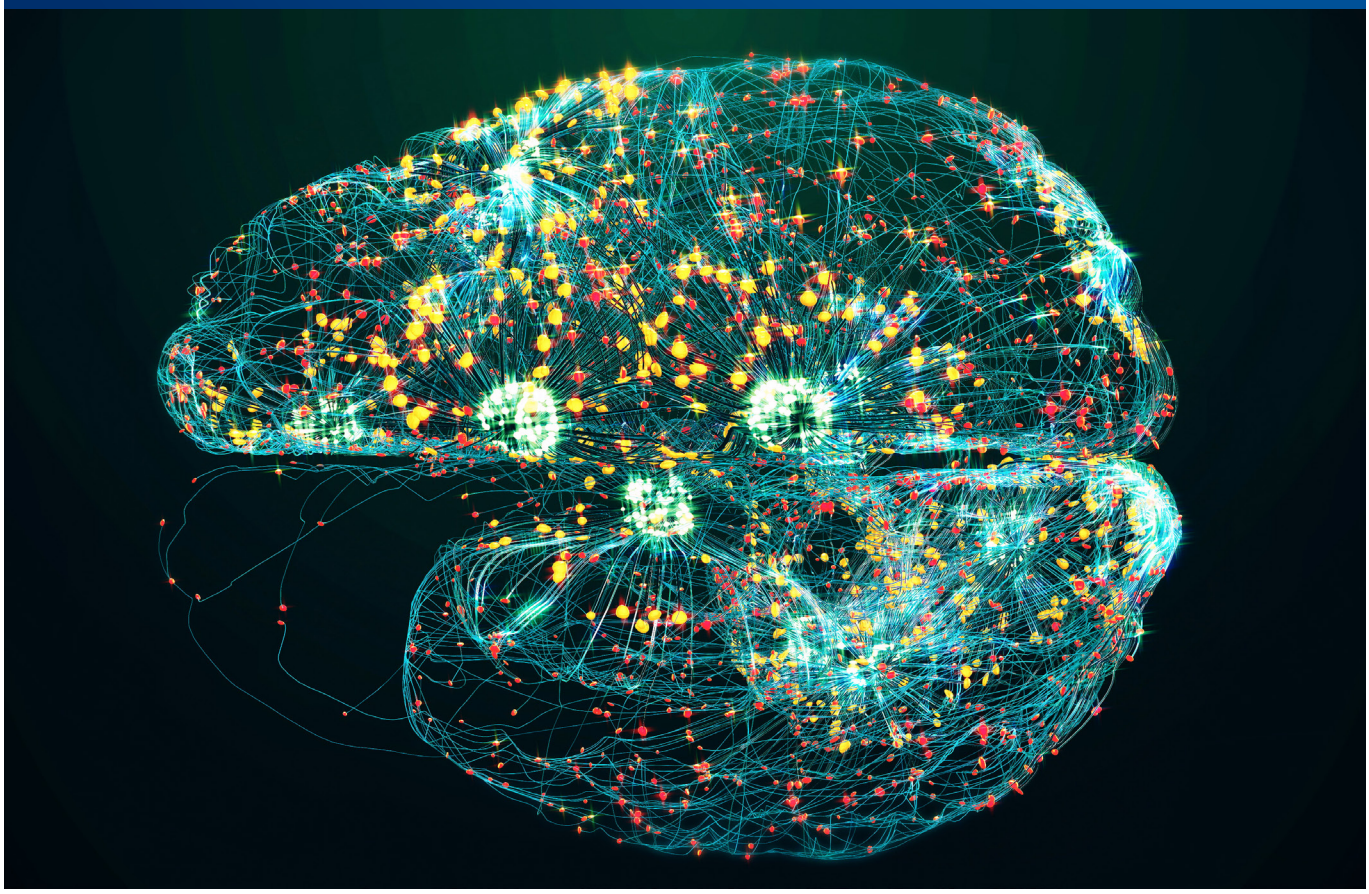
NPL
National Physical Laboratory

Dot to Dot – improving sensor performance with quantum technology

NPL has helped Quantum Science, a leading producer of quantum dot materials and technologies, to improve and validate the performance of its products, and increase sales to both new and existing customers through the Analysis for Innovators (A4I) programme.

Quantum Science is a leading British nanotechnology company specialising in the design, development and production of infrared quantum dot technologies. Quantum dots are nanoscale particles that have become pivotal for improving the performance of sensors and imaging in many industries, including medicine, security, and advanced consumer technologies. They have unique and tuneable electronic properties depending on their size, which can enhance image sensors by providing high sensitivity, broad spectrum response, and improved image quality. The tuneable properties of quantum dots, combined with their ability to integrate with existing technologies, makes them incredibly versatile and an important area of innovation in multiple sectors – from advancing medical imaging to improving night vision and screen technologies.



Challenge

The chemistry used to produce quantum dots involves the use of ligands – molecules that control their size, shape and stability so they can perform in specific ways for different applications.

Quantum Science needed to accurately measure the effects of using different ligands on its materials. This could help improve the design of its quantum dot technology and verify its performance.

This required sophisticated metrology equipment which Quantum Science did not have on-site. Quantum Science therefore applied for funding from the A4I programme to engage the support of the National Physical Laboratory (NPL).

Solution

NPL's team of surface analysis experts combined several complementary measurement techniques to assess both the chemical environment on the surface of the quantum dots, and its influence on the electronic energy levels produced, namely ultraviolet photoelectron spectroscopy (UPS); Kelvin probe microscopy (SKPM); X-ray photoelectron spectroscopy (XPS); and Raman spectroscopy. The team also used the unique facilities at the national laboratory to move samples between measurement stages in an inert environment to a vacuum using a glove box, preserving the accuracy and reliability of the measurement data.

By doing so, NPL could successfully demonstrate that the direct measurement and characterisation of Quantum Science's quantum dot surfaces was possible in an inert environment and was able to verify their performance with considerable accuracy. It also produced a significant amount of new data that expanded the team's understanding of the composition of its products and how they behave. This led to improvements to the company's fabrication processes and its choice of ligands for different applications.

Impact

The measurement and analysis conducted during this A4I project has enabled Quantum Science to maintain its world leadership in short wave infrared lead-free photodiode performance. As a result, it continues to work with leading chemical and sensor makers for supply agreements requiring kilograms of quantum dot materials.

"The enhanced competitiveness that stems from the project with NPL has ensured the company's position as the market leader in this industry," explains Dr Cong-Duan Vo, Chief Technology Officer at Quantum Science Ltd. "Access to the expertise and equipment at NPL has given us a way to improve and validate product performance that would simply not have been available to us without the A4I programme. The tangible results we have seen – both in terms of improved product performance and sales to new and existing customers – are a demonstration that A4I works for innovative growing businesses that need the highest quality of tools and experience to take them to the next level."

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