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**Solid-state materials and devices for single-photon generation and more**

CHARLES SANTORI, Hewlett-Packard

A single-photon device, which ideally emits exactly one photon on demand into a definite quantum state, can be constructed from a single atom or atom-like system excited by optical pulses and coupled to an optical micro-cavity. Solid-state single quantum systems are especially practical for this application because they do not require complicated trapping setups and can be integrated into monolithic micro-cavity structures. In the last several years single-photon generation has been demonstrated in a variety of solid-state systems including nitrogen-vacancy (NV) centers in diamond, epitaxial quantum dots in semiconductors such as InGaAs or AlGaIn, and impurities in semiconductors. A variety of microcavity geometries have also been employed to improve photon extraction efficiency and to increase the spontaneous emission rate, including micro-pillars with distributed-Bragg-reflector mirrors, micro-disks and photonic crystal cavities. Results from various systems will be summarized and compared in terms of the suppression of the two-photon emission probability (compared with a Poisson distribution), efficiency, and quantum indistinguishability of the generated photon wave packets. A device that efficiently produces single photons with high spectral purity can also be used in other ways. For example, two photons incident onto such a device should in theory exhibit a strong optical nonlinearity. In addition, if the device uses a three-level Lambda-type system in which two lower long-lived levels are coupled by optical transitions to a common excited state, the possibility exists for efficient matter-photon quantum state inter-conversion, an important ingredient for quantum networks and other applications. It has recently been demonstrated that two solid-state systems, charged quantum dots and nitrogen-vacancy centers in diamond, have the required level structure for this scheme. Recent results demonstrating coherent population trapping in single NV centers will be described which are promising in terms of optical manipulation of single spins and eventually spin-photon inter-conversion.