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All-optical coherent control of energy transfer between a quantum dot and a cavity mode TAO CAI, RANOJOY BOSE, KAUSHIK CHOUDHURY, Department of Electrical Engineering, University of Maryland, College Park, GLENN SOLOMON, Joint Quantum Institute, University of Maryland, College Park and National Institute of Standards and Technology, Gaithersburg, EDO WAKS, Department of Electrical Engineering, University of Maryland, College Park
— Here we demonstrated all-optical coherent control of energy transfer in a quantum dot strongly coupled to a photonic crystal molecule at optical frequency. The photonic crystal molecule composes two photonic crystal cavities, supporting a pair of strongly coupled normal modes. One of the modes strongly couples with a quantum dot and the other induces a cavity enhanced a.c. stark shift to rapidly tune the quantum dot resonance on timescales much shorter than the vacuum Rabi period of the strongly coupled dot-cavity system. The quantum dot initially detunes from the cavity mode. By tuning the quantum dot onto resonance with the cavity mode on picosecond timescales, we achieved coherent transfer of energy between a quantum dot and the cavity mode through vacuum Rabi oscillation. We investigated the energy transfer as a function of stark laser power to confirm the coherence of the energy transfer process. We further demonstrated coherent control of light-matter states by implementing a Ramsey-type experiment. These results pave the path for achieving gigahertz controlled generation of quantum states of light and synthesis of photon wavefunctions using integrated semiconductor nano-photonics platform.

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