potential failures in later use. There is a need for automated inspection by non-destructive means, for determining and separating the good and bad batches during production.

Objectives

In PM parts can suffer from porosity and cracking; hence the need for an automated inspection to ensure 100% quality. Dgital X-ray radiography allows them to be inspected without being destructed.

The AutoInspect consortium has developed a digital radiographic system for the on-line inspection of sintered PM and metal injection moulded parts.

The main features are:

- a digital radiography inspection technique, able to inspect PM parts in seconds
- embedded time-delay integration (TDI) linear X-ray detectors that allow the supply conveyor to run continuously, while a row of parts is scanned. The TDI technique creates very low-noise X-ray images with resolution up to 10 m pixel size, depending on the X-ray set-up magnification
- dedicated image analysis algorithm for the automatic defect recognition with pre/post processing and an enhancement algorithm are used to sentence good/bad components.

Benefit

This technique has been developed to detect small cracks, flaws and density variations in-line during the manufacturing process of PM parts in a factory environment.

www.autoinspectproject.eu

Project budget	£ 1,234,637
Grant to TWI	£ 433,826

Project partners: Accent Pro 2000 srl, MIMTech ALFA SL, Polkom Badania, Innovation Science and Technology Ltd, TWI, Brunel University London, Vienna University of Technology

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 283288.

FoFAM

Industrial and regional valorisation of Factories of the Future additive manufacturing projects

Objectives

FoFAM takes up the challenge of clustering the technological developments related to additive manufacturing (AM) under the public-private partnership Factories of the Future (FoF) to develop a strategy to market. Moreover, it will be aligned with the regional research and innovation strategies for manufacturing.

FoFAM main objectives are to:

- define specific value chains (VCs) in key sectors for additive manufacturing deployment
- cluster existing activities along the specific VCs for the target products of FoF-funded projects
- identify the gaps and extract strategic actions along all the VC stages
- map the specialised regions related to the VCs to complete the path to market
- produce an implementation map that reflects the main actions, market trends and additive manufacturing capabilities and enablers.

Benefits

FoFAM intends to contribute to define a strategy for the short-to-medium term for increasing European market share on manufacturing. A rational use of resources and good alignment between industrialists and policy makers, as proposed in FoFAM, would facilitate the advance of the European share on AM revenues.

www.fofamproject.eu

Project budget	£ 290,175
Grant to TWI	£ 46,979

Project partners: PRODINTEC, Netherlands Organisation for Applied Scientific Research, European Regions Research and Innovation Network, TWI

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 636882.

INTRAPID

Innovative inspection techniques for laser powder deposition quality control

Objectives

The powder deposition process works by melting a layer of powder in a pattern determined by the path of a laser. To take full advantage of the intricacy of form enabled by these additive technology approaches in these applications, commensurate non-destructive testing (NDT) inspection capability is needed which can support the cycle times needed in rapid agile manufacture of high performance, high loading efficiency structures. This requires an inspection process capable of handling the complex evolving forms, in cycle with a processing environment with a feature resolution on a scale relevant to the component structural elements.

Three NDT techniques (laser ultrasonics, eddy current and laser thermography) were chosen in INTRAPID as it was expected that each would have limitations or find a niche in the variety of shapes and materials that will eventually be used for the components. They were chosen because they each operate with a different physical principle, which enhanced the chances of overall success, and they each had the capability to test very small areas of a component, which is essential for this application.

The specific project objective was to develop the three inspection methods to a stage where prototype systems were integrated into a production process and to complete a demonstration of this. These objectives were achieved and detection curves related to target sensitivities of size and depth were produced.

Benefits

The INTRAPID project developed three NDT techniques for inspection of parts and components manufactured by an additive manufacturing process, in particular laser metal deposition (LMD). LMD is a technology that has been maturing over the last 20 years and has found application in rapid prototyping and repair and manufacture of small intricate parts that can be used in aero and automobile engines to improve efficiency.

This technology has significant potential advantages over conventional casting methods in that small parts with internal features can be built, enabling special processes and light structures to be constructed.

www.intrapid.eu

Project budget	£ 1,201,922
Grant to TWI	£ 391,244

Project partners: TWI, Bytest, Tecnitest, LPW Technology, Polkom Badania, Kingston Computer Consultancy, Toyota Motor Europe, University of Palermo

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 283833.

ManSYS

Manufacturing decision and supply chain management system for additive manufacturing

Most manufacturers outsource some or all of their manufacturing operations to third-party specialists on a global basis. This allows them to realise cost advantages and open new markets, but not without complications. Communication problems with external suppliers, supply chain visibility and coordination are just some of the obstacles.

Objectives

There are three key elements to be developed as part of the project:

Decision support software:
Software will enable the user to make key decisions on the production of the part early on in the development lifecycle. End users can decide whether 3D printing is applicable and/or what is required for adoption.

Supply chain management system:
This will enable end-users to obtain a detailed overview of the status of the part design, production, material supply, post-processing, shipping and inventory.

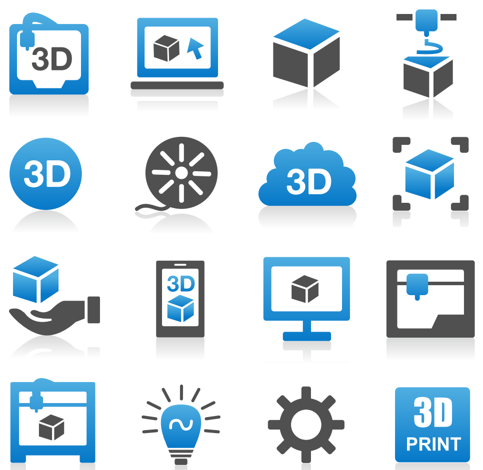
Facilitation of the co-evolution of better or new products:
As part of the system, the ManSYS software tool will allow members of the platform (including end-users/consumers) to suggest areas where processes and designs can be optimised. This data can then can be fed back into the decision-making and supply chain management tool, leading to the evolution of either better or new products.

Benefits

The ManSYS project will deliver a number of breakthrough developments in the area of 3D printing.

It will be a complete decision making system and robust supply chain management system for metal additive manufacturing, enabling the production and delivery of quality-assured, highly customised products and services.

www.mansys.info



Project budget	£ 3,671,276
Grant to TWI	£ 501,918

Project partners: TWI, AIMME, BCT, Berenschot, GE Marmara Technology Center, LPW Technology Ltd, Materialise NV, Poly-Shape, Smith and Nephew Research Centre, TNO, Twocare S.r.l, Wisildent

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 609172.

OXIGEN

Oxide dispersion strengthened materials for the additive manufacture of high-temperature components in power generation

While the fundamental material properties of ODS alloys are exceptionally well suited to power generation, the manufacture of components using ODS alloys is currently subject to economic and technical barriers:

- currently available mechanical alloying processing equipment for production of ODS alloys are time-consuming and ineffective, leading to high production cost
- oxide particle coarsening using conventional fusion (high heat input) joining techniques can lead to reduced high-temperature creep strength.
- difficult to repair for reasons given above.
- difficult to manufacture with traditional machining techniques (drilling, milling, grinding) due to their superior properties.
- superior high-temperature creep strength in an ODS material requires recrystallisation which produces coarse, usually high-anisotropic grain structure.
- coarse-grained ODS alloys can give significant component to component variability in creep life.

Moreover, these alloys tend to be creep-brittle, so there can be little warning of failure using time-averaging approaches, increasing the risk of unplanned downtime.

Objectives

OXIGEN will address the limitations given above for existing ODS alloys, focusing on the manufacturing of gas and steam turbine engine components for power generators. To achieve this, OXIGEN proposes to undertake development in four areas:

- development of new ODS powder materials
- development of ODS powder production techniques
- development of flexible and efficient powder-based additive manufacturing routes for component manufacture
- embedded sensing for in-service monitoring.

Benefits

The concept of OXIGEN is to achieve increased efficiencies (>30 per cent) in power generation by enabling higher operating temperatures of gas and steam turbines. This will be achieved by the development of ODS alloys, a class of materials that offer exceptional high-temperature strength, oxidation and corrosion resistance at temperatures exceeding 1000°C.

Project budget	£ 4,732,933
Grant to TWI	£ 527,083

Project partners: TWI, Inspire Corporation for Mechatronic Systems & Manufacturing Technology, University of Liverpool, MBN Nanomaterialia SpA, Eidgenoessische Materialpruefungs-Und Forschungsanstalt, MATRES SCRL, State Scientific Institution "Powder Metallurgy Institute", Siemens AG, Heriot-Watt University, Zaporozhye Machine-Building Design Bureau Progress State Enterprise named after Academician A.G. Ivchenko, GE Power

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 310279

ANVIL

Forging the standards which will shape the UK's additive manufacturing sector

Additive Manufacturing (AM) has the potential to revolutionise the design, production and supply of parts, but exploitation has been limited. A major challenge for the industry is to understand the true capability of the new techniques – especially making comparisons between machine platforms.

Objectives

The ANVIL project will design and manufacture benchmark parts which will be used to evaluate a range of state-of-the-art metal powder bed machines to create industry standards and develop an on-line resource of machine performance for end users.

Benefits

To enable a potential selective laser melting user to make comparisons between different machine platforms and assess suitability for specific applications

Project budget	£ 877,913
Grant to TWI	£ 104,556

Project partners: 3T RPD Ltd, Rolls-Royce Engine Control Systems Ltd, Magna Parva Ltd, K-Tech Suspension Ltd, LimitState I, JRI Orthopaedics Ltd, The Manufacturing Technology Centre Ltd, TWI

Innovate UK
Technology Strategy Board

This project was co-funded by the UK's innovation agency, Innovate UK.

AssureNET

Automated 100 per cent production quality assurance of net shape manufactured components using in-line micron resolution x-ray stereographic imaging

One of the longest established and most widely used non-destructive techniques for volumetric examination of components is radiography; a technique which uses X-rays or gamma-rays to produce an image or series of images that shows differences in thickness, density, material and defects. Radiography enables the end user to inspect parts in a non-destructive manner with little operator input.

Objectives

This project will use stereo-radiography, which combines two separate radiographs taken from different angles into one image to give a three-dimensional effect. This allows defects to be identified, and their location within the part to be calculated.

Benefits

Detection of any defects and cracks will enable corrective action to be taken prior to the parts being sent to the customer, so as not to affect their strength and functionality. Detection of any trapped powder inside the parts, enabling its removal prior to despatch. This will be of particular benefit to the medical market, as the removal of the powder from implants is imperative to ensure their safety for the recipient patient.

Project budget	£ 3,331,727
Grant to TWI	£ 880,000

Project partners: 3TRPD, Advanced Laser Technology Ltd, TWI,Computerised Information Technology Ltd, Kingston Computer Consultancy Ltd, Brunel University, Innovative Technology and Science Ltd

The AssureNet project is funded by the Advanced Manufacturing Supply Chain(AMSCI) reference number (36409-233576)

HiResEBM

High-resolution electron beam melting

Objectives

HiResEBM has the aim of developing an electron beam melting (EBM) additive manufacturing process to enable the fabrication of high-resolution medical implants with optimised porous structures directly from metal powder. Currently the design of some medical implants with porous structures is limited by production technologies not being able to implement complex 3D structures with high enough resolution of the porous structure.

In order to achieve this, the project objectives were as follows:

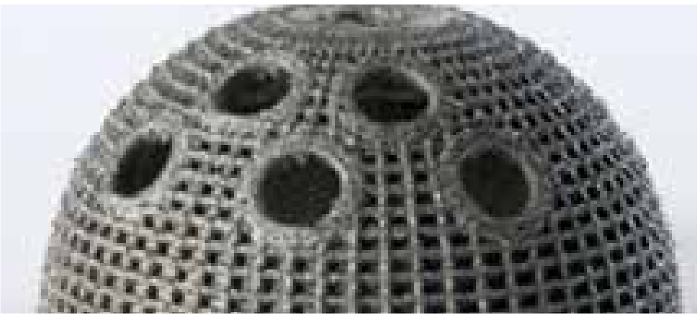
- develop a new electron beam gun with a smaller beam spot size (<50μm).
- develop a new powder distribution system for use with finer powders (<50μm).
- bring together the above technologies to produce prototype optimised implants.

Benefits

The project will develop an efficient manufacturing process that will allow any designed porosity to be incorporated into any part of an implant – giving complete freedom to design the 'optimum' implant.

- The partnership benefits from the development of the HiResEBM process and prototype as a result of extended applicability of existing EBM machines and a new prototype
- The partnership has a prospective first-to-market offering of implants produced using the improved EBM process
- HiResEBM allows prospect for expansion of services in the future.
- HiResEBM provides a knowledge advantage over competitors.

www.hiresebm.eu



Project budget	£ 1,170,610
Grant to TWI	£ 507,441

Project partners: TWI, Arcam AB, Eurocoating, Spark Power Ltd, LPW, AiMME

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 286762

ImplantDirect

Direct manufacturing of personalised implants using selective laser melting

Objectives
ImplantDirect will create a cost-effective, faster manufacturing route for orthopaedic, maxillofacial or trauma implants, tailored to the individual needs of patients. The overall project aims are to improve the quality of the implants, reduce the recovery time, improve the quality of life for the patients and reduce the healthcare costs.

Benefits
- An innovative software solution that will allow the surgeon to directly design the 'best' (not limited by existing manufacturing techniques) implant shape for his patients, based on CT-scan data, which will then allow implant creation using the flexible rapid manufacturing technique of selective laser melting
- Deliver functional Ti6Al4V personalised implants within three days from receiving the designs from innovation 1002E.

www.implantdirect-project.eu

Project budget	£ 1,247,761
Grant to TWI	£ 431,208
Project partners:	JRI, BCT, Realizer, TWI

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 286577.

SocketMaster

Developing a new technique for rapid design and manufacturing of optimised prosthetic sockets for lower-limb amputees

In developed countries, more than 90 per cent of limb amputees achieve their mobility through the use of prostheses. The comfort of a prosthetic limb is a key consideration for both manufacturers and service providers, as they are keen to help the prosthetic limb user – who will have to wear the prosthetic indefinitely – regain a good quality of life.

Objectives

To overcome the challenges, TWI is leading a consortium of eight partners from Greece, Italy, Poland, Portugal and the UK to develop a new technique, entitled SocketMaster. The consortium aims to integrate various micro sensors into a medical tool, which will help prosthetists achieve fast, customised design and manufacturing of prosthetic sockets for lower limb (trans-femoral and trans-tibial) amputees.

Benefits

It is expected that by wearing the SocketMaster tool, comprehensive data characteristics of the patient during typical activities will be able to be measured and collected. This data will then be used to optimise the socket design to maximise the patient's comfort. The digital 3D data of the optimised socket design will be fed into a rapid prototyping machine for fast fabrication.

At least 50 clinical trials will be carried out to validate the SocketMaster technique. It is envisaged that SocketMaster will enable same-day socket fabrication with optimised quality, and the fit and function of the prosthetic socket will be less dependent on the skills of the prosthetist

www.socketmaster.eu

Project budget	£ 3,291,738
Grant to TWI	£ 708,271

Project partners: Innora SA, Fondazione Bruno Kessler, Veneto Nanotech SCPA, Polkom Badania SP ZOO, Sensing Future Technologies Lda, University of Surrey, Hugh Steeper Ltd, TWI

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 645239.

AM-Motion

A strategic approach to increasing Europe's value proposition for additive manufacturing technologies and capabilities

Among the most innovative manufacturing solutions of the last decade, additive manufacturing (AM) technologies have been identified as one of the most promising production technologies at global level. They are considered to empower the transition from mass production to mass customisation in several leading sectors; AM technologies are mainly concerned with "high performance manufacturing" and were identified as a segment with "particular high growth potential". Their potential for smart production and efficient processes opens up new perspectives which are often associated with the new "industrial revolution".

Europe is aware of the importance that AM is playing at a global level and its potential as the driver for European reindustrialization shifting towards smart and sustainable manufacturing. Nevertheless, aside from the existing knowledge portfolio and expertise, it has been demonstrated that exploitation of this technology is far from its potential, due to many factors including lack of awareness, limited competences, market access, re-sources, and limited inter-linking of regions and/or sectors. Therefore, there is a need to take steps in the strategy by bridging complementary capabilities and resources across Member States and to boost the results achieved to date, particularly from efforts/funds provided by public-private partnerships.

To enable real AM industrial innovation and deployment the entire value chain from modelling, design, process and product development to new business models and services, needs to be considered. Successful exploitation of this cooperation and expertise along these chains will not only reinforce the individual's competitiveness of each stakeholder, but also the whole European industry.

Objectives

The overall aim of the AM-Motion CSA is to contribute to a rapid market uptake of AM technologies across Europe by connecting and upscaling existing initiatives and efforts, improving the conditions for large-scale, cross-regional demonstration and market deployment, and by involving a large number of key stakeholders, particularly from industry.

In order to deliver the overall aims of the project the following objectives have been defined:

- map the AM landscape at regional, national and international level
- build a robust AM ecosystem
- develop a minimum of 3 models for business collaboration
- fully integrate AM technology with connected industries (industry 4.0), including SMEs
- assess job market demands with regards to AM
- analyse non-technological issues
- detail an AM roadmap that ensure large scale deployment and industrial exploitation

Benefits

The AM-Motion proposal will achieve a unique combination of expertise and networks in the following important areas:

- key technological capabilities and infrastructure (technology development and supply)
- barriers and market failings to industrialisation and deployment (both technological and non-technological)
- key future applications and markets o Relevant industrial lead-users
- links with regional initiatives and policies

By doing this, the AM-Motion project has the ambition to develop a strategy and set up the pillars for its efficient implementation that, ultimately, will contribute to reinforcing the European ecosystem of AM.

Project budget	£ 827,543
Grant to TWI	£ 74,625

Project partners: Fundacion Prodintec, Nederlandse Organisatie voor Toegepast Natuurwetenschappelikj Onderzoek TNO, TWI Ltd, Commissariat a l'Energie Atomique et Aux Energies Alternatives, European Regions Research and Innovation Network, Idea Strategische Economische Consulting, Brainport Development NV, Airbus Operations SL, European Powder Metallurgy Association Aisbl, d'Appolonia SpA, Siemens Aktiengesellschaft, European Committee for the Co-Operation of the Machine Tools, Materialise NV

www.am-motion.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723560.

OpenHybrid

Developing a novel hybrid additive manufacturing approach which will offer unrivalled flexibility, part quality and productivity

The OpenHybrid project will overcome the technical and commercial barriers of current hybrid manufacturing systems to deliver a single manufacturing system capable of undertaking a wider range of processes in a seamless automated operation. The new system will offer unrivalled flexibility in terms of materials, including the ability to switch between powder and wire feed-stock within a single part. Moreover the process can be fitted to a diverse range of platform to produce parts from 2cm to 20m in length. The capability of the OpenHybrid approach will be validated through the production of industrial demonstrators from the power generation, automotive and mining equipment sectors.

Objectives

The OpenHybrid project will develop an all in one hybrid additive and subtractive multi tool platform. It will utilise directed energy deposition additive manufacturing (AM), known as cladding, where a metal powder or wire feed is melted using electron/laser beam or electric arc. This approach has significant advantages over conventional powder bed fusion AM, in that cladding offers very high deposition rates, increased material flexibility, and can be used in a hybrid approach, enabling complex features or different material to be deposited onto an existing component produced conventionally.

Benefits

- 15 per cent increase in productivity for high volume AM production
- 20 per cent reduction in inventory due to single step process and flexibility
- 25 per cent reduction in time and cost with respect to current equipment and processes
- 40 per cent reduction of work floor space

Project budget	£ 5,536,432
Grant to TWI	£ 506,432

Project partners: The Manufacturing Technology Centre Ltd, LBG, Siemens Aktiengesellschaft, Weir Group Plc (the), Fraunhofer Gesellschaft zur Foerderung der Angewandten Forschung e.v., Esi Group, Picasoft, Hybrid Manufacturing Technologies Ltd, Gudel AG, TWI Ltd, BCT Steuerungs und DV-Systeme GMBH, European Federation for Welding Joining and Cutting, Centro Ricerche Fiat S.C.P.A, Esi Software Germany GmbH, Picasoft, gf+

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723917.

SafeStore

Safer, low-cost nuclear material storage through cold spray-formed boron carbide-coated components

Objectives

- Identification of the required characteristics of the new coating
- Explore the working hypothesis and determine the feasibility of producing the required coating properties.
- Selection of the optimum coating in terms of neutron absorbing capability.
- Assessment the challenges associated with future production-scale use of these coatings in the intended market.
- Development a boron-rich aluminium-matrix coating, with a range of thicknesses and a minimum of 30 per cent volume fraction B_4C using the Cold Spray process, on large prototype components made from low cost metal alloys for the nuclear industry.

Benefits

Transport and/or storage of spent nuclear fuel can require neutron shielding materials. Two such materials currently used are composite plate materials consisting of aluminium (or aluminium alloys) containing varying proportions of boron carbide particulates, which have a high neutron absorbing capability. Whilst these metal matrix composite (MMC) materials are suitable for specific niche applications, the current manufacturing route is unable to produce them in anything other than flat solid plates. This limits the design options for containers/canisters.

Following the integration of a second powder feeder hopper with its cold spray system, TWI has established the capability to co-deposit metallic materials and hard ceramic particles (e.g. B_4C, Al2O3 and SiC). The advantage of cold spray deposition is that it does not melt the material to be deposited and therefore it can be used to incorporate thermally sensitive materials including carbides and polymers into metallic matrices, such as Al and Ni based alloys. A great deal of flexibility in the types of materials and their relative proportions is now possible. The proportion of each phase can also be adjusted through the coating thickness to form functionally graded coatings for a wide variety of applications.

In the SafeStore project, this capability was used to develop a material that is similar to the MMC but can be applied to sheet metal fabrications in any desired thickness up to tens of millimetres. Cold spray technology facilitates the co-deposition of thermally sensitive and/or easily oxidised materials such as Al and B_4C without thermal degradation. The coatings were developed and applied to steel samples and plates and the deposition parameters were then further improved to obtain higher levels of B_4C in the coatings. The use of a coating results in better design flexibility and hence better and more cost-effective dry cask storage options.

Project budget	£ 125,999
Grant to TWI	£ 67,500
Project partners:	TWI, Graham Engineering Ltd

Innovate UK
Technology Strategy Board

This project was co-funded by the UK's innovation agency, Innovate UK.

Re-LASE

Refurbishment of torpedo ladle and locomotion axles through laser-applied surface engineering

The highly demanding in-service conditions of torpedo ladle axles in steel production and high speed locomotion axles result in high levels of abrasive wear (often during wheel removal) and corrosion, which raise concerns over fatigue performance.

Applying a suitable Laser Engineered Coating (LEC) on to axles can potentially generate large savings on replacement costs, as well as eliminating the CO_2 burden of manufacturing new components. LEC technology is a recent development that has been successfully implemented in a variety of applications where resistance to wear is the foremost consideration and fatigue performance is not so important.

However, up to now there has been little development of metallurgical powders for enhanced fatigue performance. This research gap has limited the growth of LEC into broader applications, including axles, where behaviour under cyclic stress is a key safety concern.

This project will undertake a comprehensive programme of powder and LEC development to produce new coatings optimised for combined high fatigue, wear, adhesion and corrosion performance, which will be validated through both destructive and non-destructive evaluation.

Objectives

The project aims to deliver a process that offers a coating which benefits from increased fatigue, wear and corrosion resistance, coupled to an inspection method that ensures and validates the safety of the part prior to service. Such a coating would allow for refurbished axles to be in service for longer than the original un-coated components, reducing scrappage rates by more than a half.

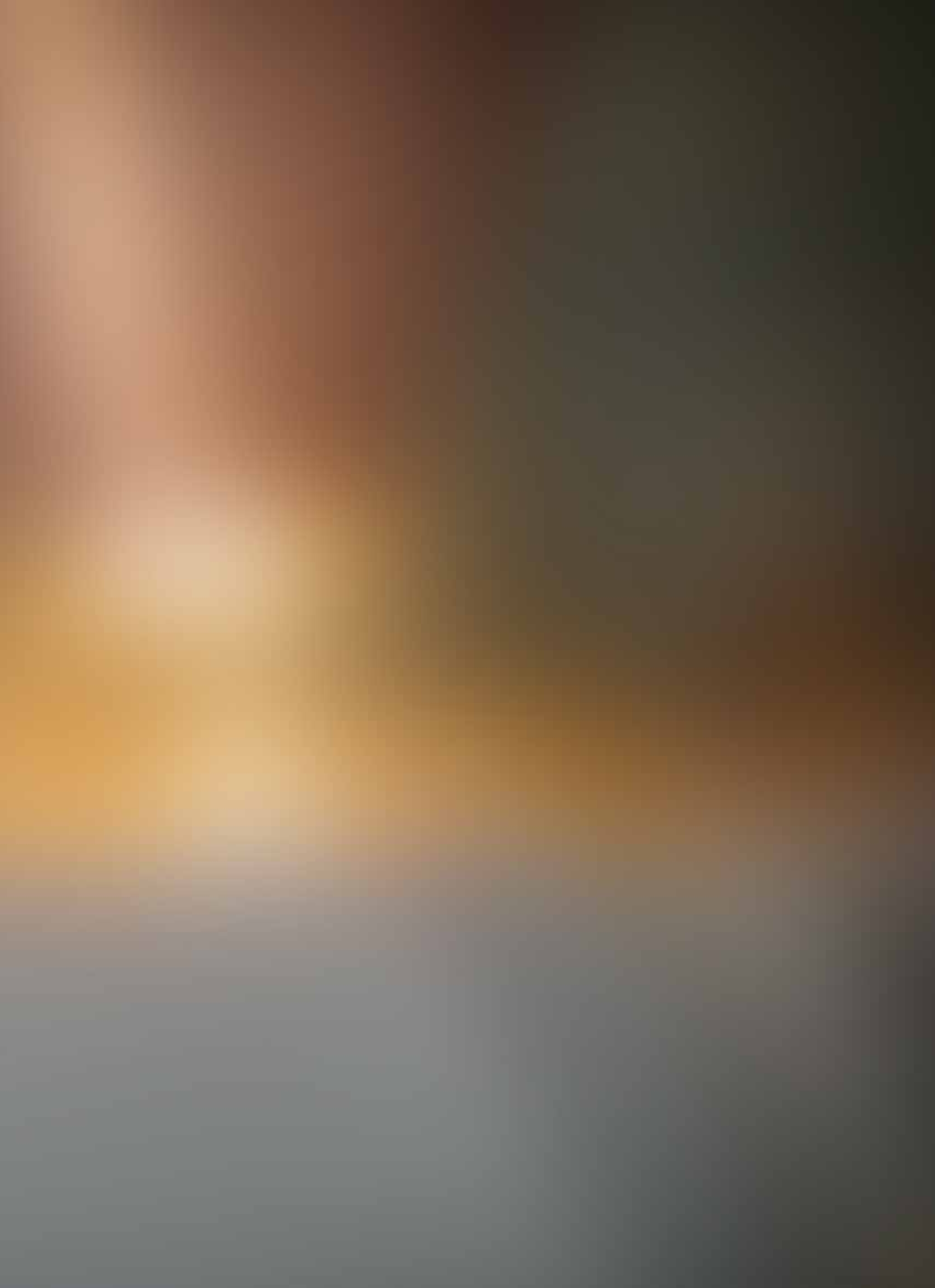
A comprehensive test programme will be designed to quantitatively assess the mechanical performance of the laser applied coating. Mechanical and non-destructive testing will be carried out for a number of powder and process developments to develop a final coated product that resists the formation of persistent slip bands arising due to cyclic slip.

A robust process for evaluating coating adhesion, the presence of porosity and other potential defects will be developed using ultrasonic techniques, and a variety of other NDT techniques will be trialled and considered. Once the NDT procedure is finalised, pre-use inspection of the part will ensure that the component is fit for purpose and free from any defects that may arise from any fluctuation in processing parameters.

www.relaseproject.co.uk

Project budget	£ 851,949
Grant to TWI	£ 255,182
Project partners:	Tata Steel, Wall Colmonoy, LASE Ltd, TWI

This project was co-funded by the UK's innovation agency, Innovate UK.



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