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Controlling Light at the Nanoscale[1]

ALEXANDER A. GOVYADINOV, Physics Department, Oregon State University

The ability to confine and process optical radiation at deep subwavelength scale will fundamentally improve a number of applications including high-resolution sensing, imaging, lithography, and signal processing. We explore the perspectives offered by nanoplasmonic metamaterials for manipulation of optical signals at the nanoscale. We first show that in contrast to conventional dielectric waveguides, plasmonic and anisotropy-based systems support confined optical modes even when the waveguide size is much smaller than the operating wavelength. The effective modal index in these nano-thick structures is inversely proportional to the waveguide size, and can be either positive or negative, providing a versatile mechanism for manipulating the phase velocity at the nanoscale. We next demonstrate that in contrast to diffraction-limited systems, in nano-scale systems the combined effect of waveguide- and material-induced dispersions provides new versatile controls for pulse manipulation. In particular we demonstrate that the group velocity in such waveguides can be changed from negative to large or small (in comparison with c) positive values by a relatively weak modulation of either material properties or waveguide dimensions or both. We finally explore the prospects of active plasmonic metamaterial in provide a unique platform for *independent manipulation of group and phase* velocities of electromagnetic radiation in sub-wavelength domain.

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