Plasmonic circuitry for future optical communications

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Surface plasmon polaritons (SPPs) can be seen as new optical carriers of information, enabling signal manipulation at the scale below the diffraction limit imposed by the currently used infrared light. Plasmonics has the potential to combine the best properties of both electronic and photonic worlds, leading to the development of new types of lasers, modulators, waveguides, photodetectors and other optical components with terabit-per-second speed implemented in nanoscale footprints. Application of plasmonics in optical communications would lead to integration of plasmonic circuitry with digital electronics, which in turn would open new opportunities in research applications and lay the foundation for the next-generation digital technology.

All these potential advantages of plasmonics have been recognized for more than a decade; however, they have not yet led to commercial products because the development of plasmonics has lagged the overall progress in optical communications. Since the end-unit footprints in optical communications need to be nanoscale, plasmons must be sub-nanoscale, which is very far from being achieved even in research laboratories. Another problem is the use of graphene, which is the promising direction for solving many problems in plasmonics application in optical communications. While the theoretical studies of graphene plasmonics are laying a solid foundation for the development of basic optical-communication components, most of the work is done in the spectral regions below that required for optical communications. In addition, experimental work in this direction meets great difficulties caused by the two-dimensional scale of graphene structures.

So, will we see plasmonic devices in the future optical communication systems and when? We believe that the answers to these questions will be found in consecutive research advances, and our paper is one of the steps in this direction. In this paper we consider a possible solution to one of the abovementioned problems. Specifically, we focus on plasmonic field modulation under two conditions: narrow-band coupling and the use of graphene as an intermediate layer between the conductor and the cover. We find that the graphene layer will increase coupling efficiency at the 1550 nm optical wavelength. We also analyze the enhancement in modulation performance caused by the insertion of the graphene layer in the plasmonic structure.