SPEARHEADS TAKE AIM FOR INNOVATION

By: Rebecca Waters

Of all of the Graphene Flagship's initiatives, it's possible that the Spearhead Projects are the most effective tool for advancing our goal to bring graphene out of the lab and onto the market. The Spearhead Projects are company-led initiatives with well-defined, application-oriented objectives, aiming to produce industrial prototypes using graphene and layered materials within two years.

In fact, the Spearhead Projects' objectives are so important to the Graphene Flagship that roughly 30% of the budget allocated to the current phase of the project is assigned to them. "This is a bold move that shows our firm commitment to maximising the impact of the Graphene Flagship," says Graphene Flagship Director Jari Kinaret.

Here, we take a look at three Spearhead Projects that are driving graphene-based technology forward on the road to a better world.

GRAPHENE COLLISION AVOIDANCE SYSTEMS FOR AUTONOMOUS VEHICLES

Autonomous driving is the future – but is it safe? With current technology, driving in darkness or adverse weather conditions such as rain, fog and snow could be dangerous. The AUTOVISION Spearhead Project is developing a new high-resolution image sensor for autonomous vehicles, which can detect obstacles and road curvature even in extreme and difficult driving conditions.

Currently, self-driving cars use visible cameras, but in dense fog, these cameras are insufficient. Autonomous cars will also use LIDAR sensors, relying on pulsed laser to measure distances and constantly scan the area around them. However, this is a relatively slow-processing technology in comparison with the potential of next-generation imaging systems.

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The AUTOVISION project, led by ICFO in Barcelona, benefits from collaboration with industrial partners such as Aixtron in the UK and Veoneer in Sweden. The project will help to make safe the deployment of autonomous vehicles possible. Afterall, the success of autonomous driving will largely depend on how split-second moments of imminent danger are handled.

Over the course of three years, AUTOVISION will produce complementary metal-oxide semiconductor (CMOS) graphene quantum dot image sensors in prototype sensor systems, ready for uptake in the automotive sector. Across the duration of the project, the image sensor under development is set to take huge leaps in terms of sensitivity, operation speed and pixel size.

In the wider electronics industry, CMOSs are at the heart of technological revolution. They have enabled compact and low cost micro-electronic circuits and imaging systems, but the diversification of this technology in applications other than microcircuits and visible light cameras has seen limited progress. This is due to the difficulty of combining CMOSs with semiconductors other than silicon.

Recently, monolithic integration of graphene into a CMOS-integrated circuit was made possible, enabling high-resolution image sensing that detects UV, visible, infrared and even terahertz frequencies.

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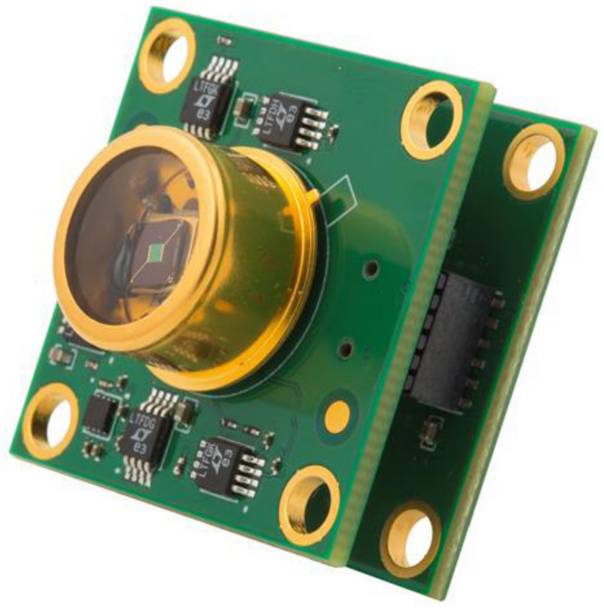

This graphene broadband infrared imager for camera systems allows users to see beyond the capabilities of the human eye, to quickly analyse and determine the chemical composition of organic products such as food. Image: Emberion

The sensor's ability to see in the infrared – effectively night vision – means that same graphene CMOS sensors can be used as part of a self-driving car's automatic brake system, specifically in bad weather. This collision avoidance system is set to be a crucial application for graphene, and one that will support the wider uptake of autonomous driving technology.

NEXT-GENERATION AEROSPACE FILTRATION

Developed in collaboration with Naturality Research & Development in Spain, and Lufthansa Technik, Phi-Stone and Sixonia Tech in Germany, the AEROGrAFT Spearhead Project is on a mission to develop prototype self-cleaning air filters that utilise aero-graphene foam.

Developed with graphene's homogenous heat distribution properties in mind, the graphene-enabled foam will ensure even heat throughout the air filter, to elicit a consistent cleaning across all air filter surfaces. What's more, the self-cleaning air filters can use the same graphene foam repeatedly, for recurrent cleaning cycles, without losing stability.

Not only will the self-cleaning filter need servicing, but it can also be cleaned quicker. The team believes they will have developed a prototype filter that will take less than 30 minutes to clean within 18 months. By the end of the project in 2023, this will be below the ten-minute mark.

Moreover, this project will explore the use of graphene-foam filters to remove contaminants from cabin air. Their unique qualities allow them to filter out germs that current HEPA filters are unable to eliminate. Imagine the benefits of filters that can materially reduce the chance you'll get sick when you fly!

GRAPHENE BROADBAND INFRARED IMAGER FOR CAMERA SYSTEMS

The graphene broadband infrared imager for camera systems (GBIRCAM) Spearhead Project is developing a camera that detects visible light (VIS), near-infrared (NIR), short-wavelength infrared (SWIR) and long-wavelength infrared (LWIR) in one single superpixel device, which will reduce the costs of broad spectrum imaging.

The lower costs make imaging technology more accessible to businesses, not only for sensor integration in products, but also from an end-user perspective. The broad-spectrum capabilities allow users to see beyond the capabilities of the human eye, to quickly analyse and determine the chemical composition of organic products such as food. This means vastly improved safety for the food, pharmaceutical and security sectors, among others.

Led by industrial partner Emberion, the main goal of the GBIRCAM project is to produce a broadband and high resolution single focal plane array infrared imager that covers all wavebands from 400 nm to 14 micrometres. The final product will be capable of simultaneously detecting light in all atmospheric transmission bands, enabling many commercial applications.

Detectors for the wavebands of interest, from VIS to LWIR, currently rely on very different material solutions. There is an inherent difficulty in combining these on the single substrate needed for a compact imager, which is why broadband focal plane arrays do not yet exist on the market. Suitably functionalised graphene offers the opportunity to combine the needed waveband sensitivities onto a single substrate, enabling a broadband-sensitive single focal plane array.

The final broadband camera product, using a single detector array, is set to perform in an operational environment at a pre-commercial scale by the end of the three-year project.

Learn more about Graphene Flagship Spearhead Projects that support a more sustainable future on page 26.