

Nanometric ultrabright light sources

Many quantum information protocols rely on photons manipulation. Besides, quantum technologies require device miniaturization. Therefore, it is crucial to develop light nanosources which can be included within a quantum circuit. The "nanostructures and optics team" has realized optical nanosources based on the coupling of a single nanoemitter to a plasmonic nanoantenna in order to optimize its emission.

A 10 nm diameter semiconductor nanocrystal is inserted between a thick gold layer and a micrometric gold patch. Illuminated by a violet laser, such a patch antenna emits red light by fluorescence. The brightness of the light source, its photons emission quickness and the direction of emission depend on the precise location of the nanocrystal inside the antenna.

The team has developed lithography methods, patented for some of them, which allow a precise location of the single emitter inside the antenna where its interaction with the electric field is maximum. This in-situ lithography allowed a nanocrystal location inside the antenna with a few nm axial resolution and 25nm lateral resolution.

For very thin nanoantennas, having a few tens of nanometers thickness, single nanocrystal emission has been controlled, allowing emission acceleration by a factor over 200, and brightness by 70.

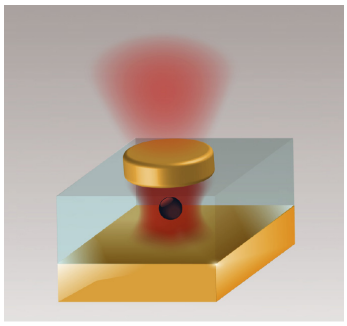

Figure 1
Patch antenna with a single nanoemittor
The single emitter is located inside a transparent material, between a gold thick layer and a patch, which transmits emitted light. In-situ optical lithography makes it possible to position exactly at the nanometric scale the emitter inside antenna, and to optimize its emission.

Light confinement inside nanometric volumes inside antenna allows very high interactions between emitter and nanostructures, which deeply alter emission characteristics. Thus it is possible to develop optimized optical nanosources for quantum information applications.

Reference
"Extreme multiexciton emission from deterministically assembled single-emitter subwavelength plasmonic patch antennas"
Amit Raj Dhawan, Cherif Belacel, **Juan Uriel Esparza-Villa**, Michel Nasilowski, Zhiming Wang, **Catherine Schwob**, Jean-Paul Hugonin, **Laurent Coolen**, Benoit Dubertret, Pascale Senellart, **Agnès Maître**
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