CASE STUDY

Silicon Quantum Computing

Where semiconductors meet quantum and AI: building quantum processors one atom at a time

Visual representation of Watermelon™
Image courtesy of Silicon Quantum Computing

Silicon Quantum Computing is showing how advanced semiconductor manufacturing in Australia can turn world-leading research into globally significant quantum technologies – and make artificial intelligence faster and more efficient.

The next generation of computing will not be shaped by quantum technologies, semiconductors or AI alone. Increasingly, the opportunity lies where these technologies converge, as an Australian company has shown.

Silicon Quantum Computing (SQC), spun out of the University of New South Wales in 2017, is developing quantum systems that help conventional AI models identify complex patterns in sparse and time-series data that they otherwise struggle to see.

Their manufacturing technology, which has been built on 25 years of research, precisely positions individual phosphorus atoms into silicon– the same material at the heart of the conventional semiconductor chips found in phones and computers. Each phosphorus atom is positioned to an accuracy of 0.13 nanometres, roughly 100 times smaller than the world's leading semiconductor foundries like TSMC.

"Owning our globally unique, full-stack manufacturing capability here in Australia means we can design, produce, and test new quantum chips each week," said Professor Michelle Simmons, Founder and CEO of SQC.

SQC has used this technology to develop its first commercial product Watermelon™ – a quantum feature generator for machine learning, built on a silicon-based semiconductor platform but operating on quantum principles. Watermelon can help AI models train faster, with less reliance on power-hungry graphics processing units (GPUs) – the traditional semiconductor chips that power most AI. It has applications in areas such as defence, transport, telecommunications, energy, finance and high frequency trading. SQC's second commercial product, Quantum Twins™, uses the same atomic-precision chip-manufacturing approach to simulate chemistry and materials.

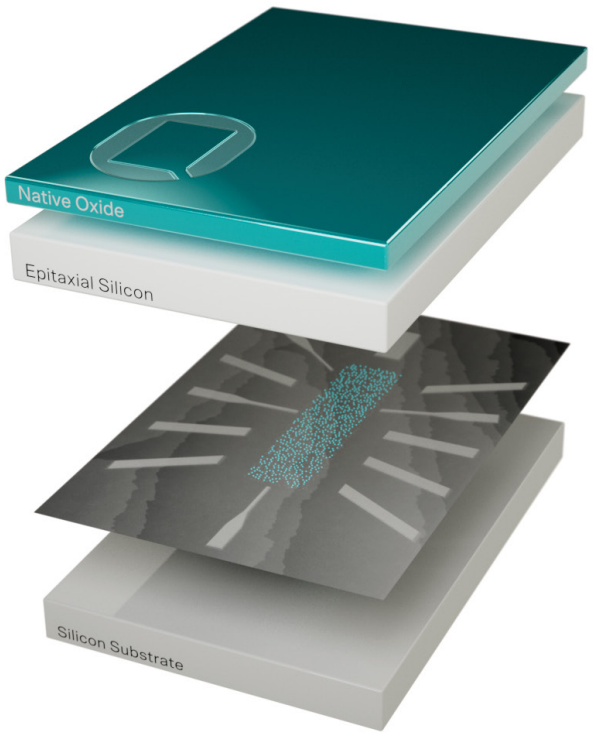
In a one-year trial with Telstra, an AI model using Watermelon predicted network metrics as accurately as Telstra's existing deep learning model, but took days to train rather than weeks.

"Hybrid architectures combining CPUs, GPUs and QPUs provide an immediate answer to the resource and power constraints seen among classical infrastructures today," Professor Michelle Simmons said.

Developing this type of advanced technology isn't easy. It requires highly specialised scientists and engineers, advanced nanofabrication equipment, ultra-pure materials, cryogenic testing, sophisticated electronics, software and sustained investment over many years.

SQC is building towards its ultimate goal to deliver a full-scale quantum computer by 2033. Recently, the Australian Government backed this onshore approach with a $60 million investment through the National Reconstruction Fund Corporation (NRFC) to expand SQC's quantum chip manufacturing capability.[40]

"For decades, Australia has established itself as an international hub for scientific excellence and innovation in quantum physics. Today, we are building on that excellence to create globally competitive products, companies and industries," Professor Michelle Simmons said.



Watermelon - chip rendering
Image courtesy of Silicon Quantum Computing