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EDITORIAL

Photonic Crystal Devices

Editor-in-Chief

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The engineering of electromagnetic modes at optical frequencies in artificial dielectric structures with periodic and random variation of the refractive index, enabling control of the radiative properties of the materials and photon localization, was first proposed independently by Yablonovitch and John in 1987. It is possible to control the flow of light in the periodic dielectric structures, known as photonic crystals (PC). As light waves scatter within the photonic crystal, destructive interference cancels out light of certain wavelengths, thereby forming a photonic bandgap, similar to the energy bandgap for electron waves in a semiconductor. Photons whose energies lie within the gap cannot propagate through the periodic structure. This property can be used to make a low-loss cavity. If a point defect, such as one or more missing periods, is introduced into the periodic structure a region is obtained within which the otherwise forbidden wavelengths can be locally trapped. This property can be used to realize photonic microcavities. Similarly, a line of defects can serve as a waveguide.

While the realization of three-dimensional (3D) photonic crystals received considerable attention initially, planar two-dimensional (2D) structures are currently favoured because of their relative ease of fabrication. 2D photonic crystal structures provide most of the functionality of 3D structures. These attributes have generated worldwide research and development of sub-μm and μm size active and passive photonic devices such as single-mode and non-classical light sources, guided wave devices, resonant cavity detection, and components for optical communication. More recently, photonic crystal guided wave devices are being investigated for application in microfludic and biochemical sensing. Photonic crystal devices have been realized with bulk, quantum well and quantum dot active regions.

The Cluster of articles in this issue of *Journal of Physics D: Applied Physics* provides a glimpse of some of the most recent advances in the application of photonic crystals. The modelling of PC defect-mode cavities are described by Zhou *et al*. Ye and co-authors describe the concept and realization of a novel 3D silicon-based spiral PC. It is, in fact, the only article on 3D PCs. The design and realization of ultra-high Q heterostructure PC nanocavities are described by Song and co-authors. The concept of self-collimation of light in PCs and its applications are presented by Prather and co-workers. Experimental and numerical studies on the negative refraction related phenomenon in 2D PCs are the subject of the next article by Ozbay and co-authors. The emerging subject of slow light generation, control and propagation in PCs is presented in the next two articles by Baba and Mori and by Krauss. Finally, the progress made in the development of PC microcavity lasers and electrically injected microcavity light emitters and arrays is described, respectively, by O'Brien *et al* and by Chakravarty *et al*.

It is hoped that readers will get a sense of the exciting developments and the possibilities presented by heterostructure photonic crystals and their devices from reading the articles in this Cluster.