Abstract

The subject of this thesis are metal-dielectric nano-structures, in which light propagation is possible thanks to the excitation of surface plasmon-polaritons. The layered structures considered in the thesis enable imaging with superresolution. The thesis is devoted to optimization of superresolving layered structures, their description with the use of the effective medium theory, the application of the theory of linear systems to their development, and to their potential applications.

It has been demonstrated that thin layered metal-dielectric superresolving structures developed with use of the effective medium theory are suboptimal with respect to the attainable resolution and transmittance. It has been proven that these two characteristics can be improved simultaneously by means of numerical optimization, and the resultant structures consist of thicker layers, more feasible from the technological point of view. Propagation losses predicted by the effective medium theory for thin layered structures may differ significantly from the precise result, even in the case of structures with very thin layers - several-fold thinner than the free-space wavelength. In particular, a structure with a finite thickness of layers may show also several-fold smaller losses than a respective one with infinitesimally thin layers.

It has also been demonstrated that superresolving layered structures can be combined into optical systems that allow for changing the spatial distribution of intensity of a propagating light beam, while its phase characteristics remains not aberrated. It has been proposed to combine three thin layered stacks to obtain a system capable of focusing the energy of an incident Gaussian beam into a subwavelength area, simultaneously preserving homogeneous and planar phase fronts.