Physicists move closer to efficient single-photon sources

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A team of physicists in the United Kingdom has taken a giant step toward realizing efficient single-photon sources, which are expected to enable much-coveted completely secure optical communications, also known as "quantum cryptography." The team presents its findings in *Applied Physics Letters,* a journal published by the American Institute of Physics.

Fluorescent "defect centers" in diamond act like atomic-scale light sources and are trapped in a transparent material that's large enough to be picked up manually. They don't need to be kept at super cold cryogenic temperatures or trapped in large electromagnetic fields to be stable—unlike quantum dots or trapped atoms.

This makes them strong contenders for use as sources of single photons (the quantum light particle) in provably secure quantum cryptography schemes, explains J. P. Hadden, a Ph.D. candidate in the Centre for Quantum Photonics, Department of Electrical and Electronic Engineering & H. H. Wills Physics Laboratory at the University of Bristol.

"Defect centers could also be used as building blocks for 'solid-state quantum computers,' which would use quantum effects to solve problems that are not efficiently solvable with current computer technology," Hadden says.

To fulfill the potential of diamond defect centers, it's essential that the light be collected efficiently from the diamond material. But this collection efficiency is dramatically reduced by reflection and refraction of light passing through the diamond-air interface.

"We managed to show an improvement in the brightness of these defect centers of up to ten times by etching hemispherical 'solid immersion lenses' into the diamond," notes Hadden. "This is an important result, showing how nanofabrication techniques can complement and enhance quantum technologies, and opens the door to diamond-defect-center-based implementations of quantum cryptography and quantum computation."

More recently, Hadden and colleagues developed a technique that allows them to reliably etch these structures over previously characterized defect centers to a precision of about 100 nanometers — another significant step toward a practical and repeatable combination of nanotechnology and quantum optics.

More information: apl.aip.org/

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