• Nanocomposites and nanomaterials

Towards real-time tunable plasmon nanolaser

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Plasmon lasers are promising nanoscale coherent sources of optical fields because they support ultra-small sizes and show ultra-fast dynamics. Although plasmon lasers have been demonstrated at different spectral ranges, from the ultraviolet to near-infrared, a systematic approach to manipulate the lasing emission wavelength in real time has not been possible. The main limitation is that only solid gain materials have been used in previous work on plasmon nanolasers; hence, fixed wavelengths were shown because solid materials cannot easily be modified. In April 2015 Odom's research team has found a way to integrate liquid gain materials with gold nanoparticle arrays to achieve nanoscale plasmon lasing that can be tuned dynamical, reversibly and in real time.

The purpose of this report is to discuss the other possibility of frequency tuning in the optical domain using methods of nanoplasmonics. We restrict ourselves to the case of plasmon nanolasers (PNL). PNL dimensions are, by definition, much smaller than the wavelength of the optical radiation and should not apply the frequency tuning techniques are used for lasers having macro- or microsizes. For this purpose, first of all we analyze the dependencies of the plasmon resonance frequency of different implementations of nano-emitters on control parameters. So the frequency of the radiation of a single nano-emitter can be varied depending on the size, shape and structure (e.g., nanocomposites different topology), and other factors. In currently implemented two-dimensional sets of nanolasers great influence on the radiation frequency has interaction between the individual nano-emitters. We demonstrate some new ideas to transform the eigen-frequency nanoplasmonic structures and nanocomposites: the use of quantum mechanical superposition related plasmon oscillations (for example, in case of nanoring); quantum interference of continuous and discrete spectra transitions (Fano-like plasmonic resonances), in particular, quantum interference of two closely spaced plasmonic resonances, for realizing extremely narrow plasmonic line.