SAND2013-6958C

Influence of the Metamaterial Geometry on Ultra-Strong Light-Matter Interaction

Alexander Benz[1,2], Salvatore Campione[3], Ines Montano[2], Sheng Liu[1,2], John F. Klem[2], Michael B. Sinclair[2], Filippo Capolino[3] and Igal Brener[1,2]

[1] *Center for Integrated Nanotechnologies (CINT), Sandia National Laboratories P.O. Box 5800, Albuquerque, NM 87185, USA*

[2] *Sandia National Laboratories, P.O. Box 5800, Albuquerque, NM 87185, USA*

[3] *Department of Electrical Engineering and Computer Science University of California, Irvine 4131 Engineering Hall, Irvine CA 92697*

Metamaterials are artificial composites of sub-wavelength building blocks that allow for designing the electromagnetic permeability and permittivity. New materials with optical properties that cannot be found in nature such as negative refraction, super-resolution or cloaking can be realized.

We use two-dimensional metamaterials to study ultra-strong light-matter interaction in sub-wavelength volumes. The optical cavity (metamaterial) exchanges energy with a two-level system (intersubband transition in a quantum-well) at a characteristic rate, called vacuum Rabi frequency. In contrast to conventional strong coupling experiments we are able to achieve Rabi frequencies that are comparable to the fundamental optical oscillation itself. One of the immediate consequences of the ultra-strong interaction between the metamaterial cavity and the two-level system is the non-classical ground state. These systems are potentially suitable to release correlated photon pairs. We demonstrate experimentally that the strength of the interaction can be controlled by choosing the right metamaterial geometry.

This work was performed, in part, at the Center for Integrated Nanotechnologies, a U.S. Department of Energy, Office of Basic Energy Sciences user facility. Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. #158883