Archer Materials Limited (ACN: 123 993 233)
Ground Floor, 28 Greenhill Road, SA 5034

ASX Announcement (ASX:**AXE**) 9 March 2020

Progress towards single qubit quantum measurements

Highlights

- Archer is on-track performing quantum measurements required to build an operational room-temperature qubit processor ("chip") prototype.
- Archer joins the Sydney Knowledge Hub to strategically engage with researchers in the Australian quantum computing economy.
- Collaboration Agreement with UNSW Sydney now includes access to world-class infrastructure for quantum materials characterisation.
- Archer holds an exclusive international licence to patents protecting the chip technology.

Archer Materials Limited ("Archer", the "Company", "ASX:**AXE"**) is pleased to update shareholders on the development of its ^{12}CQ technology that aims to build a quantum computing qubit processor ("chip"). Archer is one of very few companies globally that provides investors a direct, on-market opportunity to invest in quantum computing technology.

The Company uses a unique carbon-based qubit material that has the potential to enable chip operation at room-temperature and integration onboard modern electronic devices (see *Quantum Technology & Archer's ^{12}CQ Advantage*).

Commenting on the Company's ^{12}CQ developments, Archer CEO, Dr Mohammad Choucair, said: "We are strategically expanding Archer's direct access to infrastructure, specialised measurement instruments, and internationally recognised researchers to accelerate performing the quantum measurements required to successfully develop the ^{12}CQ chip."

"We have secured important and significant access to specialist equipment and world-renowned personnel through robust commercial agreements with world-class institutes. As a result, the quantum measurements related to qubit control, which form the basis of the chip's basic function, have commenced and are on track."

Archer is performing various quantum measurements on the chip qubit components at the University of Sydney ("University"), and École Polytechnique Fédérale de Lausanne ("EPFL") in Switzerland (ASX Announcement 28 Jan 2020), and will now expand to conduct specialised, state-of-the-art quantum measurements at the University of New South Wales ("UNSW Sydney").

The quantum measurements focus on several complimentary approaches to achieve quantum electronic and magnetic control of the chip qubit components in-line with Archer's key commercial development goals to demonstrate the potential for chip function and integration in modern devices (Image 1 and 2) (see *Further Technical Reading*).

The ^{12}CQ chip is being developed by Archer's in-house team, led by CEO Dr Mohammad Choucair and Quantum Technology Manager, Dr Martin Fuechsle, who have been recognised internationally as pioneers in Nanotechnology and Quantum Computing, respectively[1]. While Archer will be accessing equipment, laboratories and people at the University, UNSW Sydney, and EPFL, these institutions are not involved in developing the ^{12}CQ chip technology.

The Company recently joined the Sydney Knowledge Hub to strategically engage with researchers in the Australian quantum economy that will help accelerate chip development.

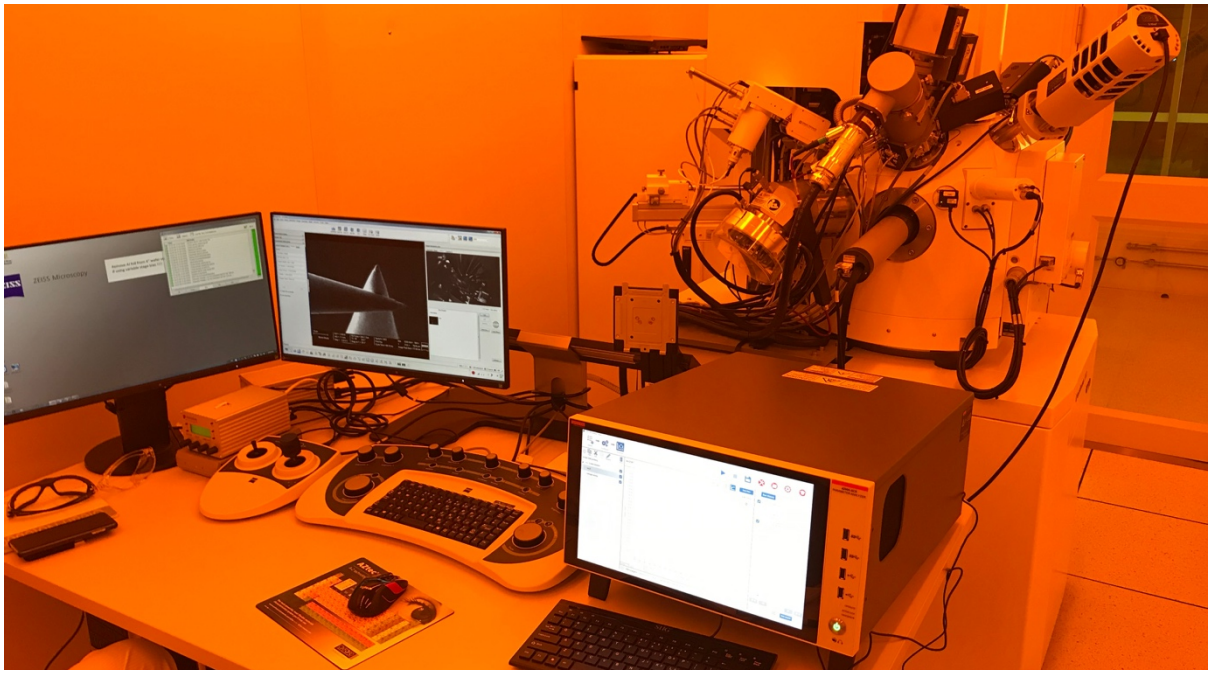

Image 1. Set-up of a measurement being performed on ^{12}CQ chip qubit components at the University Research and Prototype Foundry. The measurements require access and use of specialised instrumentation, like the ones pictured, to be performed successfully. The orange appearance is part of the sterile protocol inside the Research and Prototype Foundry.

Next Steps

The technical development of ^{12}CQ is a world-first, and the outcomes of the quantum measurements will be used to validate the patents protecting the chip technology, strengthen and grow Archer's intellectual property, and to advance the commercial readiness of the chip.

Key measurements will be released to ASX and discussed and reviewed under confidentially with delegates at the Quantum.Tech Conference in London from 20-22 April, 2020, which Archer will be attending to Chair a session on Quantum Computing (see ASX Announcement 28 Nov 2019).

Archer intends to commercialise chip products through licencing and direct sales by seeking to establish commercial partnerships with highly resourced organisations. More information on Archer's ^{12}CQ chip commercialisation pathway is found in ASX Announcement 30 Oct 2019.

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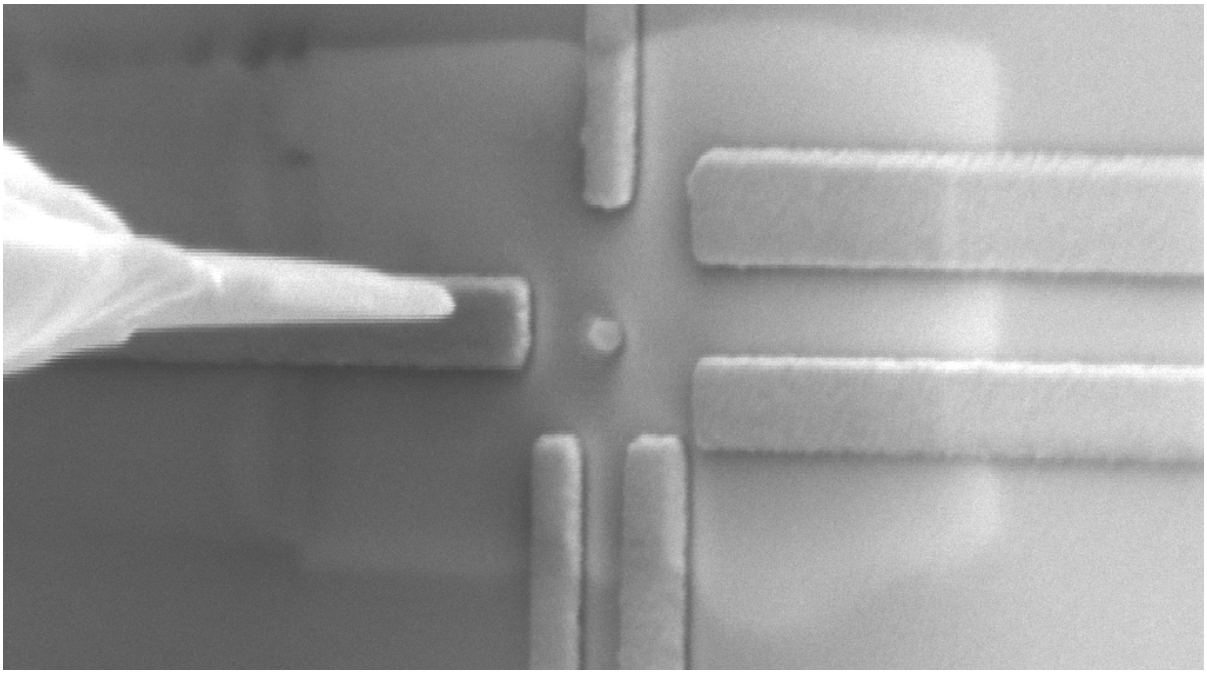

Image 2. A single qubit component undergoing direct quantum measurements related to the materials' electronic characteristics, with the qubit component observed in the centre of the image (round particle of about 50 nanometres in size) and surrounded by rectangular nanoelectrodes prepared using facilities at the University.

Quantum computing market summary and background

Market and Key Growth Catalysts

Australia forms a significant part of the growing quantum computing economy, however there are currently limited opportunities for on-market investment and exposure to financial returns from quantum computing technology[2]. Archer is one of very few companies globally that provides investors a direct, on-market opportunity to invest in quantum computing technology.

According to McKinsey[3], currently the highest-value currently in the quantum computing economy is derived from technology development in the US, EU, and Australia. Investment bank Goldman Sachs predicts that by 2021, quantum computing could become a $US29 billion industry[4], while the Boston Consulting Group[5] highlighted the dependence of the market size on achieving technical milestones, like those in this announcement, over the coming decades.

Quantum computing forms part of the mature US$500 billion+ semiconductor industry[6]. There are few companies with large market share including Samsung, Intel, and Qualcomm, giving rise to potential opportunities for M&A based on disruptive technology integration.

Quantum Technology & Archer's ^{12}CQ Advantage

A qubit processor ("Processor") is the most crucial hardware component of a quantum computer[7]. It consists of a core device (a chip) made from materials capable of processing quantum information (often called qubits) necessary to solve complex calculations. Processors come in a variety of forms depending on the qubit type and materials used. Many quantum computers currently use Processors that can only operate at low temperatures and/or are difficult to integrate in modern electronics, limiting ownership and use.

The successful development of the 12CQ room-temperature qubit processor chip could potentially overcome both the limitations of low operating temperatures and electronic device integration for qubits and would represent a breakthrough solution to the widespread use and ownership of quantum computing powered technology. The development of quantum computers is envisioned to impact industries reliant on computational power, including finance, cryptocurrency and blockchain.

Archer CEO, Dr Mohammad Choucair, invented the first material known to overcome both the limitations of sub-zero (cryogenic) operating temperatures and electronic device integration for qubits. The conducting carbon material was able to process quantum information at room temperature[8] and offered the potential for scalability: a solid-state material of workable dimensions for nanofabrication (less than 100 nanometres in size), easily processed and handled, and produced in quantities useful for quantum computing.

This unique combination of physical, chemical, and structural properties has the potential to reduce commercial barriers to quantum computing and make it globally accessible. The patented device incorporating these materials forms the subject of IP that was exclusively licenced from the University of Sydney by Archer (ASX Announcement 12 December 2018), and the materials are available in Archer's wholly owned subsidiary Carbon Allotropes.

Further technical reading

The electronic and magnetic control of a single qubit is essential for successful quantum information processing. Archer is currently performing a variety of quantum measurements and materials characterisation at different laboratory facilities with the aim of achieving quantum control in a single qubit. Further reading with much deeper technical details on what is generally and fundamentally involved in progressing towards performing quantum measurements on a single qubit is available online[9,10].

About Archer

A materials technology company developing materials in quantum computing, biotechnology, and lithium-ion batteries, and exploring for minerals in Australia. The Company has strong intellectual property, broad-scope mineral tenements, world-class in-house expertise, a diverse advanced materials inventory, and access to over $300 million of R&D infrastructure.

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

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Website:
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YouTube:
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[1] Dr M. Choucair received the Royal Australian Chemical Institute Cornforth Medal for the most outstanding Chemistry PhD in Australia (2011); Dr M. Fuechsle received the Australian Institute of Physics Bragg Gold Medal for the most outstanding Physics PhD in Australia (2013). Proof of international recognition has also been made with seminal peer reviewed publications: https://www.nature.com/articles/nnano.2008.365; https://www.nature.com/articles/nnano.2012.21
[2] Elizabeth Gibney, The Quantum Gold Rush, Nature 574, October 2019. https://www.nature.com/articles/d41586-019-02935-4
[3] Appears in: https://www.economist.com/news/essays/21717782-quantum-technology-beginning-come-its-own
[4] Quantum Computers: Solving problems in Minutes, not Millennia. Goldman Sachs. February 2018. http://www.goldmansachs.com/our-thinking/pages/toshiya-hari-quantum-computing.html
[5] Matt Langione, Corban Tillemann-Dick, Amit Kumar, and Vikas Taneja. Boston Consulting Group. May 2019. https://www.bcg.com/publications/2019/quantum-computers-create-value-when.aspx
[6] Global Semiconductor and Electronic Parts. IBISWorld Industry Report. May 2018.
[7] Philipp Gerbert and Frank Rueß. Boston Consulting Group. November 2018. https://www.bcg.com/en-au/publications/2018/next-decade-quantum-computing-how-play.aspx
[8] M. Choucair et al. Nature Communications 7, Article number: 12232 (2016). https://www.nature.com/articles/ncomms12232
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