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Perspective Article
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Photon-Plasmon Coupling from Rare-Earth Ions and Localized Surface Plasmon

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Plasmonics is an exciting and promising edge research, which can join electronics and photonics at nanoscale by providing us an actual solution to the problems of nanoscale integration and data transfer-rate. Such research area is so-called nanophotonics, one of the most promising frontiers of knowledge, from not only a scientific but also a technology strategy, dealing the light-matter interaction below the diffraction limit [1,2] and may potentially revolutionize the telecommunications, integrating optical, and sensing areas.

Rare-earth-ions (REI)s are, from our point view, the most promising elements because of their unique characteristics, such as their magnetic, luminescent, and electrochemical properties [1]. They suit newly emerging devices for their greater efficiency, high speed, greater durability, and their miniaturization potential. In this route, nanophotonics is not only about nanodevices, it is also about new ways of sculpting the flow of light by means of plasmonic nanostructures that exhibiting fascinating optical properties which we are learning to manipulate the quantum states of a REI and control its electromagnetic radiation at the nanoscale. With innumerable practical applications in telecommunication, clean energy, biophotonics, and medical testing.

In fact, surface plasmon (SP) can create evanescent fields penetrating the metal surface, up to several micrometers into the substrate r. Within this distance, a single REI represented by a two-level system with an electronic transition, can create an electromagnetic field that may strongly interact with SP, creating induced surface plasmons (ISPs) at the metal–dielectric interface. The frequency of these ISPs corresponds to the emission frequency of the REI, consequently, their emissions have the same spectral shape and are highly polarized as a result of induced polarization from the localized SP (LSP) [1,3]. Collective photon-plasmon interactions could have either a positive or negative impact for a specific electronic transition REI and depends on the efficiency of the coupling [2]. In this manner, we have the ability to engineer a way to counteract the losses in metal, modulate the down/up-conversion emission of the REIs [2-4], and control the polarization/phase of the REIs emission with applicability in areas afore-cited.

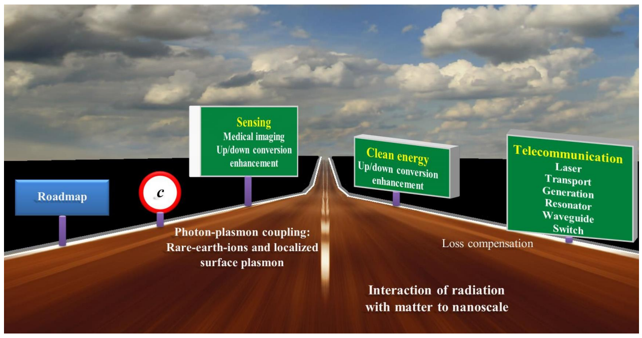

Figure 1: A roadmap based on the interactions of LSP with REIs. Three big areas are highlighted owing to their technological importance and benefits to society.

In Figure 1, we present a roadmap highlighting some exciting and as-yet-unexplored topics related to these points, with the promise of achieving the next stage of research in REIs and LSP coupling with a very fruitful and productive future.

References

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