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Optics with complex materials and (sub)nanostructures: introduction

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Comprising 15 contributed papers and three invited review papers, this feature issue is focused on theoretical and experimental research on electromagnetic optics with complex materials and (sub)nanostructures.

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Scientific and technological progress for the last two decades has been dominated by the conceptualization, characterization, fabrication, and application of many different classes of materials and structures. Although some are found in nature, others are entirely synthetic, created by chemical and physical processes, often at the nanoscale. Nanostructural engineering is often used to fabricate materials and structures with the same chemical composition but different optical response characteristics depending on nanoscale morphology. Certain materials are multi-phase nanocomposites designed for desirable response characteristics that are otherwise unavailable.

This feature issue is focused on theoretical and experimental research on electromagnetic optics with complex materials and nanostructures. Complex materials cannot be macroscopically described locally by just a single frequency-domain local constitutive parameter that is either a permittivity or a permeability. Complex composite materials arise from combining simple materials. By judicious design, their response characteristics may exceed, or be entirely different from, those of their component materials. Material complexity may engender multifunctionality. Interaction of electromagnetic fields with (sub)nanostructures requires quantum and/or semiclassical approaches for understanding, analysis, and design.

Original unpublished contributions were solicited on the following topics for publication after review: chiral, anisotropic, and bianisotropic materials; topological materials; low-dimensional materials; nonlinear and/or nonlocal materials; materials with (sub)nanoscale morphology including nanocomposite materials; quantum-well structures; macroscopic, mesoscopic, and atomic-scale models; and optical and optoelectronic applications. A few key researchers were invited to write review papers.

We received a total of 29 submissions, of which 18 were accepted for publication. Three of the accepted papers are invited review papers on: active metamaterial absorbers, polarimetry of biansiotropic materials, and optics of hyperbolic materials. The 15 contributed papers span: harmonic generation, metasurfaces, nanophotonics, nanoplasmonics, scattering and radiation, sensing, and surface waves. We expect that all 18 shall be of service to the optics and photonics research community.