

ASX Announcement ([ASX: AXE](#))

10 October 2022

Quantum information detected using a CMOS chip

Highlights

- Step-change advance in Archer's ^{12}CQ chip development with quantum information detected in its qubit material at room temperature using CMOS technology.
 - CMOS is a widely used semiconductor technology for building the chips found in most modern-day devices.
 - Integrating Archer's ^{12}CQ qubit material with CMOS technology provides a potential pathway for the development of practical quantum-enabled mobile devices.
 - Archer is the only ASX listed company and one of a few players in the world developing qubit processor technology.
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Archer Materials Limited ("Archer", the "Company", "[ASX: AXE](#)") is pleased to announce that the Company for the first time has used complementary metal-oxide-semiconductor ("CMOS") chip technology to detect quantum information in the ^{12}CQ qubit material at room temperature.

CMOS is the predominant technology used in designing chips in the semiconductor industry and it is broadly used today to form integrated circuits in numerous and varied applications. Processors, memory, and sensors are among many electronic devices that make use of this technology. The use of CMOS technology in the semiconductor industry is expected to continue in the long-term[†] therefore, it is important to demonstrate the functional incorporation of the ^{12}CQ qubit material with CMOS devices.

Archer has now shown that quantum information in the ^{12}CQ qubit material can be detected using:

- + high electron mobility transistor ("HEMT") technology, widely used in integrated circuits, for example in mobile phones
- + CMOS technology, the dominant integrated circuit technology used to make chips in the semiconductor industry

The quantum information in the ^{12}CQ qubit material is in the form of electron 'spin' states. Significant innovation is required to, firstly, design and develop on-chip devices that can detect the electron spin states in the ^{12}CQ qubit material under practical conditions, and secondly, have these devices manufactured using standard industrial semiconductor processes.

In a major technological feat, Archer has now used a single-chip integrated electron spin resonance detector based on CMOS technology to detect the quantum spin states in the as-prepared ^{12}CQ qubit material in a controlled atmosphere at room temperature (Image 1). The quantum states were found to be sufficiently well preserved when operating in the on-chip environment.

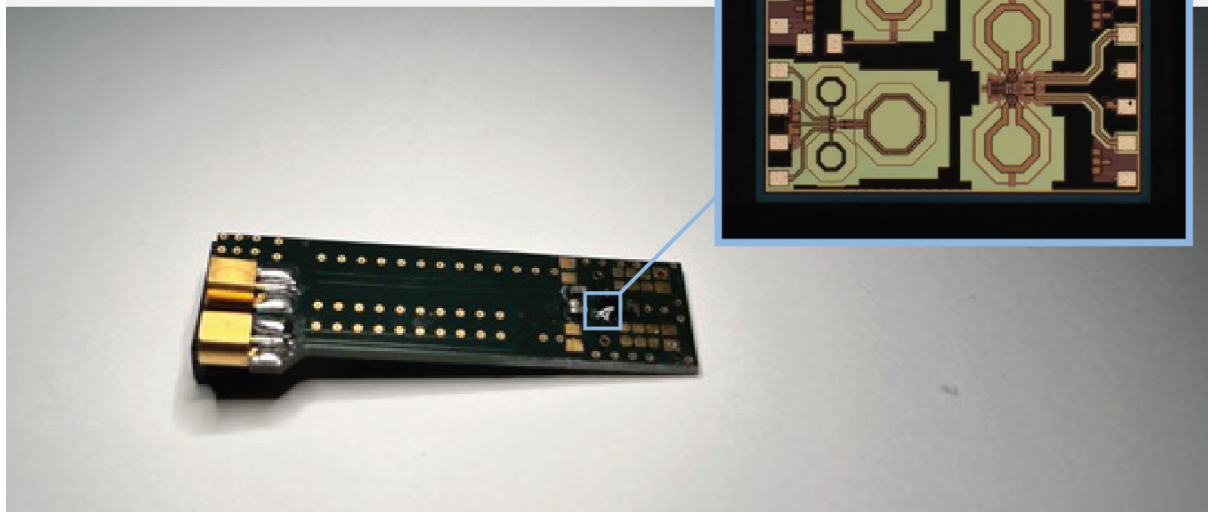
[†] <https://irds.ieee.org/>

The CMOS single-chip detectors:

- + were developed by Archer collaborators at EPFL[‡], are potentially industrially scalable, and were manufactured by Taiwan Semiconductor Manufacturing Company ([NYSE: TSM](https://www.tsmc.com))
- + apply the most widely adopted semiconductor technology used to build chips found in most modern-day devices
- + pave the way for implementing complex qubit control required in quantum circuits
- + were of sufficient sensitivity to detect the electron spin in a few picolitres (picolitre is a trillionth of a litre) of qubit material at room temperature

The signal characteristics obtained agreed with the well-studied, repeatable, and scientifically published results of measurements performed on macroscopic ('bulk') quantities of the qubit material using continuous wave electron spin resonance instruments[§].

Image 1. The integrated single-chip electron spin resonance detector based on CMOS technology. The CMOS single-chip detector is in a small region of approximately 0.5 mm x 0.5 mm on the printed circuit board (main image). The inset (right) shows a microscope image magnifying the spin-sensitive region in the CMOS device where the quantum spin states in Archer's ¹²CQ qubit material are detected at room temperature by the miniaturised on-chip componentry.



Commenting on the ¹²CQ chip progress, Archer CEO Dr Mohammad Choucair said: “The significance of the work to realise a CMOS chip that successfully detects the quantum spin states in our qubit material at room temperature cannot be understated and represents a step-change technological achievement in advancing Archer’s ¹²CQ quantum chip development.

“A key advantage of the new CMOS chip is that the componentry is made using standard and commercially available semiconductor fabrication technology.

“This achievement builds on the considerable progress Archer has made this year in the design and development of the ¹²CQ chip, which all link to the future operation of the technology.”

[‡] <https://www.epfl.ch/about/>

[§] <https://www.nature.com/articles/ncomms12232>

Further information on Archer's global competitive advantage and tech differentiation

The outcomes in this Announcement build on the significant technological progress made by Archer this year, including the development of a high electron mobility transistor ("HEMT") device for electron spin detection (ASX ann. [Feb 2021](#)). HEMT devices are generally based on gallium arsenide (GaAs) chips, while CMOS refers to both a type of circuitry design and the semiconductor device fabrication (manufacturing) processes used to implement that circuitry on the widely used silicon chips found in most modern day devices.

The scientific breakthrough made in 2016 to realise Archer's ¹²CQ qubit material is available online in the peer-reviewed scientific journal [Nature Communications](#), which reports the advantages, technological trade-offs, and the technological barriers that have been overcome towards realising practical quantum computing, over several other qubit proposals. Patent information related to the ¹²CQ chip qubit and proposed device(s) is available online, including examiner reports, through the [WIPO website](#).

About Archer

Archer is a technology company developing advanced semiconductor devices, including processor chips that are relevant to quantum computing. Archer is developing the ¹²CQ chip, a world-first qubit processor technology, that could potentially allow for quantum computing powered mobile devices ('QPMDs'). For more information, visit www.archerx.com.au.

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

General Enquiries

Mr Greg English
Executive Chairman

Dr Mohammad Choucair
Chief Executive Officer
Tel: +61 8 8272 3288

Media Enquiries

Mr James Galvin
Communications Manager
Email: hello@archerx.com.au

For more information about Archer's activities, please visit our:

Website:

<https://archerx.com.au/>

Twitter:

<https://twitter.com/archerxau>

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