

From Metamaterials to Metasurfaces

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Recent progress in the development of optical metamaterials allows unprecedented control over the flow of light at both the nano- and macroscopic scales. Metamaterials (MMs) are rationally designed artificial materials with versatile properties that can be tailored to fit almost any practical need and thus go well beyond what can be obtained with “natural” materials. We review the exciting field of optical metamaterials and discuss the recent progress in developing tunable and active MMs, nanolasers, artificial optical magnetism, semiconductor-based and loss-free negative-index MMs, and a new means for engineering the photonic density of states with MMs. A powerful paradigm of shaping space for light with transformation optics, which can enable a family of new applications ranging from a flat magnifying hyperlens to an invisibility cloak, will be also discussed. Finally, we review a new approach for controlling light by using meta-surfaces. Similar to the surface science that in the past revolutionized the physics and open up a family of new phenomena and applications unattainable with 3D systems, we envision that *metasurfaces* can make a difference for the fields of metamaterials and transformation optics as well as for the science of light in general.