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Quantum information gets a boost from thin-film breakthrough

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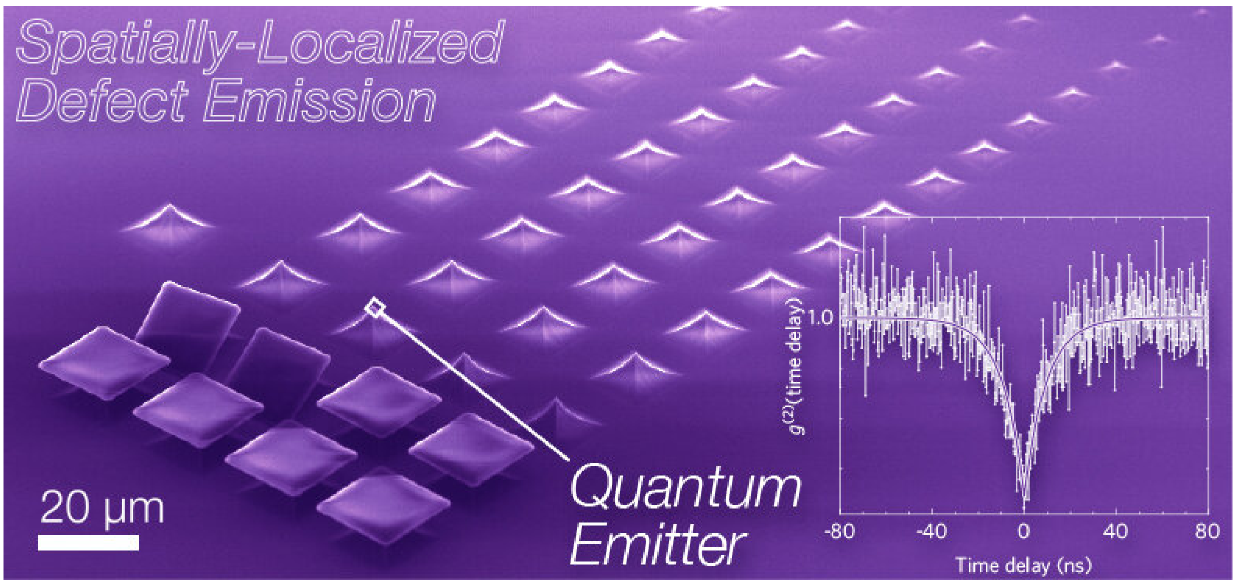

An innovative method for controlling single-photon emission for specific locations in 2D materials may offer a new path toward all-optical quantum computers and other quantum technologies. This image shows a false-color scanning electron micrograph of the array used to create place single-photon sources in epitaxial tungsten diselenide. Inset shows the Hanbury-Brown Twiss interferometry measurement proving quantum emission. Credit: Michael Pettes Los Alamos National Laboratory image

Efforts to create reliable light-based quantum computing, quantum key distribution for cybersecurity, and other technologies got a boost from a new study demonstrating an innovative method for creating thin films to control the emission of single photons.

"Efficiently controlling certain thin-film materials so they emit single photons at precise locations—what's known as deterministic quantum emission—paves the way for beyond-lab-scale quantum materials," said Michael Pettes, a Los Alamos National Laboratory materials scientist and leader of the multi-institution research team.

The scalability of these two-dimensional, tungsten/selenium thin films makes them potentially useful in processes to manufacture quantum technologies. Single-photon generation is a requirement for all-optical quantum computing and key distribution in quantum communications, and it is crucial for advancing quantum information technologies.

The project, documented as a Featured Article in the journal *Applied Physics Letters* this week, exploits strain at highly spatially localized and well-separated emission sites, or tips, in a tungsten/selenium film. The team synthesized the film through chemical vapor deposition using a multi-step, diffusion-mediated gas source.

Because the material is very thin, it conforms to the radius of the tips and the material bends towards the substrate by more than a few percent, like someone lying on a bed of nails. The resulting strain is enough to change the electronic structure, but only at the tips. The affected area emits light of a different color and nature than light from the rest of the film.

"While more research is needed to fully understand the role of mechanical deformation in creating these quantum emission sites, we may enable a route to control quantum optical properties by using strain," Pettes said. "These single-photon sources form the basis for photonics-based, all-optical quantum computing schemes."

Engineering of quantum emission in 2-D materials is still in a very early stage, the authors note. While studies have observed single photons originating from defect structures in these materials, previous work has suggested that non-uniform strain fields might govern the effect. However, the mechanism responsible for this emergent phenomenon remains unclear and is the focus of ongoing work at Los Alamos.

More information: Wei Wu et al, Locally defined quantum emission from epitaxial few-layer tungsten diselenide, *Applied Physics Letters* (2019). DOI: 10.1063/1.5091779

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