Plasmonic waveguides: routers for light and efficient mediators between quantum emitters

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Surface Plasmons (SPs) are surface electromagnetic waves that decorate metal-dielectric interfaces. Despite the inherent absorption, the propagation length of these surface waves can be as large as hundreds of microns at telecom wavelengths. Additionally, SPs provide sub-wavelength confinement in the perpendicular direction.

In the first part of the talk we will review recent developments in the search for building-up a kind of (nano)-photonic circuitry based on the aforementioned capabilities of SPs. We will put more emphasis on three routes that look very promising. 1) The so-called channel plasmons (CPs) that run in V-grooves perforated on metallic films. These surface modes were theoretically predicted almost twenty years ago but its experimental realization has only been reported very recently [1]. Moreover, the first prototypes of photonic circuits based on CPs have been also presented [2]. We will describe in detail the propagation characteristics of these surface waves and how these properties can be tailored by just tuning the geometry of the groove [3]. 2) An alternative way for light routing uses the SPs that propagate along metallic wedges, termed as wedge plasmons (WPs). We will show how these WPs present similar propagation lengths to those of CPs but they present a more pronounced subwavelength confinement [4]. 3) Very recently, we have also reported [5,6] a new type of SPs that we term as domino plasmons as they are supported by a periodic chain of metallic box-shaped elements protruding out of a metallic surface. It is shown that the dispersion relation of the corresponding electromagnetic modes is rather insensitive to the waveguide width, preserving tight confinement and reasonable absorption loss even when the waveguide transverse dimensions are well in the subwavelength regime.

In the second half we will show how both the subwavelength confinement associated with SPs and the one-dimensional character of plasmonic waveguides can be exploited to enhance the coupling between quantum emitters. Resonance energy transfer and the phenomenon of superradiance will be analyzed in three different waveguiding schemes (wires, wedges, and channels).

References

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