Coupling of Quantum Dot Light Emission with Point Defect Cavity Resonances in Three-dimensional Photonic Crystals

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ABSTRACT

Regardless of the excellent feature of three-dimensional (3D) photonic crystals (PhCs) to manipulate lights in all direction irrespective of their polarization directions, two-dimensional (2D) PhCs have been preferred by researchers in this field than 3D PhCs, because 2D PhCs provide us manipulatability of light, which is nearly comparable to those of 3D PhCs, without apparent difficulty in fabrication. However, the present condition, where the killer application of PhCs is absent after 20 years intensive research, makes us to reconsider whether the polarization-limited condition for use and fragile structures of 2D PhCs are really a drawback for practical application or not. The sole reason why 3D PhCs have been avoided is their intrinsic complexity of the structure. Once a technology, which enables stable assembly of 3D fine structures with high precision, the balance of favor between 2D and 3D PhCs would change.

In this talk, we introduce the first demonstration of coupling of light emission from quantum dots (QDs) with a nanocavity in a 3D PhC operating at optical communication wavelengths. The combination of QDs and a nanocavity in a 3D PhC provides a fully-confined system both for electrons and photons simultaneously. Such a system operating at optical communication wavelengths could move the realization of quantum cryptography communication and quantum computer a step closer. Our demonstrations increase their importance with the fact that they were done using III-V semiconductor materials at room temperature. The fabrication technology established here should greatly enhance exploration of not only 3D PhCs but also PhCs and fine-structure devices in general.

Details of our work will be presented at the talk.

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