ASX Announcement (ASX: **AXE**) 8 January 2025

Archer improves quantum carbon film material and moves further towards quantum device realisation

Highlights

- Archer has improved the electron spin lifetime and sample-to-sample repeatability and uniformity for its manufacturable quantum carbon film.
- The carbon films deposited on quartz tubes exhibited spin lifetimes of 800 ns at room-temperature, with work underway to produce these spin lifetimes on silicon or quartz chips.
- The spin lifetimes and repeatability results move Archer towards realising devices like qubits and magnetic sensors/microscopes.
- Testing has started on devices fabricated in nanoscale islands of the carbon films to begin verification of key quantum properties.
- This development builds on the work done with Queen Mary University of London to demonstrate single spin readout in prototype qubits.
- Complementary work with The École Polytechnique Fédérale de Lausanne is underway to further develop the carbon films for spin readout and in carbon nano onions.

Archer Materials Limited ("Archer", the "Company", "ASX: AXE"), a semiconductor company advancing the quantum technology and medical diagnostics industries, has improved the electron spin lifetime of its novel manufacturable quantum carbon film (see ASX announcement on 30 September 2024) to 800 ns (nanosecond), up from 385 ns, and the films' reproducibility from sample-to-sample.

The improved electron spin lifetimes and the sample-to sample repeatability is an important development achieved by Archer, as it moves closer to realising devices like qubits and magnetic sensors. Archer will now look to reproduce and translate these results from the manufacturable carbon film base to silicon or quartz chips and then ensure the repeatability of the results between sample chips.

Spin lifetimes of 800 ns have been demonstrated under certain synthesis conditions, although some work is required to reproduce this on silicon (or other) substrates for chips. Uniformity across a wafer (ensuring consistent electrical and optical properties) and repeatability between sample chips (variability) is critical for reproducing the chips. Both uniformity and variability have been improved significantly, with standard deviations of 25-100% down to ~7%.

Realisation of quantum devices like qubits or quantum magnetic sensors requires demonstration of key quantum effects like Coulomb blockade (see announcement on 30 October 2024) and electrically detected magnetic resonance ("EDMR"). Some of these effects have been recently demonstrated and work continues at Queen Mary University of London ("QMUL") and The École Polytechnique Fédérale de Lausanne ("EPFL").

It is equally important to increase the spin lifetime and film reproducibility. For example, increasing towards 1 microsecond at room-temperature allows better functionality for the control and readout (the reading of the output of quantum information) qubits on the device.

In other technology, like quantum magnetometers, these lifetimes entitle sensitivities to incredibly small magnetic fields of nanotesla to microtesla ranges. To scale from single qubits or magnetic sensor pixels, the uniformity across a chip and from run-to-run is also critical.

The spin lifetimes have been verified on nanoislands of the films, showing no significant change of electron spin lifetime when patterning from bulk films to nanoscale dots, down to a size of 150 nanometers.

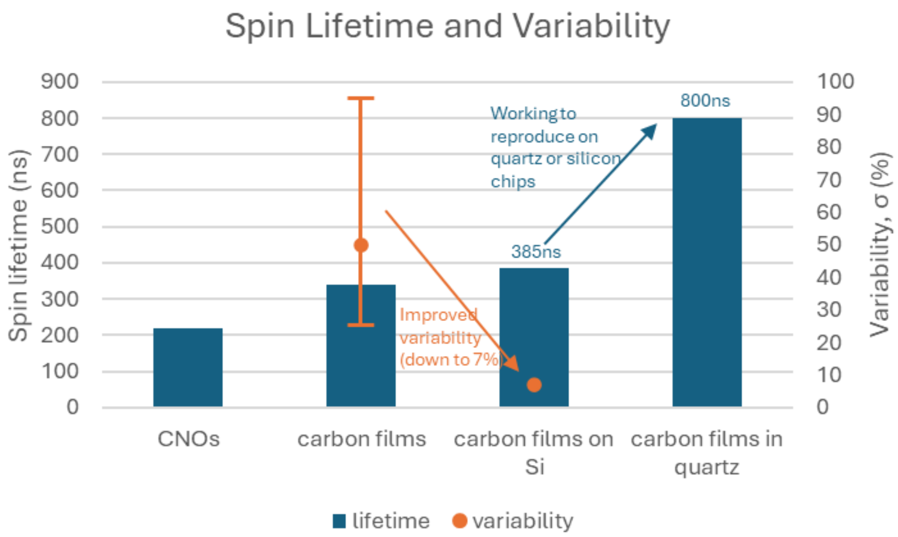

Figure 1. Electron spin-lifetime has been increased to 800 ns under certain conditions. Work is in progress to repeat this to increase from 385 to 800 ns on chips. Significant improvements have been made on uniformity. Variability has been driven down from >25% to ~7%.

The work Archer has contracted to EPFL is now focused on developing EDMR on the Company's carbon films. Initial attempts with electrical readout test devices built around Archer's carbon films are now underway. Once demonstrated, the team will work to implement quantum magnetic sensing and readout of qubits.

Electrical readout for quantum magnetic sensing is a key differentiator of Archer's technology over others, such as those based in diamond, where readout is implemented using an optical system.

Archer is continuing work at QMUL to extend the Coulomb blockade measurements through to single spin readout of a basic qubit based in carbon nano onions. Complementary work is underway within Archer, so it can extend this to carbon film-based qubits.

Commenting on the carbon film development, Greg English, Executive Chair of Archer, said,

"These advancements of Archer's manufacturable quantum carbon film material bring the 12CQ project closer to the readout of qubits and quantum magnetic sensing. Readout is an important component for the development of our quantum computing chip and bolstering magnetic sensing will go towards the work being done on our tunnel magnetoresistance sensors.

"The team is now working with its partners to research how its carbon films and carbon nano onions can get further towards a qubit, and the sensing and reading of quantum information at room temperature, to ultimately bring quantum computing and sensing to life in everyday environments."

The Board of Archer authorised this announcement to be given to ASX.

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About Archer

Archer is a technology company that operates within the semiconductor industry. The Company is developing advanced semiconductor devices, including chips relevant to quantum computing and medical diagnostics. Archer utilises its global partnerships to develop these technologies for potential deployment and use across multiple industries. www.archerx.com.au