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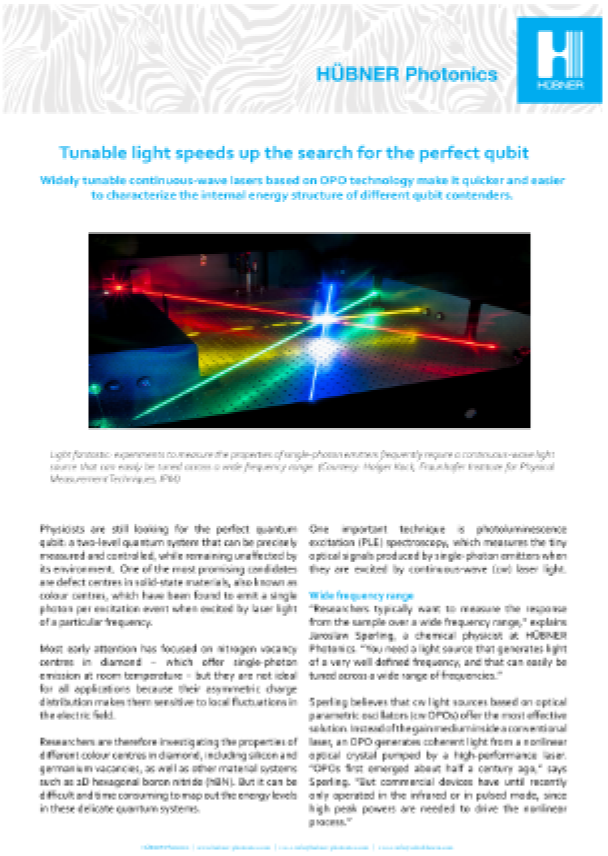

HÜBNER Photonics

Tunable light speeds up the search for the perfect qubit

Widely tunable continuous-wave lasers based on OPO technology make it quicker and easier to characterize the internal energy structure of different qubit contenders.

Light fantastic: experiments to measure the properties of single-photon emitters frequently require a continuous-wave light source that can easily be tuned across a wide frequency range. (Courtesy: Holger Kock, Fraunhofer Institute for Physical Measurement Techniques, IPM)

Physicists are still looking for the perfect quantum qubit: a two-level quantum system that can be precisely measured and controlled, while remaining unaffected by its environment. One of the most promising candidates are defect centres in solid-state materials, also known as colour centres, which have been found to emit a single photon per excitation event when excited by laser light of a particular frequency.

Most early attention has focused on nitrogen vacancy centres in diamond – which offer single-photon emission at room temperature – but they are not ideal for all applications because their asymmetric charge distribution makes them sensitive to local fluctuations in the electric field.

Researchers are therefore investigating the properties of different colour centres in diamond, including silicon and germanium vacancies, as well as other material systems such as 2D hexagonal boron nitride (hBN). But it can be difficult and time consuming to map out the energy levels in these delicate quantum systems.

One important technique is photoluminescence excitation (PLE) spectroscopy, which measures the tiny optical signals produced by single-photon emitters when they are excited by continuous-wave (cw) laser light.

Wide frequency range

"Researchers typically want to measure the response from the sample over a wide frequency range," explains Jaroslaw Sperling, a chemical physicist at HÜBNER Photonics. "You need a light source that generates light of a very well defined frequency, and that can easily be tuned across a wide range of frequencies."

Sperling believes that cw light sources based on optical parametric oscillators (cw OPOs) offer the most effective solution. Instead of the gain medium inside a conventional laser, an OPO generates coherent light from a nonlinear optical crystal pumped by a high-performance laser. "OPOs first emerged about half a century ago," says Sperling. "But commercial devices have until recently only operated in the infrared or in pulsed mode, since high peak powers are needed to drive the nonlinear process."

Tunable Light Speeds up the Search for the Perfect Qubit

One of the most promising candidates for the perfect quantum qubit are defect centres in solid-state materials, also known as colour centres, which have been found to emit a single photon per excitation event when excited by laser light of a particular frequency. Widely tunable cw lasers make it quicker and easier to characterize the internal energy structure of different qubit contenders. Learn about these lasers and how they are used to characterise colour centers in this white paper.

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