Abstract

The optical properties of sub-wavelength gold nanostructures and organic nano-aggregates receive great interest in different fields of research, for instance plasmonics, photonics, optoelectronics. Gold nanostructures are distinguished for their ability to enhance electric field several orders of magnitude, while organic nanofibers are attractive for their inherent strong nonlinear response. Therefore, it is logical to combine gold nanostructures with organic nanofibers in order to enhance the nonlinear response of the latter.

This Ph.D. thesis is focused on fabrication and investigation of the mechanically robust field-enhancing substrate which can be combined with organic nanofibers thus forming the organic-plasmonic hybrid system. This system possesses unique ability to convert plasmonic mode into photonic one and vice versa making it right candidate for integration into different optoelectronic devices in order to improve their performance.

The optimum size and shape of nanostructured substrates were estimated via numerical simulations. Following the optimum parameters found via simulation, gold nanostructures were fabricated by means of lift-off and high resolution electron beam lithography techniques. The optical response of fabricated nanostructures was characterized using a recently developed "imprint" technique, where a polymer film, deposited on the nanostructures is ablated by the structure-enhanced electric near-field. The improvement of mechanical durability of gold nanostructures coated with optically transparent and hard diamond-like carbon thin films was investigated by means of atomic force microscopy. The following optical characterizations of nanostructures with different coating thicknesses allow one to find the optimum balance between their optical and mechanical properties. Finally, the organic nanofibers were transferred on gold nanostructures and optically characterized. It was observed, that the second harmonic signal intensity increases in organic nanofibers, as a consequence of the field enhancement on the gold nanostructures. Additionally, the organic nanofibers transferred on a silver film were investigated by means of leakage spectroscopy, demonstrating the possibility to excite surface plasmon polaritons by luminescence from irradiated nanofibers. As example for applications of such hybrid systems, the organic phototransistor with integrated gold nanostructures between electrodes was fabricated. Overall, this work can be seamlessly integrated into the fabrication of field enhancing platforms for advanced optoelectronic devices.