Extreme multiexciton emission from deterministically assembled single emitter subwavelength plasmonic patch antenna

A. R. Dhawan, J. U. Esparza, M. Nasilowski, L. Coolen, B. Dubertret, P. Senellart, A. Maître

Plasmonic antennas are attractive optical structures for many applications in nano and quantum technologies. They have the ability to confine light on highly sub-wavelength volumes to improve significantly light-matter interaction between single quantum emitters and plasmons. By providing enhanced interaction between a nanoemitter and light, they efficiently accelerate and direct spontaneous emission. One challenge, however, is the precise nanoscale positioning of the emitter in the structure [2]. Here we present the realization of a patch plasmonic antenna [2] consisting in a single colloidal core/shell CdSe/CdS deterministically positioned with three-dimensional nanoscale control between a thick gold layer and a thin gold –subwavelength size –nano disk [3].

![Schematic design of a metallic patch antenna with a single emitter in the center. b) and c) emission diagram of the antenna](image)

![Decay curve for the single emitter inside patch antenna. b) autocorrelation function after 2ns filtering](image)

By exploiting the properties of metal-insulator-metal structures at the nanoscale, the fabricated single emitter antenna exhibits an extremely high Purcell factor (>72) and brightness enhancement by a factor of 70. Due to the unprecedented quenching of Auger processes and the strong acceleration of multie exciton emission, more than 4 photons per pulse can be emitted by a single quantum dot. Our technology permits the fabrication of bright room-temperature single-emitter sources emitting either multiple or single photons. After application of a temporal filter on the auto correlation function, those antennas exhibit superpoissonian emission.

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[2] C. Belacel, B. Habert, F. Bigourdan, F. Marquier, J-P. Hugonin, S. Michaelis de Vasconcellos, X. Lafosse, L. Coolen, C. Schwob, C. Javaux, B. Dubertret, J-J. Greffet, P. Senellart, A. Maître, Controlling spontaneous emission with plasmonic optical patch antennas, Nanoletters 13 1516 (2013)
[3] A. R. Dhawan, C. Belacel, J. U. Esparza-Villa, M. Nasilowski, Z. Wang, C. Schwob, J-P. Hugonin, L. Coolen, B. Dubertret, P. Senellart, A. Maître, Extreme multie exciton emission from deterministically assembled single emitter subwavelength plasmonic patch antenna, arXiv:1811.11449 [quant-ph]