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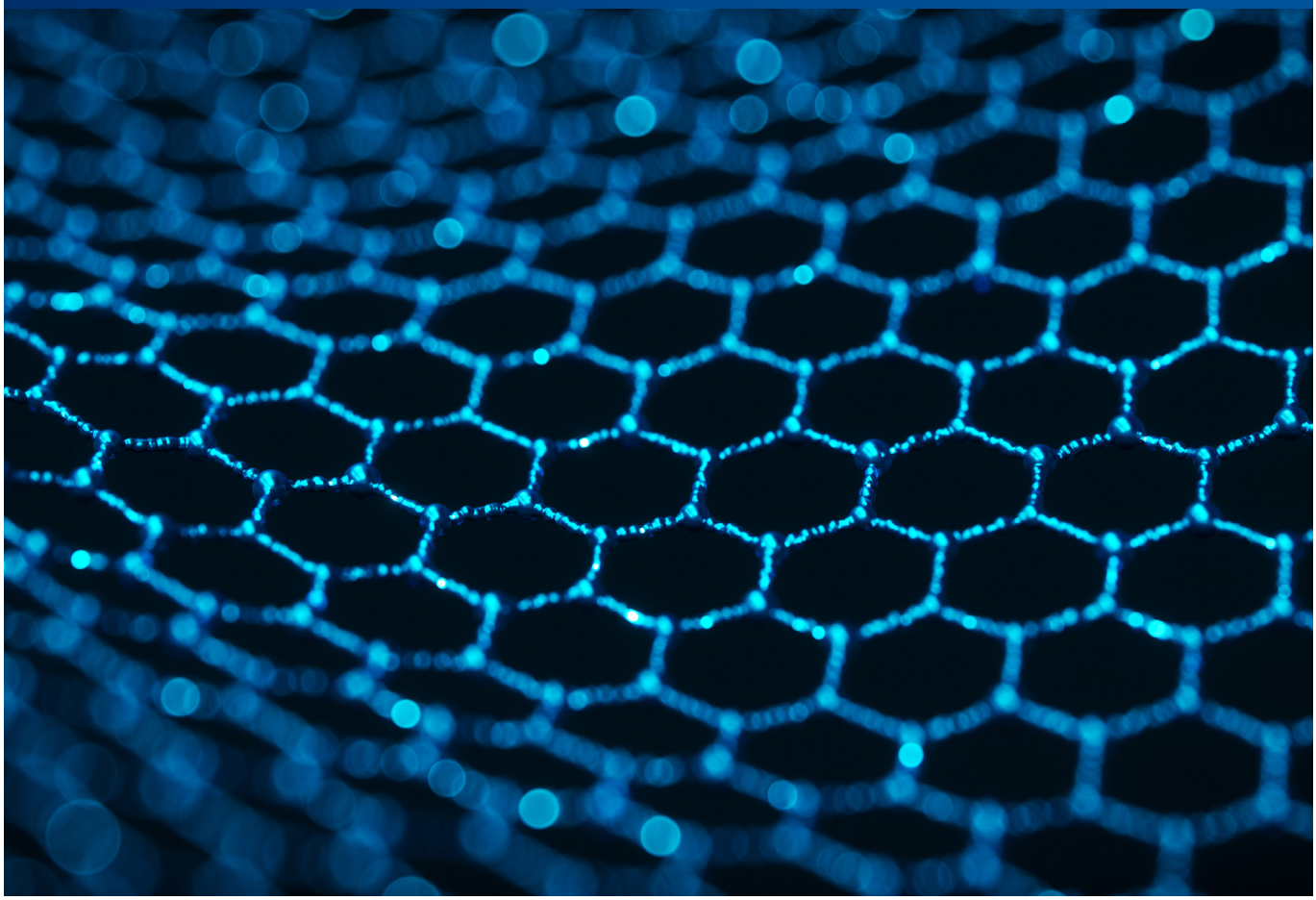
Real-time measurement of graphene quality boosts business case for Levidian

Methane emissions are one of the most potent drivers of climate change. Levidian's innovative LOOP technology offers a transformative solution by converting waste methane into valuable hydrogen and high-purity graphene, all in a single device housed in a shipping container. The technology provides heavy emitters and hard-to-abate industries with a route to decarbonise their processes and open up new revenue streams, unlocking decarbonisation projects that might not otherwise happen due to cost.

The graphene that LOOP produces is of an exceptionally high purity and consistency. "This is hugely important" explains Mike Lloyd, Head of Sustainability and Innovation Funding at Levidian. "Graphene has amazing physical and electrical properties that can benefit all sorts of products, from more efficient batteries to stronger concrete. But to produce any of these products at scale, we need large batches of consistent quality graphene, and that has historically been hard to generate. This is one of the problems our technology solves."



Challenge

Levidian currently has 10 LOOP devices in the field or under construction which will produce tonnes of graphene annually. To prove this graphene meets the high purity standards it promises to customers, Levidian must perform regular checks.

Currently, this quality control involves taking a minimum of three samples per batch, and shipping them from remote LOOP sites to test labs. There they require time-consuming sample preparation, analysis, and data processing.

Levidian wanted to explore whether it could do this quality control as part of a self-contained process in the LOOP system, providing real-time quality control.

Solution

To address this challenge, Levidian worked with NPL through the Analysis for Innovators (A4I) program.

The project trialled integrating NPL's portable Raman spectrometer – a device that uses the scattering of laser light to measure structural properties of materials – into Levidian's LOOP system, to measure the graphene being produced.

Drawing on NPL's measurement expertise, the combined team first performed Raman measurements of Levidian graphene in controlled conditions to establish baseline measurement data.

They then used the LOOP-installed spectrometer to measure graphene as it was produced, moving up in complexity from sample flakes that were separated from the batch, to in-situ batch measurements of the graphene powder post-production, to real-time measurements of the flow of powder as it was being produced. Results from each measurement condition were compared to baseline data, analysed, and protocols optimised to reach measurements comparable with the baseline, eventually demonstrating a viable setup for all three use cases.

Finally, NPL helped develop a package of analysis software, a dashboard and tools for data analysis, and a simple user interface that could turn the complex results into a simple Pass/Fail answer for non-expert users.

Impact

The project proved that it was possible to develop an in-situ graphene quality assurance device, by customising an off-the-shelf portable Raman spectrometer, and gave Levidian the knowledge and data to do that themselves.

"Once deployed, the in-line Raman testing device could save significant time and money through eliminating cumbersome lab-based quality checks and associated transportation costs," says Oliver Walker, Head of Production Technology at Levidian. "This could save us tens of thousands of pounds per year in lab analysis fees – and those savings will of course scale as we deploy more LOOP systems."

It could also avoid lost income in the event of contaminated batches, by spotting any drift and making corrections quickly. Walker calculates that, on the basis of 1% of batches being contaminated, early detection and prevention could save around £70k per year in material losses.

"And all of this sends a clear signal to customers that we take the quality and consistency of our graphene seriously" he adds. That in turn could lead to greater innovation in industries from aerospace to electronics, where graphene has long held promise of delivering innovations in strong, lightweight, and highly conductive materials, but has so far underwhelmed due in part to widespread issues around quality and consistency.

The device could also support product monitoring and improvement by linking any drift in quality directly to its cause, including changes in methane quality or possible degradation in system setups over time. Although this has not been an issue to date, it puts Levidian on the front foot should problems arise in the future.

Levidian is now looking to source its own spectrometers and make decisions about where and how to implement them. Initial use cases are likely to be on larger and remote systems where current quality control costs are high, and ability to respond to any drift in quality is reduced.

"Working with NPL has been highly beneficial," says Walker. "We've accessed a very high level of graphene and Raman spectroscopy expertise through a really collaborative project. Although there was a real business benefit, the project worked so well because we were all motivated by curiosity to find better ways to make complex measurements."

"Basically, the A4I project has shown us that a complex in-situ graphene quality assurance system can be done. It has shown us the instrument to use, how to optimise it for our needs, and how to collect the right data. That has given us the confidence to move forward with a potentially transformational product that, a year ago, we had no idea was even going to be possible."

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