Pulling nanoparticles by a non-diffractive light beam

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Pulling radiation pressure force recently revealed is discussed. In contrast to the ordinary optical manipulation based on the gradient-field forces we push forward the idea of dragging nanoparticles with the single gradientless (non-difracting) electromagnetic beam, e.g., Bessel beam. Except the strong non-paraxial nature of the beam there are no more heavy limitations on the parameters of the beam or material parameters of a nano-sized bead. Thus, pulling and pushing as result of dominating forward and backward scattering, respectively, is the advanced technique in optical manipulation.

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Angle-dependent excitation of surface plasmon polaritons in gold nanowires in alumina

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Extinction spectra of parallel gold nanowires (diameter – 28 nm, length – 9 mkm) in porous alumina were studied in spectral range of 360 – 1200 nm. The spectra were measured at various angles of incidence theta of exciting light beam. Here, theta is the angle between the propagation direction of exciting beam and the axis of nanowire. The extinction spectra contain two bands. First, T-band is caused by the excitation of the transversal oscillations of the free electrons, i.e. longitudinal surface plasmon (SP) mode in Au nanowire. Second, L-band is caused by longitudinal surface plasmon modes of nanowire. The spectral position of L-band changes non-monotonically with theta: it red shifts at the increase of theta from 0 to 30 degrees and blue shifts at the increase of theta from 30 to 70 degrees. The bandwidth changes with change of theta non-monotonically as well: it has maximum at theta = 30 degrees, and has smaller values at lower and higher incidence angles. The longitudinal surface plasmon modes in long metallic nanowires have the character of surface plasmon polaritons (SPP) propagating along the axis of nanowire. SPPs are reflected from the ends of the nanowire, and the standing SPP waves arise. Thus, the nanowire acts as optical resonator. The theoretical calculations show that theta = 30 degress is the angle at which the most efficient excitation of the longitudinal SPP occurs. At this condition the axial SPPs are excited that propagate along the nanowire axis. This mode has lowest energy and damping. At other angles of incidence the non-axial SPP modes are excited that propagate angle-wise to wire axis. Non-axial modes have the higher energies and damping that explains the observed dependencies of L-band characteristics on theta.

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