Light coupling from active polymer layers to hybrid dielectric-plasmonic waveguides

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Nowadays there is a lot of interest to integrate plasmonic waveguides into photonic technology in order to utilize the advantages of plasmonics, such as the compact size of plasmonic devices. However, surface plasmon-polaritons (SPPs), the signals in plasmonic waveguides, suffer significant loss due to the presence of the metal. In addition, it is necessary to develop convenient methods of coupling light into plasmonic structures so that hybrid photonic-plasmonic systems are practical.

To increase propagation lengths, gain materials can be used adjacent to the metal. Nanocomposites made by the dispersion of colloidal quantum dots (QDs) in a polymer matrix are an interesting choice as a gain material for plasmonic structures. Such nanocomposites join the properties of the nanostructures (room temperature emission and tunable wavelength) with the technological feasibility of polymers (deposition in films by coating methods or patterned by e-beam or UV lithography). In this work, multilayer QD-PMMA, PMMA and gold films are proposed as waveguides with integrated dielectric active, passive and plasmonic layers. A QD-PMMA film acts as an active core of a dielectric waveguide when it is deposited on SiO_2/Si substrate. Under these conditions, the improvement of the waveguided photoluminescence (PL) is demonstrated by depositing a cladding polymer on the top of the nanocomposite. If the nanocomposite is adjacent to a metal layer, the PL can excite the propagation of the surface plasmon-polariton. Moreover, if the layers are designed properly it is possible to improve the propagation of the SPP by combining dielectric and plasmonic modes in the same structure. Under optimal conditions, gain is provided to the SPP. The device offers a convenient method of coupling light into plasmonic structures so that hybrid photonic-plasmonic systems are practical.