Multifunctional Metagratings

Younes Ra'di and Andrea Alù
Department of Electrical and Computer Engineering, The University of Texas at Austin, Austin, TX 78712, USA

Metasurfaces, as two-dimensional arrays of polarizable particles, have revolutionized manipulation of light, due to the unprecedented level of control they provide over the flow of light. Gradient metasurfaces are an important class of metasurfaces that enable steering light into the desired direction. Although gradient metasurfaces have been extensively employed to engineer the direction in which light flows, it was recently revealed that these surfaces suffer from fundamental limits on their conversion efficiency. In addition, since these metasurfaces need to provide gradient surface impedance profiles, they require high resolution fabrication that complicates their fabrication process.

Recently, we proposed the concept of metagratings that takes a fundamentally different route in designing thin layers capable of efficiently rerouting the direction of light with much less fabrication complexity in comparison to the gradient metasurfaces (Y. Ra'di et al., Phys. Rev. Lett. 119, 067404, 2017). Based on this concept, by choosing the periodicity one of the diffraction orders is aligned with the desired direction to which we aim to reroute the incident wave. Next, the building block scatterer is engineered so as to have radiation nulls in the directions of all diffraction orders except the desired one. Soon after its introduction, this approach has resulted in new metagrating designs for wave manipulation in different portions of the electromagnetic spectrum (e.g., E. Khaidarov et al., Nano Lett. 17, 6267, 2017).

During our talk, we will present our recent progress on this concept. Notably, we will report new metagrating designs based on asymmetric electric dipoles that are practically easier to realize. In addition, we will present the design of tunable metagrating based on graphene. It will be shown that the proposed structure can provide multiple functionalities by tuning just two bias voltages. The efficiency of the proposed design is only limited by dissipation in graphene. The proposed reconfigurable metagrating can open new research venues in the context of highly-efficient wave manipulation using reconfigurable ultrathin devices.