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Metamaterials and Plasmonics: Improved Material Building Blocks

ALEXANDRA BOLTASSEVA, Purdue University

Optical metamaterials are rationally designed and manufactured materials built of nanostructured unit cells, or "artificial atoms" much smaller than the wavelength of operating light. These materials can be engineered to exhibit optical properties beyond any naturally occurring materials. This field has been gaining momentum over the past several years, as it continues to provide new fascinating ideas promising a variety of exciting applications including for example super-resolution microscopes, extremely efficient light concentrators and invisibility cloaks. In most metamaterial devices, noble metals (primarily gold and silver) have been used as the constituent material to make subwavelength building blocks. But metals suffer from high optical losses that are much too large to create practical and robust metamaterials devices. A recent approach that could unlock the technological potential of plasmonics and optical metamaterials is to look for better plasmonic materials that have a negative real part of dielectric permittivity. Here we provide an overview of two classes of alternative plasmonic materials - doped semiconductors and intermetallics - that could allow realization of novel transformation optics and metamaterial devices with greatly improved performance operating at near infrared and visible frequencies.