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ISBN
9781479978175

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Publication Date
2015

DOI
10.1109/usnc-ursi.2015.7303634

Field Enhancement and Optical Trapping with Plasmonic Nano Antennas on Silicon-Based Waveguides

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Plasmonic nano antennas like dimers, bowties, and others have been investigated for their capability to provide a strong near-field enhancement when illuminated by external light. Traditionally these nano antennas, isolated or arrayed, are placed on a substrate and used in spectroscopy techniques. Surfaces made of such plasmonic nano antennas have been very useful, for example for surface enhanced Raman scattering, providing various orders of magnitude of enhanced sensitivity. These instruments however are not economic and are often not mobile since surfaces require an external beam illumination and the Raman scattering is detected by a large aperture microscope. We propose a technique where optical plasmonic nano antennas are located in proximity of silicon based waveguides that provide both for illumination and detection channels. The evanescent field surrounding the waveguide is capable to excite the proximity resonant nano antenna and generate the very strong field enhancement in the antenna gaps. Intensity enhancement reaches three or four orders of magnitude. Such nano antennas are used also for detection schemes and they provide very high sensitivity to molecular scattering, for example, when molecules are placed in the antenna "hot spot". A couple of different silicon based waveguide will be investigated with coupling to various possible plasmonic nano antennas. First we investigate the field enhancement and then the coupling to waveguide modes.
Nano antennas are also convenient for their use in optical trapping for particle sorting and sensing. Here we investigate the optomechanical properties of a silicon based waveguide enhanced by gold bowtie antennas. The bowtie antenna leads to 60-fold enhancement of electric field in the antenna gap. We show that thanks to the near-field scattering by the antenna, the optical trapping force on a 10 nm radius polystyrene nanoparticle is boosted by 3 orders of magnitude.