Surface plasmon polariton interaction with Sulforhodamine 101 dye

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The integration of conventional optical elements and electronic circuits is limited by size mismatch between these components. The diffraction limit does not allow miniaturizing optical elements to nm-scale. It was realized that light being strongly coupled to coherently oscillating electrons at the metal surface could be used to overcome this limit. The coupled state is called surface plasmon polariton. Surface plasmon polariton propagates in plane of metallic film within 10-100 µm range but decay exponentially in directions perpendicular to metal-dielectric boundary. Interaction of the surface plasmon polaritons with fluorescent dye molecules may result in development of new nanodimensional photonic elements such as planar frequency converters [1], planar refractive elements with desirable refractive index etc. Conversion from light to the surface plasmon polariton modes and backwards can be done employing fluorescent molecules [2,3]. Due to imperfections of metallic film surface plasmon polariton can be scattered into photons that can excite fluorescent molecules. One of the most powerful techniques of the surface plasmon polaritons propagation imaging is based on this effect [4]. The study of surface plasmon polaritons interaction with fluorescent dye molecules is high priority task.

We performed investigation of interaction between surface plasmon polaritons (SPP) and Sulforhodamine 101 dye molecules (SR101). The dispersion relation, i.e., the dependence of energy of oscillation on the wave vector of the oscillation, was obtained for the SPP interacting with SR101 molecules. The dispersion curves for silver-Sulforhodamine 101 samples were obtained experimentally performing reflectometry measurements, and the vacuum Rabi splittings were observed at the energies of the dye excitations. Excitation was done by using prism coupling technique (Kretschmann configuration). Transfer matrix method was used to model reflection coefficient of studied multilayer structures. Detection of the scattered radiation provides another way to get dispersion relation of surface plasmon polaritons [5]. Comparison of this dispersion relation to the one obtained from reflectometry measurements provides insight into dynamics of surface plasmon polariton/dye molecules interaction. It is also shown experimentally that the value of the Rabi split is dependent on the number of Sulforhodamine 101 molecules involved into the coupling process.