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NTU's Discovery Paves the Way for Scalable Quantum Tech

Researchers at Nanyang Technological University (NTU) Singapore have made a breakthrough that could significantly advance quantum computing by miniaturising critical components and reducing the complexity of the equipment required. The discovery allows for the production of entangled pairs of photons, which are crucial for quantum computing, using materials that are 1,000 times thinner than current options. This development could lead to the creation of quantum computers that are far more compact and efficient.

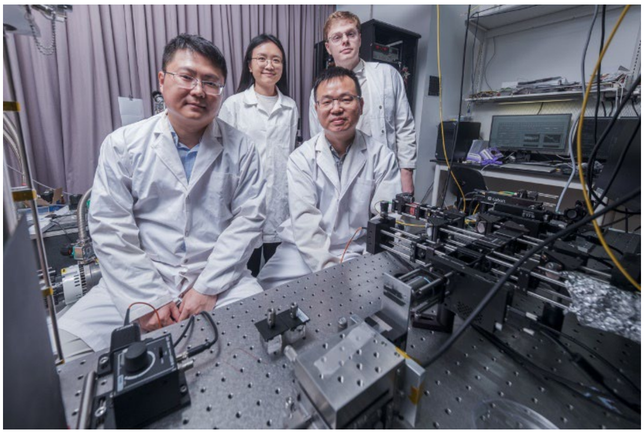

Image credits: Nanyang Technological University

Current quantum computers rely on photons, or light particles, to perform calculations using quantum bits, or qubits. These qubits differ from traditional bits because they can exist in multiple states simultaneously, enabling quantum computers to solve complex problems much faster than conventional computers.

One key challenge has been producing entangled photon pairs – two linked photons that behave in synchrony – a process that currently requires bulky optical equipment and thick crystals.

NTU scientists, led by Professor Gao Weibo, have discovered a method to generate entangled photon pairs using ultra-thin materials. The team utilised niobium oxide dichloride, a crystalline material with unique optical properties, to produce linked photons without the need for additional optical instruments. The material, just 1.2 micrometres thick, is 80 times thinner than a human hair, making it easier to integrate into quantum chips.

The significance of this development lies in its potential to shrink the size of quantum computing components by 1,000 times, which could make quantum technology more practical for widespread use. Traditionally, the production of entangled photons required thick, millimetre-sized crystals and extensive optical setups. However, NTU's method not only eliminates the need for bulky equipment but also maintains photon entanglement, making the process more efficient and scalable.

Photon-based quantum computing holds significant advantages over other approaches, such as using electrons, which require extremely low temperatures close to absolute zero. Photons, on the other hand, can operate at room temperature, making them more accessible and cost-effective.

However, producing photon pairs in thin materials has been a challenge because thinner materials typically generate fewer photons. NTU's research shows that niobium oxide dichloride can overcome this limitation, producing a sufficient number of entangled photons despite its thinness.

The NTU team's approach builds on earlier research that stacked two thick crystals at perpendicular angles to create entangled photons. By applying the same principle to ultra-thin crystal flakes, the researchers found that the photons remained in sync without requiring additional alignment tools. This synchronisation is crucial for quantum computing, as the paired photons must vibrate in perfect harmony to function as qubits.

Experts in the field, such as Professor Sun Shipei from Aalto University in Finland, have hailed the discovery as a major advancement in quantum technologies.

"This development has potential in advancing quantum computing and secure communication, as it allows for more compact, scalable and efficient quantum systems," said Professor Sun, a Co-principal investigator at the Research Council of Finland's Center of Excellence in Quantum Technology. He noted that NTU's method brings the technology closer to practical applications.

Looking ahead, the NTU team aims to refine its method further. One potential improvement includes adding microscopic patterns or grooves to the surface of the niobium oxide dichloride flakes to increase the production of photon pairs. The team is also exploring whether stacking the material with other substances could enhance photon generation even more.

This breakthrough represents a significant step toward the miniaturisation of quantum computing technology. By leveraging advanced materials and innovative techniques, NTU's research could lead to the development of more compact, powerful quantum computers capable of tackling some of the world's most complex problems.

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