Fieldwork Robotics | Exscientia | Portugal | TVG

news from the frontier

May 2022

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WELL PLACED TO WITHSTAND THE GLOBAL TUMULT

A lot has happened since the last edition of this newsletter. Inflation, the Russian invasion of Ukraine and the continuing COVID-19 pandemic, particularly in China, have compounded existing uncertainties around the domestic and global economies and their knock-on impacts on markets.

Although Frontier IP is not immune, we are in a strong place to withstand the pressures and thrive. Following the successful listing of Exscientia on the Nasdaq Global Select Market for a value of $2.9 billion last year, we sold 25 per cent of our stake for £6.1 million. As our first exit, albeit partial, from one of our portfolio companies, it represented an important milestone in our history and ensures our balance sheet is strong.

I am also delighted to say that across the portfolio, commercial and technical progress continues to be excellent. Our companies are addressing important challenges and are approaching significant inflection points. Robot-picked raspberries are now available in supermarkets, thanks to Fieldwork Robotics, which is now commercially harvesting in Portugal; Celerum has signed its first contract; and TVG continues to make good progress with its COVID-19 vaccine.

There's also a spotlight on some of our activities in Portugal and a look at wonder material graphene, where we see real potential for it to transform optoelectronics. Reality will be matching the hype soon.

Neil Crabb, Chief Executive Officer

ROBOT-PICKED RASPBERRIES ARRIVE IN THE SHOPS

Raspberries picked by Fieldwork Robotics' robot harvesting technology are now on sale in supermarkets following the launch of commercial operations.

Fieldwork has deployed two robots to Portugal, where the fruit can be harvested throughout the year.

They are successfully working autonomously, with the focus now on making the technology faster so that each four-armed robot can increase the amount it can pick from the current 1kg per hour to 2kg. Changes to the materials used in making the robots have also reduced production costs by more than 20 per cent. You can see the robot in action here.

The move marks an important milestone in achieving the company's ambitions to create robots able to work alongside people at a time when agriculture worldwide is facing labour shortages.

Fieldwork is currently developing two systems. First – and the one being used for raspberry picking – is a vertical harvester that can be adjusted depending on the height of the fruit plants.

The second is a horizontal platform designed mainly for vegetable harvesting. The company is developing a cauliflower harvester in collaboration with Bonduelle, one of the world's largest vegetable producers.

Fieldwork's robots are now harvesting commercially in Portugal

Chief Executive Rui Andres said: "Through our technological advances and commercial deployments, we are making real progress. Raspberries are very sensitive, so we have had to develop technology that can apply enough pressure to release the fruit from the stem without damaging it.

"Our sensors are now so advanced that they can tell if the fruit is ready to be harvested or not, meaning the robot will only pick what can be sold."

Fieldwork raised £675,000 last year through an equity funding round and has been granted more than £850,000 from Innovate UK to accelerate scale up of the technology.

Portugal spotlight: Frontier IP has been operating for six years in Portugal, where we partner with two institutions, FCT NOVA and INESC TEC, and currently have four spin out companies: AquaInSilico, NTPE, InSignals Neurotech, and Des Solutio.

FRONTIER IP AND AQUAINSILICO WIN UK DIT INNOVATION AWARD

Frontier IP has won an Innovation and Business Development Award from the UK Department for International Trade in Portugal for our work in collaboration with portfolio company AquaInSilico.

AquaInSilico is developing advanced software to improve wastewater management and the recovery of potentially harmful yet valuable and recyclable products such as nutrients, like phosphorus and organic matter, that can be used to produce biofertilisers, biofuels and electricity.

The DIT made the award for the company's role in the United Nations Sustainable Development Programme's Ocean Innovation Challenge. Called Phos-Value, the project is helping to conserve one of the world's most diverse marine environments around Cape Verde and improve water quality for the archipelago's inhabitants.

Phos-Value is proceeding well, and you can learn more about the difference the project is making here.

The AquaInSilico team (l to r): Pedro Ribeiro, Mariana Matos, Jorge Santos, Virginia Carvalho

INSIGNALS' LEAP FORWARD IN MONITORING MOTOR SYMPTOMS

InSignals Neurotech has made significant progress with its novel technology to analyse the motor symptoms of Parkinson's disease and other neurological disorders.

The company is developing wireless wearable devices to precisely measure motor symptoms, such as wrist rigidity, in real time to help surgeons and neurologists measure and assess the extent of disease.

Initial prototypes of the device were designed to help them identify the best locations to place implants for deep brain stimulation surgery for treating Parkinson's disease.

The improved device (pictured) can now be used to monitor symptoms more broadly for disease tracking, creating accurate symptom records to help understand better how patients are responding to treatment. The newest device is also smaller than previous iterations and has more features to aid neurologists. It has already attracted interest from several multinational medical device manufacturers.

InSignals is now setting up a multi-centre clinical study to test the updated devices. The company has already received feedback from doctors and neuroscientists at the University of Maastricht and from attendees at the Summit on the Future for Deep Brain Stimulation, held at the University of Würzburg.

The device helps doctors evaluate wrist rigidity, a key symptom of many neurological disorders. Wrist rigidity is the main means of deciding where to place an implant, in particular, and a relevant symptom when assessing disease progression and response to medication.

InSignals is a spin out from the Portuguese Institute for Systems and Computer Engineering, Technology and Science with the support of São João University Hospital, part of the University of Porto.

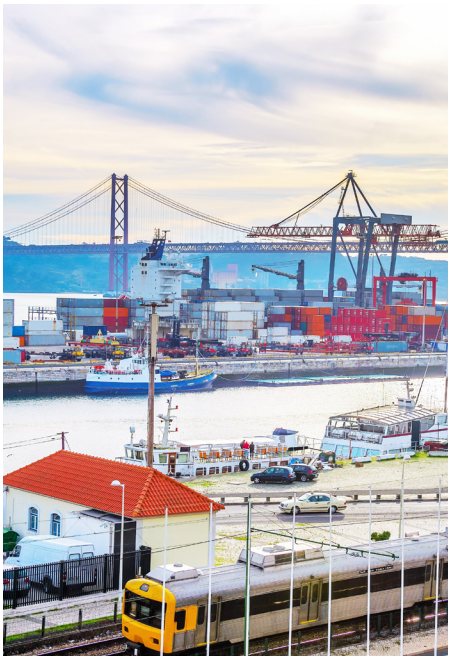
EMPORIA4KT GAINS PROJECT EXTENSION AND FUNDING AFTER INITIAL SUCCESSES

Emporia4KT, a pan-European project to improve technology transfer across the marine and coastal economies in the Atlantic, has gained further funding and a 16 month extension to build on its success to date.

Frontier IP was one of 14 original partners in the project from France, Ireland, Portugal, Spain and the UK aiming to improve technology transfer across the marine and coastal economies, the so-called blue economy, of Europe's Atlantic seaboard. The additional money has come from the European Union's INTERREG Atlantic Area funding programme, the original provider, and means the project will now run until 30 June next year.

The first phase of Emporia4KT concluded successfully in January 2022. It saw the creation and application of the Blue Economy Technology Transfer (BETT) programme, a pilot training scheme to support researchers commercialising their early-stage technologies. As part of BETT, Frontier IP helped to create the Academia Innovation Enhancer tool, which the EU selected as an example of best practice for its EU Knowledge Valorisation platform.

Following this success, the BETT programme is to be launched in the Canary Islands through cooperation with a new project partner, the La Palma Research centre. This will allow the programme and tools to be further refined and support Emporia4KT in developing recommendations for how programmes and tools might be applied more widely through the Atlantic Area.



TVG IS STARTING CHALLENGE TRIALS FOR COVID-19 VACCINE

Associate Professor Dr Michael Jarvis, the CSO of TVG

The Vaccine Group (TVG) is beginNING challenge trials in hamsters for its COVID-19 vaccine candidate for use in humans, a vital next step in its development.

If successful, the trials will provide Proof of Concept and pave the way for potential Phase I human clinical trials later this year. The move follows successful pre-clinical pig trials last year. These showed the TVG candidate stimulated a strong T cell response to SARS-CoV-2, the virus that causes COVID-19, and SARS-CoV-1 to demonstrate the potential for broad immunity against current and future variants of the disease.

Most COVID-19 vaccines either on the market or under development attack the virus directly once it has replicated by stimulating an antibody response to the spike protein on the surface of the virus. The spike protein is the likeliest part of the virus to mutate, giving rise to variants, such omnicron, which are able to evade antibodies.

TVG's vaccine candidate stimulates a subset of T cells called Cytotoxic T cells, or CTLs. CTLs destroy cells infected by the virus swiftly, before it can replicate. Its success against SARS-CoV-1, the cause of the original SARS outbreak in 2003, in the trials provides confidence it will be effective against SARS-CoV-2 variants.

Vaccine Solutions for the 21st Century

The vaccine candidate is based on TVG's novel herpesvirus platform, which is also being used to develop several other vaccines for use in animals. These include those to combat lassa fever, Ebola, and African Swine Fever. The company has signed its first commercial collaboration with ECO Animal Health for vaccines against porcine reproductive and respiratory virus syndrome.

EXSCIENTIA REVEALS SANOFI DEAL WORTH UP TO $5.3bn AND ENDS YEAR ON A HIGH

A ground-breaking research collaboration and licensing agreement between pharmaceutical multinational Sanofi and Exscientia will focus on the development of up to 15 new drug candidates across oncology and immunology.

Candidates will be developed using Exscientia's novel AI-driven drug discovery platform, and several targets have already been identified. As part of the agreement, which builds on a previous collaboration between the two companies, Sanofi has paid Exscientia $100 million in cash upfront and there is a potential for a further $5.2 billion in total milestone payments and royalties.

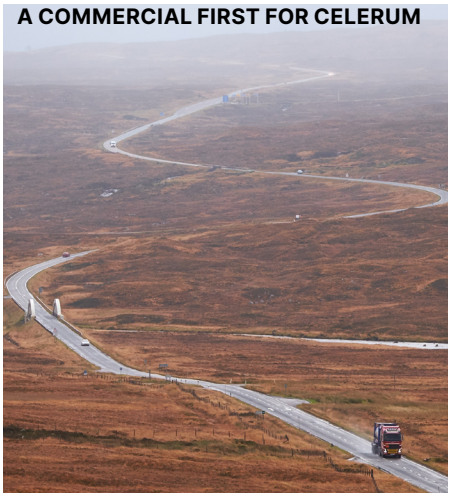
The agreement represented a strong start to 2022 for Exscientia. In recently announced annual results, the company said it ended the year to December 2021 with $758.9 million of cash on the balance sheet, having generated $85.3 million from collaborations.

Exscientia has also formed a joint programme with the University of Oxford Target Discovery Institute to expedite early-stage drug discovery research. Called Xcellomics, the programme aims to develop candidates for unmet medical needs and to bring therapies to patients sooner.

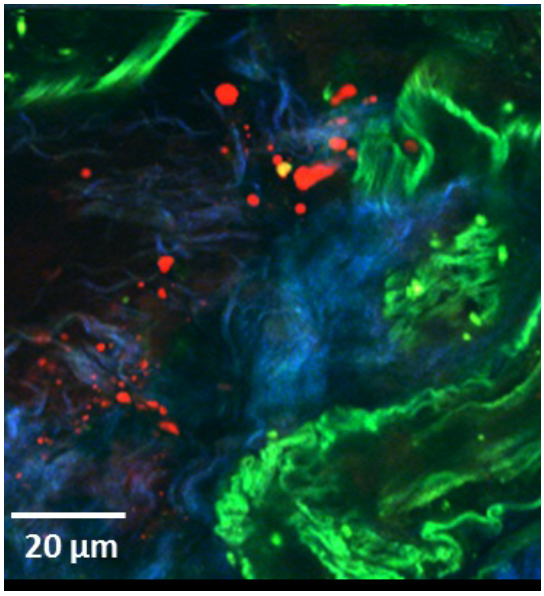
The company has also appointed Professor Charlotte Deane as Chief Scientist of Biologics AI. Professor Deane is one of the UK's leading bioinformaticians and is Professor of Structural Bioinformatics at the University of Oxford and leads the Oxford Protein Informatics Group. She was a member of SAGE.

Frontier IP is a founding shareholder in Exscientia, which floated on the Nasdaq Global Select Market last year for a valuation of $2.9 billion. We sold a quarter of our holding earlier this year, raising £6.1 million.

A COMMERCIAL FIRST FOR CELERUM



Celerum has launched its first commercial product based on its novel Nature Inspired Computing AI. Truck Logistics System (TLS) is aimed at companies operating small to medium-sized truck fleets, such as hauliers, suppliers and retailers. TLS has won its first customer, a road haulier operating 75 trucks and 150 trailers and is bedding in well.



CAMBRIDGE RAMAN IMAGING LEADS €3.3M PAN-EUROPEAN INNOVATION COUNCIL PROJECT TO TRANSFORM CANCER DIAGNOSIS AND TREATMENT

A project coordinated by Cambridge Raman Imaging aims to transform cancer diagnosis and treatment by developing a medical device using artificial intelligence and high-speed, low-cost Raman digital imaging technology.

The technology will analyse the molecular composition of patient tissue samples to distinguish cancerous from healthy cells without the need for chemical staining – and provide a basis for personalised treatments.

Because the technology creates digital images, they can be viewed remotely by histopathologists, allowing them to work more efficiently and support regions short of qualified staff.

Called CHARM, the project is a pan-European collaboration between CRI, the University of Cambridge, the Politecnico Di Milano, Consiglio Nazionale Delle Ricerche, the Jena University Hospital, and project management firm IN s.r.l. CHARM has been awarded a €3.3 million grant by the European Innovation Council, of which €1.3 million will go to CRI's wholly-owned Italian subsidiary.

It is the second pan-European project with which the company is involved. CRIMSON is developing technology to monitor diseases unfolding in cells in real time. This has the potential to deepen understanding of the cellular origins of disease and enable the development of new treatments.

GRAPHENE: THE WONDER MATERIAL FULFILLING ITS PROMISE

Frontier IP currently has two graphene spin outs, Cambridge Raman Imaging and CamGraPhIC. Here we explain more about graphene, how it is made and why after decades it is now starting to achieve its potential for transformative impact across several industries.

Graphene has been touted as a wonder material with a host of substantial benefits across many industries since it was first synthesised by a pair of University of Manchester academics armed with a pencil and a roll of sticky tape in 2004. It is the strongest material in the world, flexible and light, and has extraordinary electrical, thermal and optical properties.

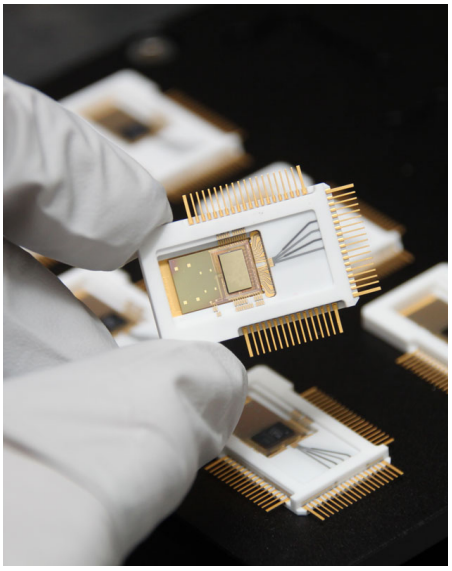
These have seen graphene's use being explored in applications as varied as coatings, composites, batteries, medicines, photonics and optoelectronics. Some believe that graphene and graphene-related materials could be enabling materials across nearly all fields of technology. It is used in smartphones, sports equipment, cars, clothing and paints. But it has yet to achieve the impact so often promised. A stronger training shoe is unlikely to change the world. As yet no significant applications have been commercialised on the scale anticipated more than 15 years ago.

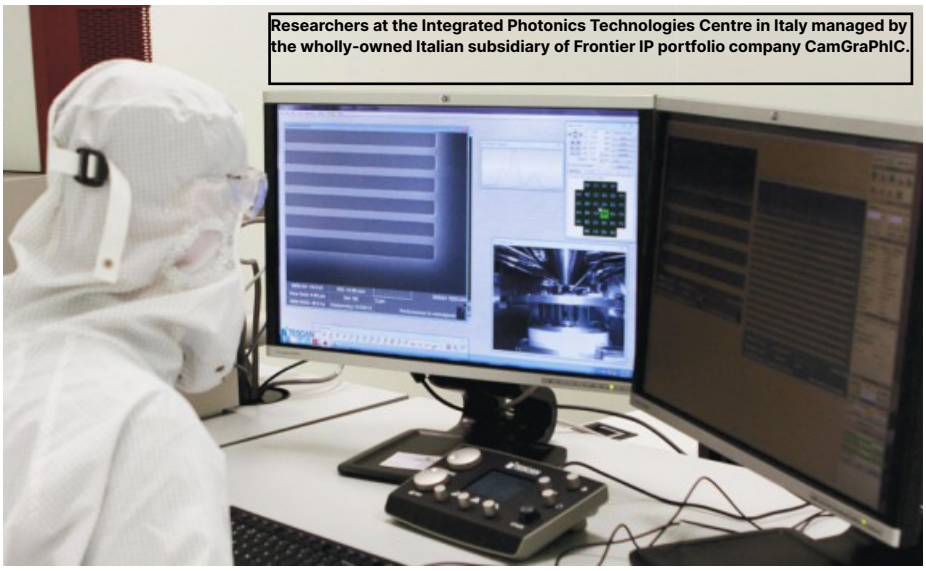
This lack of commercialisation at scale is reflected in there having been no significant scale up in graphene manufacture. Demand is currently estimated at below 1,000 tons a year. We believe, however, that graphene's true potential is close to being realised, and will have its biggest impact on photonics and optoelectronics.

What is graphene?

Graphene was originally derived from graphite. On the strictest definition, it is a one-atom-thick sheet of carbon atoms arranged in a hexagonal honeycomb lattice. It is extremely thin. A single gramme can cover an area the size of a football field. For this reason, graphene and graphene-related materials are referred to as two dimensional materials.

The Graphene Council says that the term "graphene" can be applied to material that is up to and including 10 layers of carbon atoms. Any thicker is technically a graphite nanoflake. Graphene-related materials are graphene with an added element, such as boron, to further enhance a particular property – a process known as functionalisation.





Researchers at the Integrated Photonics Technologies Centre in Italy managed by the wholly-owned Italian subsidiary of Frontier IP portfolio company CamGraPhIC.

Graphene flakes and their uses

There are two broad ways of manufacturing graphene: graphene flakes and chemical vapour deposition (CVD): exfoliation of large pieces of graphite, or growing sheets one layer at a time. Flakes are currently used in applications such as composite materials, coatings, including inks and paints, sensors, lasers and in medicines.

They are made directly by exfoliating graphite blocks either mechanically or by using chemicals. There are two main mechanical processes: physically shearing a graphite block or immersing a block in a liquid mixture and using sound waves to vibrate flakes off. Chemical processes create a graphene oxide, which is reduced to a graphene flake.

Neither process produces consistent results: mechanical processes produce flakes that range in thickness from a single layer to more than 10 layers and varying widths; while chemical methods result in graphene with impurities and a poor crystalline structure.

Despite this, graphene flakes still have advantages denied to graphite and other carbon materials, such as strength, stability, and relatively high thermal and electrical conductivity (although lower than pure graphene).

Functionalising graphene adds cost but does significantly improve the required properties that are being sought. This is likely to be the route for larger scale applications but for more specialist areas, this can also be achieved by other means too.

The benefits of chemical vapour deposition

Chemical vapour deposition one layer at a time results in a much purer, higher quality graphene, extending the scope of the material's application into a host of other technologies and into areas where it has the potential to have a major impact.

No graphite is involved in the process. Instead, a carbon-rich gas, such as methane, is mixed with a reactant, which causes graphene to be deposited on a substrate in a single layer to create a graphene sheet, or

film. The manufacturing process is high cost and consumes a lot of energy, However, the past decade has seen significant advances in manufacturing at scale.

Graphene produced in this way can be used in high-end applications, such as photoelectronics, optoelectronics, flexible displays, photonics, and semiconductors. Although manufacturing costs more, the graphene is still derived from carbon, which is easily available, unlike the rare earth minerals traditionally used in semiconductors. And the purer graphene is being used for higher value applications.

These include data and telecommunications infrastructure. Among other things future developments in areas such as 5G and 6G networks and the Internet of Things will need better photonics – technology that uses light to transmit and process information – to happen. In laboratory conditions, graphene has already shown itself to be the ideal material to enable faster transmission while consuming much less energy.

This is just one example of the material's potential for transformative impact. There will be many more to come.