Invited Paper

Recent Progress in Optical Metatronics

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The field of electronics has witnessed unprecedented development in the 20th century, and continues to evolve and grow in the 21st century. There are several reasons behind the growth and success of this field, among which one can mention the modularization, parameterization, characterization, and isolation of circuit elements and components in electronics. In recent years, in my group we have introduced, developed, and experimentally verified and realized the notion of "optical metatronics" [1-6], i.e., metamaterial-inspired optical nanocircuitry, as a paradigm to bring analogous modularization and parameterization into the field of nanphotonics, and to conceive the ideas of lumped circuit elements in optics, similar to electronics. In the paradigm of optical metatronics, where the nanostructures with specific values of permittivity and permeability may act as the optical lumped circuit elements at the nanoscale analogous to the circuit elements in RF electronics, the three fields of "electronics", "photonics" and "magnetics" may be merged together. The concepts of metamaterials and plasmonic optics [7-9] have been utilized to bring these fields together. This has allowed us to transplant concepts from one field (e.g., electronics) into another (photonics).

As one of the applications of metatronics, it is of interest to investigate how certain collections of optical metatronic elements can form "functional systems", providing important wave-based platforms at the nanoscale for optical functionalities such as system tunability and reconfigurability, optical data processing and filtering, and hybrid nonreciprocal and anisotropic elements to name a few. We are also interested in how we can "digitize" optical metatronics, involving nanostructures as "meta-bits" and "meta-bytes", forming building blocks for binary metamaterials. Interesting optical functionalities may become possible using proper combinations of such meta-bits. Moreover, nonlinearity and nonreciprocity may be added to such optical circuit elements in order to endow such optical circuits with novel properties. Furthermore, we have also extended the notion of optical metatronics to the platform of graphene, proposing one-atom-thick mid-IR and THz circuits.

In this talk, I will present an overview of the recent progress in the field of optical metatronics, and will discuss future possibilities in this field.

References

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