A4I Analysis for Innovators

Next-generation high-sensitivity X-ray detectors for a safer world

By using nanotechnology, SilverRay Ltd. is lowering the cost and increasing the sensitivity of X-ray detectors for use in medical, security and industrial settings.

Challenge

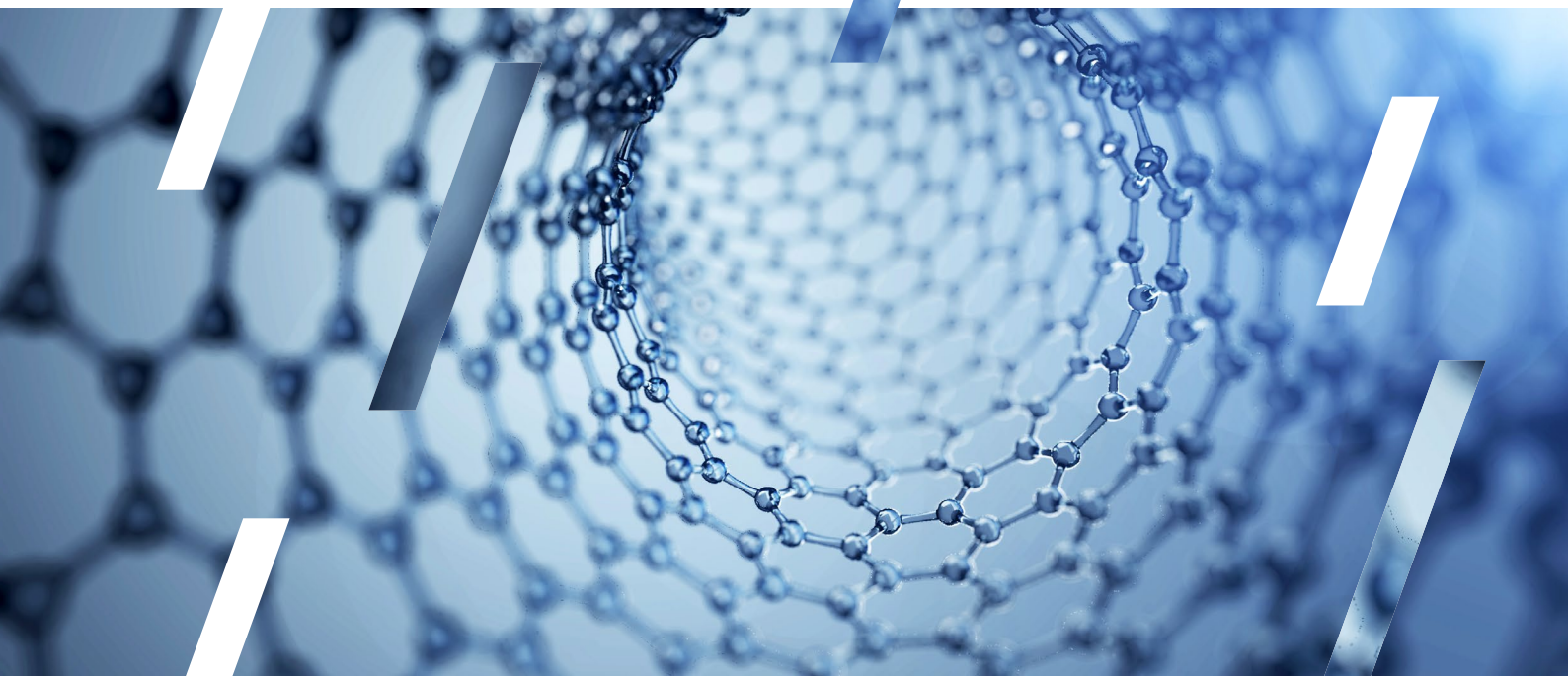
Cambridge-based SilverRay Ltd. is a seed stage spin-out from the Advanced Technology Institute at the University of Surrey. Its A4I project brings the business a step further in achieving its goal of being the leading provider of next-generation high-sensitivity X-ray detectors based on its proprietary 'X-ray sensitive ink'.

X-ray detectors are used in the medical sector in areas such as cancer therapy; across the aerospace, naval and civil engineering sectors for non-destructive testing; and in homeland security, such as baggage testing at airports. But current solid-state detectors are made from rigid, brittle materials that can make them both susceptible to damage and expensive to manufacture.

SilverRay Ltd.'s semiconductor ink can be applied on arbitrarily shaped surfaces, which has been difficult to do using current technology and would greatly broaden potential for its application, using techniques such as spray coating and 3D-printing.

The ink, which comprises a matrix network of both organic and inorganic materials, is up to three orders of magnitude more sensitive than conventional detectors based on the X-ray energy, while also operating at low voltage and therefore lower cost. But to date, its effectiveness has only been proved on small area detectors of less than $1cm^2$.

Nanoparticles in coatings tend to have a non-uniform distribution, both through the depth and from pixel-to-pixel. SilverRay Ltd. believed the positioning of the nanoparticles should be homogenised to maximise performance.



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Its A4I project saw SilverRay Ltd. partner with the National Physical Laboratory (NPL) and National Measurement Laboratory (NML), hosted at LGC, to analyse the distribution of nanoparticles over a range of length scales where a thick film is required for the ink to fully attenuate (weaken) incoming X-rays.

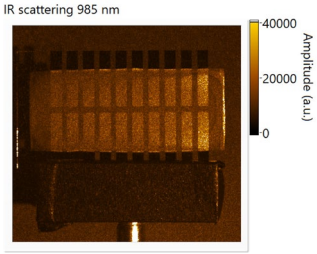
The expectation was that a homogenous distribution of nanoparticles would impact the signal-to-noise ratio generated at each pixel by the X-rays, by enabling a uniform ratio. This would allow the performance of the coating to be better understood and managed.

Solution

> SilverRay Ltd. needed to access more sensitive and precise equipment to assess the nanoparticle uniformity in thick films. Its A4I partners NPL and NML were able to deliver these solutions.

NPL provided a scaled-up laser system to accommodate samples up to 400cm^2, with lasers able to probe the full thickness of the film.

This enabled SilverRay Ltd. to analyse macroscopic nanoparticle variations over thick films, a technique not currently used in solution processed semiconductors. This allowed the business to optimise and validate the laser IR scattering system.



NML used their expertise to provide SilverRay Ltd. with quantitative results on the nanoparticle content and distribution within the thick films as well as a plan for determining the optimum total nanoparticles needed in the parent solution of the ink. These results have provided SilverRay Ltd. with a better understanding of the correlation between the coating technique and the nanoparticle distribution.

A4I

A4I is a programme that gives UK businesses, of any size, access to cutting-edge R&D expertise and facilities to help solve problems that they have been unable to tackle using standard techniques. The focus is on solving issues affecting product cost, reliability or lifetime and production problems.

NPL ktn TÜV SÜD National Engineering Laboratory NML UKRI Science and Technology Facilities Council

Impact

With nanoparticles being a key component of making the ink sensitive to X-rays, a uniform distribution of them is crucial to the performance of the X-ray detector.

The work undertaken by NPL and NML through the A4I project allowed SilverRay Ltd. to have a better understanding of the correlation between the coating technique and the nanoparticle uniformity.

Professor Ravi Silva, A4I Project Manager and Chief Technologist at SilverRay Ltd, said by gaining this knowledge, SilverRay Ltd. is better placed to produce thick ink coatings with a uniform distribution of nanoparticles on each pixel, ensuring the charge generation from each pixel due to X-rays is uniform and identical.

The project has equipped SilverRay Ltd. with this critical insight that it needed to maximise the performance of its technology and move forward with its research and development of a new, innovative product.

As such, it has taken a major step closer in bringing its low-cost high sensitivity X-ray ink to market and achieving its ambition of becoming a leading provider of next-generation X-ray detectors.

Professor Silva, who is also Director of the Advanced Technology Institute and Head of NanoElectronics Centre at the University of Surrey, said this now opens up a broad range of sectors where it could be deployed.

> *"The results of this project support work by SilverRay Ltd. on the development of low-cost high sensitivity X-ray detectors for a wide variety of applications across the medical, security and industrial sectors to create a safer and a smarter world."*

Professor Ravi Silva
A4I Project Manager and Chief Technologist at SilverRay Ltd.

SilverRay