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Diffractive Optics and Nanophotonics

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Manipulation of optical fields by micro- and nanostructured media has undergone millions of years of evolution. The structural color identified in some animals is one example that permits the study of the role of light in ecosystems and its evolution history. To transfer this natural concept of subwavelength-structured optical interfaces to provide state-of-the-art optical systems, diffractive optics' essential role must be thoroughly understood. Diffractive optics is widely recognized as an important growth area in modern optics. The successful insight into the field of optical engineering and photonics offered by diffractive optics proves tremendous advantages over conventional bulk optics. The increasing demands and desire to improve telecommunication, optical computing, consumer electronics, laser material processing, biomedical sciences, and manipulation of nano-objects through micro-optical systems have driven the advance in diffractive optics, which creates a large number of new avenues in optical research and new directions in nanophotonics research.

The application of computer-designed diffractive optics contributes to the expansion of theoretical aspects underpinning diffractive optics, such as diffractive optical transformations, application of electromagnetic field theory for investigations of diffractive gratings, transverse modes of laser radiation, etc. Simultaneous to the theoretical consideration of the best profile form of diffractive optics, both top-down and bottom-up approaches to diffractive optical elements have been investigated to provide robust, low-cost, simplified designs and fabrication processes. Advancements in micro- and nanofabrication technologies and powerful computer simulation tools have made a broad range of diffractive optical components available to expand the already-established or highly promising technological applications.

This special section assembles papers related to a variety of diffractive optics and nanophotonics. It is our aim to share the latest developments in these exciting fields to both specialists and engineers working in these areas and to evoke their enthusiasm to further develop and improve diffractive optics. As a leading technology, the novel characteristics of silicon photonic devices based on binary blazed gratings is reviewed by Z. Zhou and L. Yu. The abundant optical features of diffractive optics elements are explored to look for their potential applications. The polarization effect induced by a bilayer absorber alternating phase shift mask is comprehensively investigated by L. Yang, Y. Li and K. Liu. The bandwidth, chromatic aberration, and polarization behavior of silicon-integrated scattering optical elements is analyzed by J. Marques-Hueso et al. S. V. Karpeev, S. V. Alferov, and S. N. Khonina propose a new polarization converter to transform the linearly polarized laser modes into axially symmetric modes.

Design and fabrication of micro-optical components are the key challenges to realize the manipulation of light. To alleviate the difficulty in precisely controlling the profile of the photoresist grating mask, Q. Liu, J. Wu, and M. Chen introduce a new method of fabricating blazed gratings. V. Gâté et al. demonstrate a fast dynamic interferometric lithography to produce a 600-nm period grating of over 20 cm in length. A new type of tunable liquid crystal diffractive lens which can be performed in low operating voltage and fast response time is shown by Y. Lou et al. H. Zhang et al. report that they designed an optimized microcavity structure to enhance the emission efficiency of the bottom-emitting gallium nitride (GaN) light-emitting diode.

In total, twenty two papers organized in this special section span a wide range of activities in the field of diffractive optics and nanophotonics. We are confident that this collection of state-of-the-art works will be valuable for experts and general readers alike, and will inspire further developments in this and other related topics.

Chunlei Du is currently a professor at the Institute of Green and Intelligent Technology, Chinese Academic of Sciences. Since the early 1990s she has lead a research group in micro/nano-optics that is engaged in micro-optical structures in the aspects of theoretic methods, components/systems design, and micro/nanofabrication. She worked in the groups of Micro Optics at the Paul Scherrer Institute in Zurich, Switzerland; the group of Applied Optics in Erlengen University, Germany; and the Centre for Micro-Photonics of Swinburne University of Technology, Australia, as a visiting scholar. She received research achievement awards from the Progress Prizes of Sciences and Technologies of Chinese Academy of Sciences and Sichuan Province; Chinese Youth Prize in Sciences and Technologies; and selection for the "State level project of a billion persons with ability" in China. She is also a Fellow of SPIE. She has published over 180 papers and 60 patents in the field of micro-optics, subwavelength metamaterials, and plasmonics.