EDITORIAL

Nanostructures + Light = 'New Optics'

Guest Editors

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Suddenly, at the end of the last century, classical optics and classical electrodynamics became fashionable again. Fields that several generations of researchers thought were comprehensively covered by the famous Born and Wolf textbook and were essentially dead as research subjects were generating new excitement. In accordance with Richard Feynman's famous quotation on nano-science, the optical community suddenly discovered that 'there is plenty of room at the bottom'—mixing light with small, meso- and nano-structures could generate new physics and new mind-blowing applications. This renaissance began when the concept of band structure was imported from electronics into the domain of optics and led to the development of what is now a massive research field dedicated to two- and three-dimensional photonic bandgap structures. The field was soon awash with bright new ideas and discoveries that consolidated the birth of the 'new optics'. A revision of some of the basic equations of electrodynamics led to the suspicion that we had overlooked the possibility that the triad of wave vector, electric field and magnetic field, characterizing propagating waves, do not necessarily form a right-handed set. This brought up the astonishing possibilities of sub-wavelength microscopy and telescopy where resolution is not limited by diffraction. The notion of meta-materials, i.e. artificial materials with properties not available in nature, originated in the microwave community but has been widely adopted in the domain of optical research, thanks to rapidly improving nanofabrication capabilities and the development of sub-wavelength scanning imaging techniques. Photonic meta-materials are expected to open a gateway to unprecedented electromagnetic properties and functionality unattainable from naturally occurring materials. The structural units of meta-materials can be tailored in shape and size; their composition and morphology can be artificially tuned, and inclusions can be designed and placed at desired locations to achieve new functionality. Among important developments in the new optics was the discovery that a metal film with arrays of small holes in it could be transparent to light beyond any intuitive expectations and that a properly designed metallic structure could be made completely 'invisible' at certain wavelengths. A strong technological drive towards device miniaturization (or, perhaps we should say 'nanoturization'?) has breathed new life into plasmonics—a field many thought had matured some time ago. Surface plasmon polarition waves have come to be seen as potential broadband information carriers for highly integrated photonic devices with research now concentrating on routing and controlling plasmon–polariton signals. Among other new topics in optical electrodynamics are frequency selective surfaces, optical effects of low-dimensional chirality and electrodynamics of toroidal structures.

This Special Issue on 'Nanostructured Optical Meta-Materials: Beyond Photonic Bandgap Effects' is a very representative cross-section of research in 'new optics', with papers covering essential issues in meta-materials research, surface plasmons, nanostructured surfaces, sub-wavelength imaging, nanostructured and random laser media and nonlinearities in nanostructured films.

As the Guest Editors of this Special Issue, we are deeply grateful to all contributing authors for their efforts and their willingness to share recent results within the framework of what promises to be a landmark collection of papers in the field of 'new optics'. We are especially proud that the authorship includes pioneers and newcomers to this intriguing and fertile field of research.