Nanoplasmonics: Fundamentals & Applications

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Surface plasmon polaritons, often shortened to surface plasmons (SPs), represent hybrid excitations involving free electron oscillations in metals and electromagnetic fields in dielectrics that propagate along and strongly bound to metal-dielectric interfaces. These surface electromagnetic waves enable deeply subwavelength confinement of guided modes along with strong enhancement of optical fields, two major features of SP modes that have been and continue being advantageously exploited in plasmon-empowered nanophotonics [1]. It would be impossible to overview, even very briefly, all fascinating topics found within plasmonics that include metasurfaces, graphene and other 2D materials, strong-coupling phenomena, topological plasmonics, quantum plasmonics, hot-electron phenomena, and many other interesting topics (Fig. 1).

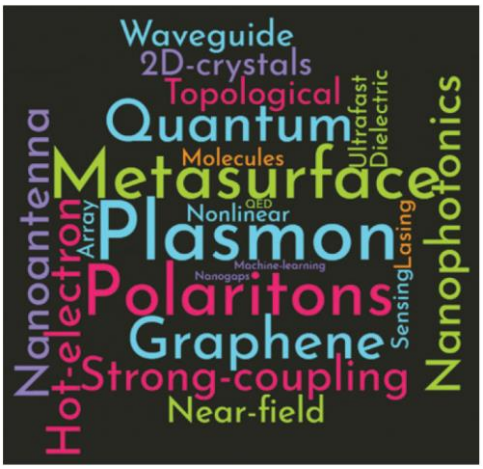

Figure 1. The breadth of research topics within plasmonics illustrated by a word cloud compiled from the book of abstract from the 9th International Conference on Surface Plasmon Photonics (SPP9) held in 2019 [2].

In this tutorial, the first part is devoted to introducing various SP modes supported by different configurations and their main physical characteristics that in turn determine the scope of their applications [1]. In the second part, special attention is given to the progress in ultra-compact photonic circuitry, including modulators and detectors, and plasmonic metasurfaces dynamically controlling propagation of light. In particular, the most efficient and ultrafast electro-optical modulators utilizing the commercially viable material, $LiNbO_3$, in which the radiation transport is controlled using the same metal circuitry for both guiding SP modes and delivering electrical signals, are presented [3]. Plasmonic metasurfaces, which can be considered as the two-dimensional analogue of metal-based metamaterials, used for room-temperature generation of single-photon streams carrying orbital angular momenta [4] and dynamic control of optical birefringence [5] are also discussed. A personal view on the nearest perspectives for plasmon-empowered nanophotonics concludes this talk.

REFERENCES

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