PLASMONIC COMPONENTS FOR INTEGRATED NANOPHOTONIC CIRCUITS

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Abstract— **Plasmonic waveguides provide very efficient means to confine and guide photonic signals on subwavelength scales. Here we will discuss passive and active nanophotonic components based on plasmonic waveguides and crystals for optical signal manipulation, routing, modulation and amplification.**

Keywords- surface plasmon, waveguiding, nanophotonics

Surface plasmon polaritons (SPPs) have proved to be very efficient in confining and guiding photonic signal on sub-wavelength scales hardly attainable with conventional dielectric waveguides. Moreover, due to the SPP field confinement and enhancement near the metal interface, various functionalities can be efficiently implemented with SPPs through nonlinear, electro-optical or thermo-optical effects.

A surface plasmon polariton is an electromagnetic wave coherently coupled to electron oscillations and propagating in a wavelike fashion along a metal-dielectric interface [1]. Being a surface wave, a SPP is intrinsically confined near the metal surface, exponentially decaying from it at a sub-wavelength distance in dielectric and in metal. A variety of two-dimensional optical elements for surface polaritons, such as mirrors, lenses, resonators, sources, detectors, etc., have been demonstrated [2]. Moreover, it is possible to implement various SPP waveguiding structures, such as metallic stripes and wires [3–5], grooves and gaps in a metal surface [6,7], metallic wedges [8,9], chains of metallic nanoparticles [10,11] *etc.*

A SPP wave, however, experiences attenuation as it propagates due to Ohmic losses in the metal. Thus approaches to increase SPP propagation length are of outmost importance for future of plasmonic circuits [12-14]. The concept of active plasmonics for switching and modulating of SPP waves all optically or electronically has been also proposed [5,15–18].

These developments facilitate various possible applications of SPPs in telecommunication networks, integrated photonics, and lab-on-a-chip systems.

One prospective type of the waveguide is the dielectric-loaded surface plasmon polariton waveguide (DLSPPW) formed by a dielectric stripe on the top of metal surface [19–25]. The advantage of DLSPPWs compared to other SPP waveguide types is that a dielectric ridge can be easily functionalized to provide thermo-optical, electro-optical, or all-optical functionalities and can be used for the development of active plasmonic components. Moreover, DLSPPWs fabrication is compatible with current lithography process used in the fabrication of electronic circuits. Combined with intrinsic possibility to control optical signals by electronic ones and *vise versa*, this can lead to the realization of hybrid electro-optical devices.

In this paper we will discuss various realisations of plasmonic components for integrated nanophotonic circuits with particular emphasis on the active functionalities such all-optical and electro-optical modulation and amplification of SPP signals.

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