



Graphene

The Centre for Process Innovation

From innovation to commercialisation



CATAPULT

High Value Manufacturing

The High Value Manufacturing Catapult is a partnership between industry and government, which is a catalyst for the future growth and success of manufacturing in the UK. Its long-term goal is to stimulate growth in the manufacturing sector and grow the sector's contribution to UK GDP to a level more commensurate with that of competitor economies. It does this by helping businesses accelerate new concepts (often started in research institutions) to commercial reality (where they can be funded through market sources). In doing so, the Catapult reduces companies' risk in innovation, and it enables the UK to address market needs in key areas, making the country more competitive on the global stage.

The High Value Manufacturing Catapult combines the strengths of seven UK technology and innovation centres, each focusing on major underpinning manufacturing technologies. The Catapult brings these centres together to develop cross sector manufacturing capabilities, which can span from raw materials to finished processes. It also enables innovation to cut across sectors by bringing together businesses from diverse industries and giving them access to a pool of world-class expertise, equipment and processes invested and supported by UK government.



The Centre for Process Innovation

From innovation to commercialisation

The Centre for Process Innovation is the UK's national technology and innovation centre to serve and support the process manufacturing industries. We are chosen by key industry leaders and SMEs to develop, prove, prototype and scale up the next generation of products and processes.

We work across a range of technology platforms, each of which have the potential to generate a substantial impact on the future of manufacturing. We provide product and process development facilities and expertise in industrial biotechnology and biorefining, formulation and flexible manufacturing, printable electronics and biologics with the overall aim of creating less waste, cleaner, more efficient and more economic products and processes.

Our open innovation model enables our clients to develop products and prove processes with minimal risk. We provide assets and expertise so our customers can demonstrate the process and prove it is feasible before investing substantial amounts of money in capital equipment and training. New products and processes can be proven; on paper, in the lab and in the plant before being manufactured at an industrial scale.

By utilising our proven assets and expertise companies can take their products and processes to market faster. There is no down time in production as all of the process development is completed off-line.

Better Products, Faster

We help our clients to produce better products with increased quality and performance. We can create processes with higher yields and reduced manufacturing time with faster conversion of raw materials or feedstock to product.

Low Cost, Low Waste Manufacturing

We enable companies to decrease capital and manufacturing costs by facilitating batch to continuous processes, increased automation and reduced manufacturing time. We help reduce and reuse wastes, utilise natural materials and decrease reliance on fossil fuels.



Introduction

Graphene at CPI

Graphene has the potential to transform many products. Its electrical and thermal conductivity, optical properties and mechanical strength could be used in a wide range of materials such as inks, coatings and composites, sensors, flexible screens, high-capacity batteries and ultra-fast transistors. Ultimately, the full potential of graphene and its possible applications are still being explored but CPI's Graphene Application Centre will help UK industry to identify and exploit opportunities as they arise.

CPI has a range of enabling technologies which support the development and integration of graphene into final products including coatings, composites, membranes and sensors. Our techniques focus on the safe-handling, optimised dispersion and structuring of graphene into liquids and polymer substrates, and their translation into prototype products.

The Graphene Application Centre is located in close proximity to our Printable Electronics and Formulation facilities, and it is the ability to draw on the expertise and equipment within these complementary technologies that allows us to take graphene-enabled products through to prototyping and and commercialisation, employing

industrially-relevant applications testing and characterisation at every step.

Above all, our industry trained staff have a wide range of market knowledge and product expertise covering the major end-user sectors currently identified for graphene-enabled products.



Our Capabilities

Expertise and Facilities

CPI has developed capability and expertise in the safe handling, functionalisation and dispersion of graphene and other 2D nanoparticles and their incorporation into various materials including resins and polymers. Together with complementary expertise in producing appropriate test pieces, we enable companies to understand how their graphene-enabled product will perform in application.



Safety, Health, Environment and Quality Handling

The Graphene Application Centre is fully SHEQ optimised with unique nano-powder handling capability. Contact between Graphene dust and powder, and operators is minimised through the use of bespoke extraction systems which reduce potential risk for staff and customers.

Our operators are fully trained in techniques for the safe handling of nano-particles including graphene. We are working to develop and disseminate such practice through AssuredNano™. This is a recognised good current practice guide and audit system developed in conjunction with the Institute of Occupational Medicine to promote the safe handling of nano-materials. Companies can utilise our facilities to handle graphene materials in safety without incurring unsustainable capital expenditure associated with expensive safe handling equipment and can draw on our expertise to develop appropriate systems for safe handling in their own facilities.

Nano-dispersion

We have a comprehensive suite of techniques to cover a range of dispersion requirements from low to high viscosity at scales ranging from 10ml up to 60 litres.

Nano-particles can be dispersed under a range of shear conditions, from very low shear to provide efficient but gentle mixing without damage to particle morphology, to high shear for breaking down aggregates and distributing them quickly and efficiently. Expertise in surface engineering allows us to optimise and maintain dispersion through the use of surface active chemicals, ensuring that products remain stable. At-line and in-line characterisation allows us to assess the level of dispersion within both liquid and solid media.

Our equipment is ATEX rated for the processing of flammable liquids.

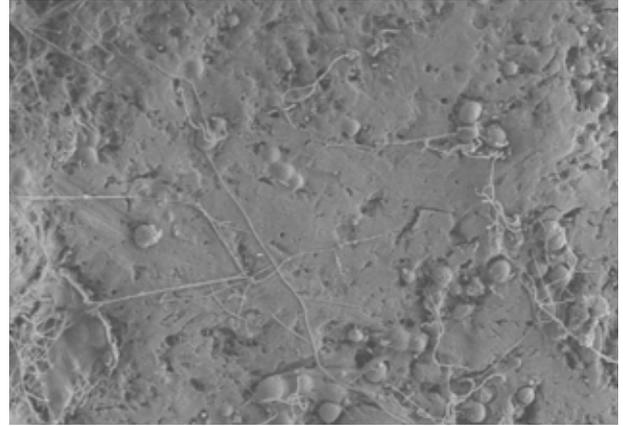


Functionalisation

Via functionalisation, we can optimise the stability of dispersions and create nano-structures to achieve specific properties, for example conductivity (thermal and electrical), flexural strength, and impact toughness for light-weighting.

CPI has capability in low temperature plasma functionalisation of graphene and other nano-particles, which allows us to select the appropriate functionalisation for incorporation of a given particle within a chosen medium.

Via surface modification using appropriate chemical groups, we can optimise the dispersion of nano-particles into media, for example increasing wettability for optimum dispersion into polar solvents.



Nano-structuring

The creation of nano-scale structures for incorporation into coatings and polymer matrices has the potential to enhance specific properties such as bulk conductivity or strength.

Through a combination of expertise in colloid chemistry, surface science and mechanical structuring, CPI enables companies to develop nano-structures to achieve the properties desired of their graphene enabled products. Depending upon the properties required, such structures may be co-flocculates of metallic and non-metallic nano-particles or co-flocculates of particles with different morphologies.

Nano-structuring may also be achieved through the encapsulation of nano-particles to enhance compatibility and dispersion of the nano-particulates within a given resin binder system.

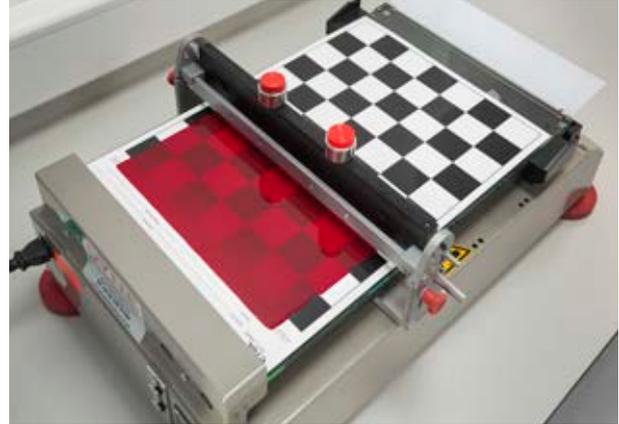


Characterisation

CPI has a wide range of techniques and expertise useful in the characterisation of graphene and graphene enabled products. Characterisation is vital for manufacturers of graphene in order to understand the nature of the graphene as supplied and its potential applications.

We can characterise graphene through the use of Raman Spectroscopy and Scanning Electron Microscope to assess morphology and also test for chemical and electrical properties such as volume resistivity, powder thermal conductivity and surface energy.

Through characterisation, we enable companies to develop specifications for graphene which will enable them to reproducibly achieve their desired final product properties, ensuring uniform product quality and control their manufacturing processes.



Testing

To measure whether the properties expected of a graphene-enabled product have been achieved, CPI can carry out sector-relevant applications testing, for example via the production of thermoplastic thin films, composite plaques, and printed media

Test pieces can be subjected to various destructive and non-destructive test methods for mechanical properties, as well as measuring surface charge, conductivity, surface roughness and surface tension.

Companies can work with CPI to test products in development as well as existing products which may require improvement or adaptation to new customer requirements.



Graphene-Enabled Products

Applications and Enhancements

CPI's know-how and expertise in functionalisation and structuring of graphene into a final product helps companies to bring graphene-enabled products to market faster for first mover advantage.

CPI enables companies to incorporate graphene into different products to achieve enhanced properties such as thermal and electrical conductivity, strength, surface hardness, among others.

We help companies to efficiently manufacture their graphene enhanced products and use in-line measurement to ensure that the correct product properties are consistently achieved.

We enable companies to develop products in the product groups:

Inks and coatings

- Industry expertise in formulating inks and coatings
- Capability to lay down inks and coatings on a range of surfaces and test for enhanced properties under simulated real-life conditions

Composites

- Formulation of graphene-enhanced resins
- Infusion of resin into composite structures and development of test pieces
- Testing of mechanical properties under simulated real-life conditions



Membranes and filters

- Application of graphene to membranes and filters for a variety of applications
- Understanding of membrane structure to enhance diffusivity, selectivity, durability, structuring and percolation control

Sensors and Antenna

- Replacement of Indium Tin Oxide in OLED display screens enabling cost reduction
- Replacement of metal-based inks in antenna facilitating enhanced product recyclability and lower manufacturing cost

Batteries

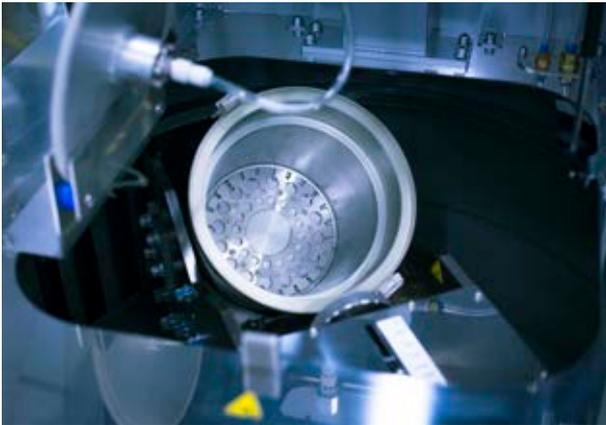
- Direct coating of a graphene-enhanced substrate on an electrode surface (e.g. CVD) to improve product properties such as thermal and electrical conductivity, morphology and structuring and resistance to passivation.
- Expertise and industrial experience in coatings & electronics – fundamental knowledge in the process of developing battery technology and the difference graphene could make

Our Services

Technology Development

The highly experienced CPI team can help guide you from concept to finished product. We have scientists, engineers, scale up experts, process technologists and commercialisation specialists to take your project from early concepts through to robust manufacturing process packages and/or products.

Our services can be customised to meet your needs wherever you are in the development process and supply chain. We are delighted to work side by side with our clients to help them overcome the challenges of commercialisation of their products and processes. Our extensive industry experience means we can make recommendations accordingly in an effort to produce the best possible outcome.



Product and process development

CPI helps organisations of all sizes to develop products and processes quickly and cost effectively with minimal risk. Clients can work with CPI's specialist teams in our open access facilities to test, develop and prove products and processes.



Prototyping, demonstration and scale up

We have the ability to scale a range of products and processes across our core technology platforms. We understand scaling factors and discrete activities are minimised and managed to de-risk the process to deliver a fully proven system, with robust cost-effective manufacturing the goal.



Materials investigation

CPI can assess materials to see how they can be utilised to create new products. We can also assess production costs and, through the use of life cycle assessment, we can confirm the overall benefits of using new materials.



Open access facilities

CPI is the only open access centre of its kind in the UK with such an extensive combination of equipment and specialist knowledge. CPI has designed an environment that fits the needs of companies whatever their size and demands, and consistently delivers customers' requirements, on time and to budget.



Business Support

CPI can offer targeted business support services aimed at addressing specific issues faced by early-stage companies and SMEs wishing to develop new products and access new markets. These support services – delivered by highly-experienced specialists – provide clients with access to training, an international network of potential new business partners, European funding sources and new markets.

Work with us

We work with companies of all sizes, from micro SMEs to large corporates to help them develop and commercialise new graphene enhanced products.

We work with companies as part of both publicly funded projects and also undertake private fee for service projects.

Partner with us to:

- Collaborate to develop CR&D bids for European and UK funding calls
- Engage in individual product development and optimisation projects to advance your formulated products on a fee for service basis

Working with us will increase the speed of commercialising innovative formulated products as well as significantly reduce the risks and costs associated with product development and optimisation.

To find out more about our full range of services
visit: www.uk-cpi.com
call: +44 (0)1642 455 340



Industrial Biotechnology
and Biorefining



Printable Electronics



Formulation



Biologics

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