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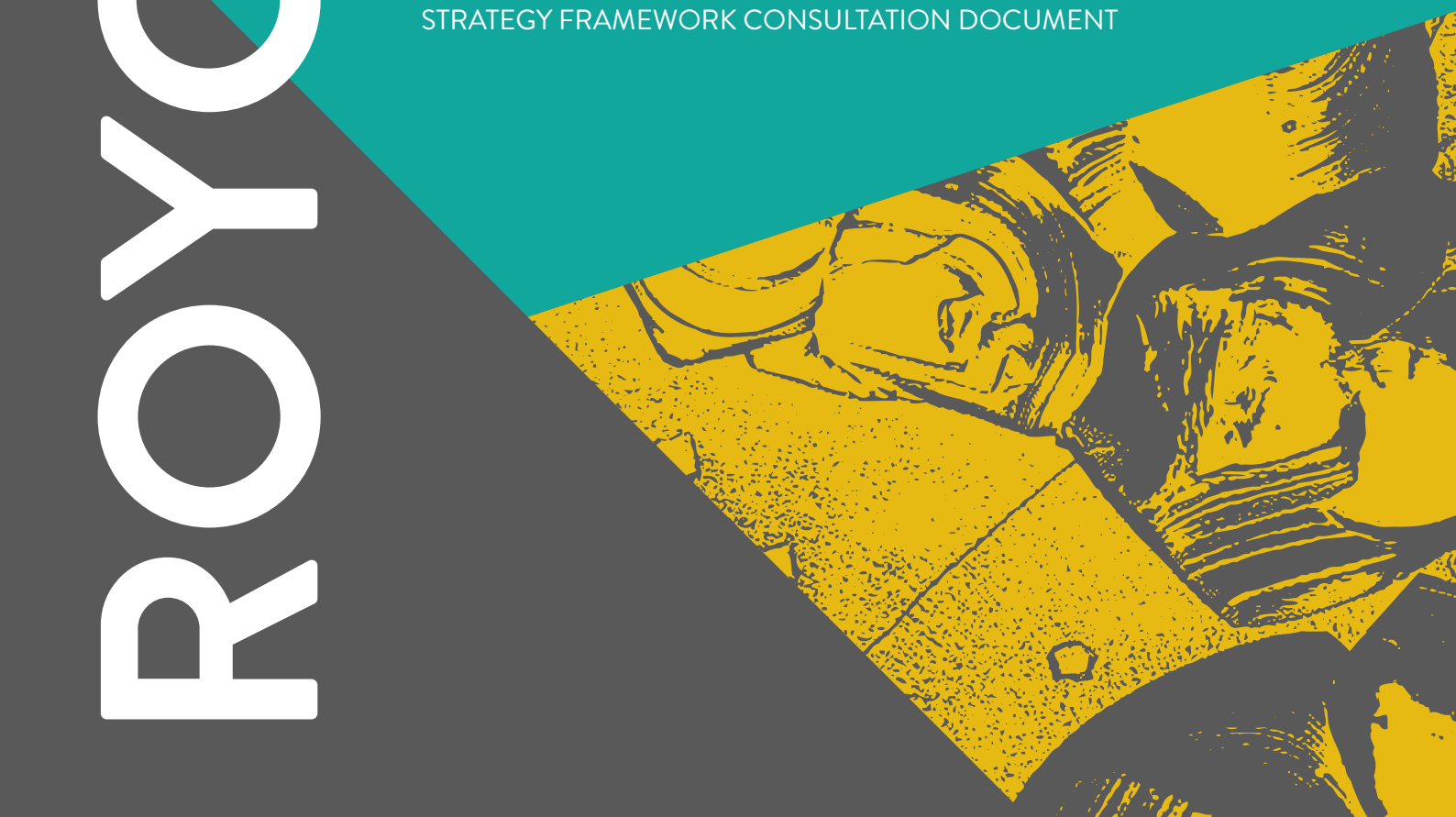
MATERIAL FUTURES

Growing the UK's critical capabilities in materials innovation

STRATEGY FRAMEWORK CONSULTATION DOCUMENT



MATERIALS INNOVATION

Materials innovation is the creation and application of a material whose properties can deliver performance or process benefits across its lifecycle.

Materials innovation is a cutting-edge research and industrial discipline. It means discovering, developing and exploiting new materials, or applying an existing material to a new process. This innovation is essential to many of our most pressing economic, social and technology challenges.

Materials affect every part of the economy – and materials innovation can help almost any market, supply chain or application.

But because materials have such a broad influence, they offer a particular challenge to policy makers, research funders and industrial leaders. The range of uses makes it difficult to focus national efforts.

MATERIALS UNDERPIN ALL INDUSTRIES

They generate value through their:

- Extraction
- Creation
- Processing
- Application
- Recycling

This framework consultation document outlines a process for creating a strategy that grows the UK's capabilities in materials innovation.

It is a summary of a full consultation report. More information about this framework consultation is available on the Royce website.

This strategy aims to establish how the UK can be competitive across all aspects of materials innovation – from research and development, to commercialisation and scale-up, recovery and re-use.

THE POTENTIAL

Materials innovation is fundamental to achieving national priorities:

	EXAMPLES
Getting to net zero The creation and use of technologies that lower greenhouse gas emissions and enable sustainable practices.	Anodes and conductive membranes for batteries and fuel cells, enabling the scaling of renewable energy sources.
Growing a high-wage, highly skilled workforce The fostering of productive industries that provide employment opportunities for skilled workers.	The computational management of material lifecycles – Materials 4.0 – accelerating material discovery and manufacture.
Strengthening the UK as a global technology leader Extending our world-leading capabilities in research, development, innovation and commercialisation.	Next-generation low energy loss electronic materials, driving a transition to highly energy-efficient information and communications devices.
Rebalancing the UK economy Winning investment for growth across the regions through the application of research and the commercialisation or scaling of solutions.	Sustainable fibre composite materials enabled through SME-pioneered recycling processes, stimulating regional economic development and growth.
Supporting national resilience and security Maintaining a technology-enabled national security capability and building resilience to global supply chain disruptions.	Quantum computing, enabled by high-temperature superconductors, improving positioning technologies for autonomous aircraft.
Enabling healthy, happy lives Delivering healthcare and creating a built environment that supports a thriving population.	Biocompatible implants and regenerative materials for vascular tissue healing and replacement.

CASE STUDY: **GRAPHENE-ENHANCED CONCRETE**

CARBON REDUCTION OF CONCRETE

A breakthrough graphene-enhanced admixture for concrete called Concretene has the potential to significantly decarbonise the construction industry.

Concrete accounts for 8 to 10% of CO_2 emissions worldwide, principally through the energy-heavy manufacture of cement. Therefore, technologies that reduce the volume of cement used in construction will have a massive impact on achieving global net zero ambitions.

Additionally, increasing the lifespan of concrete and combatting deterioration will significantly improve the resilience of the built environment.

Graphene – the world's first 2D material – has extraordinary physical capabilities. In the case of Concretene, graphene acts as a support for mineral microstructures during the hydration phase in wet concrete, leading to better bonding at the microscale and improved strength, durability and corrosion resistance.

Concretene allows for reduction of the cement content of concrete while maintaining or improving performance. This could save up to 30% in carbon dioxide emissions and – with faster curing times than existing 'green' cement replacements – could substantially reduce project costs via less time on site.

Concretene has been developed by Manchester-based Nationwide Engineering Research & Development, in collaboration with The University of Manchester's Graphene Engineering Innovation Centre.

This innovative product, which could deliver UK leadership in the sustainable construction sector, was kick-started with Innovate UK funding and has since attracted £8 million in private investment for scale-up.

THE CHALLENGE

The UK's materials innovation capabilities are a key national asset. A smart, strategic approach to managing them is essential in the face of international competition.

WHY DO WE NEED A MATERIALS INNOVATION STRATEGY?

A national strategy for materials innovation is needed to deliver a coherent approach across government, industry and the wider materials technology community.

This will give the UK a world-leading position in rapidly expanding materials markets, and substantially enhance the value of some of the largest UK-based industries.

Materials underpins manufacturing, and the UK is one of the largest global manufacturing nations, contributing £203 billion every year to GVA and supporting 5 million jobs. 84% of this manufacturing takes place outside of London and the South East. The importance of materials to the UK economy is clear.

Materials offer a particular challenge to focussing national effort because they aren't developed in isolation.

Past efforts to bring cohesion to materials innovation activities have focussed too specifically on either a sector or a capability without adequate consideration for the complex links between industries and policy aims.

This strategy will address the critical weaknesses in the lengthy and expensive commercialisation cycles of all material classes. It will break down the barriers between sectors and research, development and commercialisation activities – creating coherency and accelerating the material development cycle.

A concerted effort is needed to encourage the translation of research into adopted solutions.

The UK is a leader in primary research in this field. But it lags many countries in its capabilities to commercialise new materials. Establishing an effective commercialisation system would have major economic benefits across UK industry.

The scope of this strategy is therefore the full material innovation pipeline, and not just research and development capabilities.

IT CAN TAKE 20 YEARS FOR A NEW MATERIAL TO BE COMMERCIALISED IN THE UK.

CASE STUDY: **THIN-FILM, FLEXIBLE SEMICONDUCTORS**

FLEXIBLE INTEGRATED CIRCUITS

Semiconductors are a vital component of nearly all electronic devices. UK-based Pragmatic Semiconductor is leading the way in developing and producing low-cost, low-emission semiconductor chips.

Pioneering UK research into flexible semiconductors has enabled the manufacture of integrated circuits with 10x lower production cost, 100x lower capital expenditure and 1,000x lower carbon footprint compared with conventional silicon chips.

This allows the UK to play to the strengths of its domestic semiconductor industry, rather than trying to outcompete the established players in advanced silicon wafer fabrication.

Pragmatic is a world-leader in the development and production of these thin-film, flexible semiconductor chips.

The circuits are thinner than a human hair and can be embedded into everyday objects, adding connectivity and intelligence via radio frequency identification (RFID), as well as being used for sensing, control and computation. This enables a wide range of applications including supply chain traceability, wearable technology and smart reusable packaging.

Pragmatic's first production line is co-located with the National Printable Electronics Centre in Sedgefield, and is in the process of scaling up its production capabilities with the opening of a new 175,000ft^2 manufacturing facility in Durham. This growth was made possible by a recent series C funding round of £96 million, including strategic investment from global leaders in semiconductor IP, RFID technology, and consumer goods packaging.

AN ECOSYSTEM OF INNOVATION

This strategy takes a system-wide perspective of the whole environment that shapes materials innovation.

This approach recognises that materials innovation does not happen in isolation or as a linear process, but in a complex network of activities in organisations from across industry, research, the public sector and education.

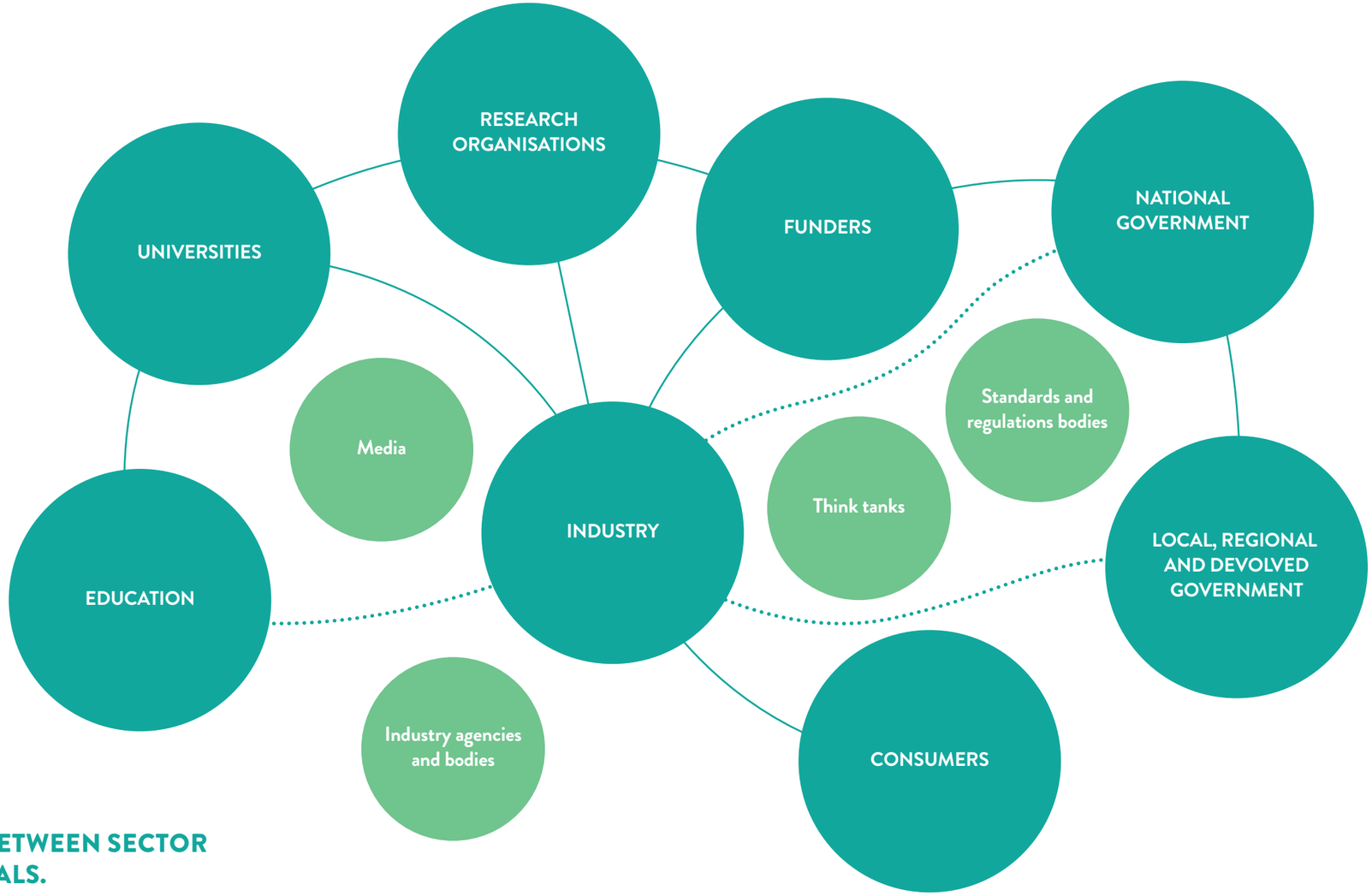
A material's development cycle can be supported by the actions and connections between these organisations and those working in them. These networks generate more value together than each of the organisations could create individually.

Often, these networks are organised around sectors, with little communication and collaboration between them. For example, industries from electrical power generation to health depend on advanced, high-performance polymers but may not work together on their development.

Barriers between sectors will be broken down by considering all materials innovation networks as part of one whole ecosystem.

In doing so, this strategy will identify and address areas where significant cross-sector funding can target gaps in innovation capabilities across the economy. It will encourage collaboration between sectors, and broker connections that will endure as the ecosystem continues to realise its potential.

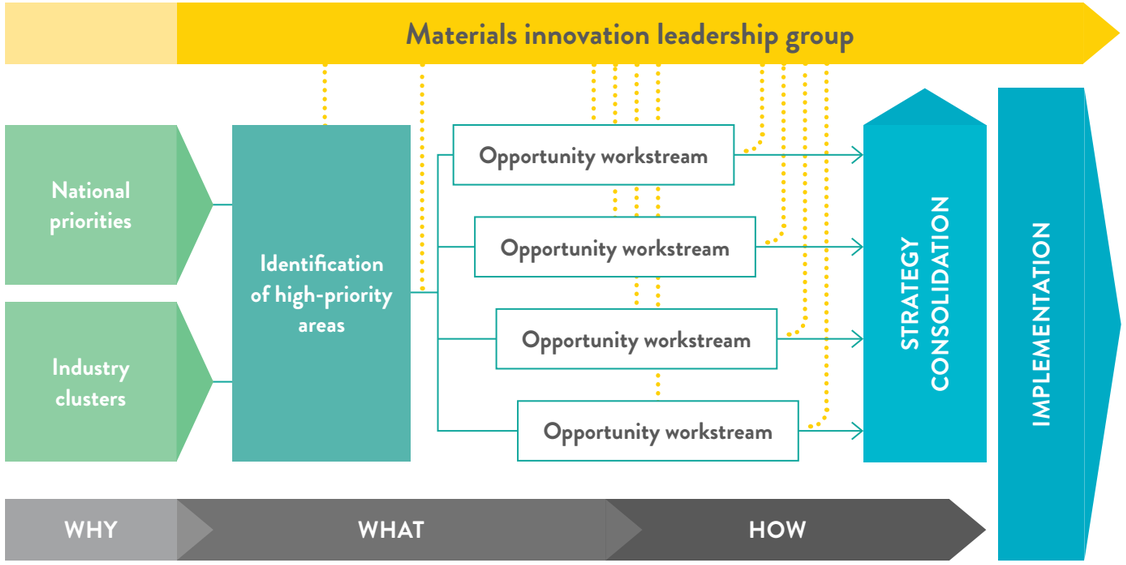
THIS APPROACH WILL ENABLE MORE COLLABORATION BETWEEN SECTOR NETWORKS THAT CREATE VALUE USING SIMILAR MATERIALS.



A VISION FOR ACTION

This strategy framework will systematically prioritise, develop and articulate the innovation enablers that will deliver results for industry and the UK.

A materials innovation leadership group will develop and deliver a strategy for implementation over the next year. They will do so through a series of interconnecting processes, that answer the key questions of "why, what, and how" for UK materials innovation capabilities growth.

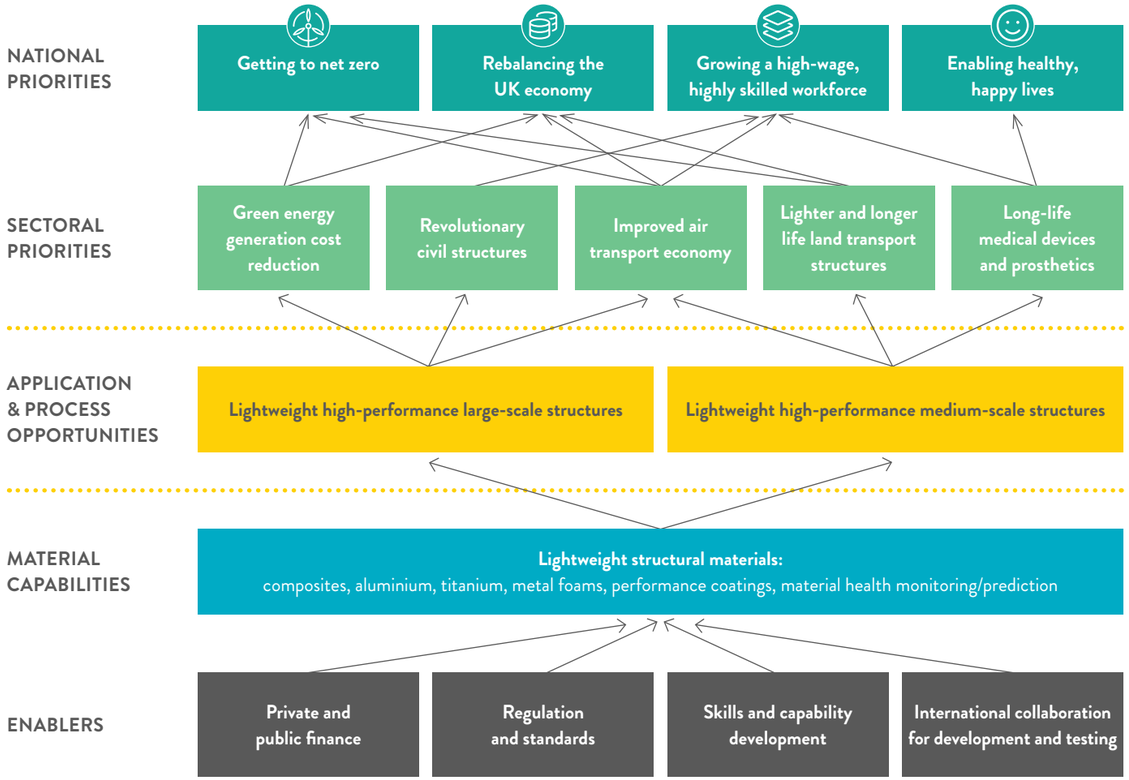


This strategy and its actions will continue to evolve into the future. The leadership group will continuously update it, reflecting the constantly developing nature of the UK's materials innovation capabilities and ecosystem.

KEY PROCESS	INPUTS	ACTIVITIES	OUTPUTS
Materials innovation leadership group	• Terms of reference • Innovation enablers from the opportunity workstreams	• A steering group that owns and champions the strategy. • Receiving outputs from the opportunity workstreams and implementing them on a rolling basis.	• Delivery of the strategy and updates to it.
Identification of high-priority areas	• National priorities • Industry cluster	• Creation of a heat map of high-priority cross-sector areas using research insights, stakeholders contributions and workshops.	• A list of high-priority areas for further development.
Opportunity workstreams	• High-priority areas	• Each workstream investigates the selected high-priority area through a series of strategy development processes. • This includes exploratory workshops, background desk research, and the synthesis of findings into a landscape definition of the area, including materials innovation opportunities and their potential impacts.	• A list of specific, prioritised materials innovation opportunities to be supported by enabling actions from the leadership group.
Strategy consolidation	• Opportunity workstream landscape findings and innovation opportunities	• Consolidation of the outputs of the opportunity workstreams and the leadership group's activities, identifying cross-cutting materials capabilities, enabling actions, and recommendations for interventions in the process. • Validation through stakeholder engagement.	• An evolving strategy, including recommended actions and policy interventions.

ILLUSTRATIVE OUTPUT: A SUMMARY LANDSCAPE FOR LIGHTWEIGHT STRUCTURAL MATERIALS

The opportunity workstream activities will explore high-priority areas and produce a multi-dimensional understanding of their potential impact for materials innovation. This will be a snapshot of all value-creating possibilities, their policy and market pulls, capabilities, and enablers.



CASE STUDY: **IMPLANTABLE BIOELECTRONICS**

ELECTRIC FIELD THERAPY IMPLANTS

QV Bioelectronics is targeting brain tumours by combining cutting-edge medical research and materials innovation.

Glioblastoma is terminal and has amongst the worst clinical outcomes of any type of cancer. However, an emerging treatment – electric field therapy (EFT) – uses electricity to interrupt cancer growth and has been shown in clinical trials to extend patient lifetimes by almost 50%.

QV Bioelectronics, a medical device start-up based in the North West of England, is developing the world's first surgically implantable EFT device, GRACE. It is designed to be implanted into the brain during an existing surgical procedure, enabling delivery of the therapeutic electrical fields directly to the site of the cancer cells. This delivers the following benefits:

- Continuous treatment for patients, with the aim of improving overall survival.
- Treating patients almost immediately after surgery with no major delay.
- No major negative impact on patient quality of life.
- Improved cost-effectiveness of the treatment.

The surgical approach of GRACE is only possible with QV's proprietary advanced materials electrode technology, based on conductive polymers, that are biocompatible and have world-leading electrical properties.

To date, QV Bioelectronics has raised £5 million in a mixture of venture capital investments and grant funding to support development of their technology. The company expects to progress to human clinical trials of GRACE in the coming years.

NEXT STEPS

The future development of a robust UK materials innovation strategy will be informed by this framework.

To make efficient, timely progress, and deliver actionable insights, a set of guiding principles will be carried into the next phase. These are:

- **Strive for simplicity, whilst not being simplistic.**
- **Lead by value across economic, environmental and societal impacts.**
- **Break down barriers between sectors and prioritise cross-sector areas of high potential value.**
- **Create a rolling pipeline of insight and priority actions.**
- **Maintain engagement across the full materials innovation ecosystem.**

This consultation document is intended as an input to the future development of the strategy. Following feedback from key stakeholders, the following immediate actions are proposed:

- **Launch the strategy framework and create collective buy-in to resource the strategy's development.**
- **Identify and establish the materials innovation leadership group and associated governance arrangements.**
- **Finalise the methodology under that governance.**
- **Appoint delivery support suppliers.**
- **Build communication channels across industry, academia and key public and private sector organisations to enable participation throughout the strategy's development.**

We invite a broad range of participants from the materials innovation ecosystem to join in with both strategic leadership and detailed exploration activities. Participants will benefit from the new networks, communities, insights, and business opportunities that this process aims to develop.

Please contact the strategy's team via **info@royce.ac.uk** to join the consultation network.

SCAN THIS QR CODE FOR MORE INFORMATION

HENRY ROYCE INSTITUTE

The Henry Royce Institute was established to ensure the UK can exploit its world-leading expertise in advanced materials and accelerate innovation from discovery to application. With over £200 million of facilities in dedicated state-of-the art laboratories, Royce is ensuring that academics and industry in the UK's materials community have access to world-class research capabilities, infrastructure, expertise, and skills development.

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