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Nano-patterned hyperbolic metamaterials for high-frequency nanowire quantum dots single photon source

Feiliang Chen, Mo Li, Qian Li, Hui Zhang, Feng Huang and **Jian Zhang**
Microsystem and Terahertz Research Center, China

Plasmonic metamaterials at optical frequencies can be used to manipulate the local photonic density of states and tailor the spectrum purposefully and selectively. Here nano-patterned hyperbolic metamaterials (HMM) for high-frequency quantum dots single photon source (SPS) will be presented. Nanowire quantum dots fabricated by top-down method or selective area grown can obtain electrically driven site-controlled SPS, which is promising for integrated chip-scale SPS. However, considering the quantum confinement effect in quantum dots, the diameter of the nanowire is often less than 50 nm, which shows weak photon confinement and low spontaneous emission rate. HMM shows hyperbolic dispersion and corresponds to infinite local photonic density of states, which can be used for broadband Purcell effect radiative decay engineering. But due to the non-radiative behaviour of plasmonic modes in HMM, most of the emission photon will dissipate inside the metamaterial due to ohmic losses in planar HMM. Here we propose a nano-patterned hyperbolic metamaterials for nanowire quantum dots SPS. Combining the broadband enhancement of spontaneous emission from HMM and directional light extraction enhancement from nano-patterned scattering structures, broadband enhancements of both spontaneous emission rate and photon extraction efficiency were demonstrated over the whole visible range. Our research provides a novel idea for high-frequency and high-brightness nanowire quantum dots SPS, which has good prospect in many applications such as quantum information processing.

Biography

Feiliang Chen has completed his PhD from the University of Chinese Academy of Sciences. He is working as Assistant Researcher of Microsystem at Terahertz Research Center. His research focuses on the plasmonic photonic structures, single photon source and nanophotonic devices. He has published more than 13 papers in reputed journals and has been serving as peer reviewer for many journals. He is Member of the Optical Society of America (OSA).

chenfeiliang@mtrc.ac.cn

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