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Hernán Ruy Míguez
Sergei G. Romanov
Lucio Claudio Andreani
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Editors

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(Germany)

Introduction

The 2012 edition of the Photonic Crystal Materials and Devices Conference held in Brussels once again confirmed the importance of this research field. Photonic crystals represent a matured branch of nanophotonics evidenced by the growing number of submissions and participants. We aimed at the tradition of a program combining works focused on the theoretical description of materials and devices with their actual realization and characterization. We achieved a good balance of presentations held in well-established research areas, such as self-assembled photonic crystals or light propagation in photonic crystal waveguides, with sessions devoted to research aspects introduced in the last 2010 Conference, for example, photonic crystals for photovoltaic or sensing applications. A great interest was generated by the session on disorder-related optical effects, an area which is currently developing a high impact on photonic crystal research. A full new session was established to highlight the emergent area of photonic-phononic (so-called phoXonic) crystals, in appreciation of the growing interest for simultaneous control on different collective excitations by using periodic architectures.

Prospective applications

We must emphasize the continuous trend towards implementation of photonic crystals in optical devices. This year the Conference was inaugurated by the invited talk of Christelle Monat (Ecole Centrale de Lyon). Her presentation introduced the extraordinary developments that photonic crystal waveguides have experienced in the last years. The large number of follow-up presentations accentuated the attention to this topic, which involves the engineering of slow light modes and generation of non-linear interactions as issues of primary interest.

Reflecting the growing attention to applications of photonic crystals, the conference covered the exciting subject of novel biological and chemical sensing devices. Based on multifunctional photonic crystal structures this field evolves owing to the converging scientific expertise from different areas. A presentation on sensing devices based on slotted photonic crystal waveguides, offered by Andrea di Falco (University of Saint Andrews), opened a session in which we were introduced to novel proposals on gas detection by ordered ensembles of plasmonic rods or on photonic crystal cavity-enabled optofluidics.

The continuing involvement of photonic crystals in photon management in photovoltaic devices was highlighted in the invited talk by Ralf Wehrspohn, who presented the systematic investigation of exploiting silicon- and ZnO-inverted opals in tandem solar cells. The effect of periodic structuring on the light-to-current conversion efficiency of dyes was also discussed. Overall, the need in improving the solar-to-electric power conversion efficiency generates great interest to this research area. Photonic crystals offer light localization, slow propagating modes and optimized coupling towards enhancing the optical absorption. Current state of the art allows us to foresee exciting results in the next years.

Novel materials and effects

The mounting interest towards achieving photonic crystals with novel functionalities was inaugurated in the invited presentation given by Alexander Poddubny (Ioffe Institute of St. Petersburg). He presented theoretical insight in two issues, the photonic

crystals operating on combined electromagnetic excitations, like exciton-polaritons, and prospects of quasi-crystals as building blocks of future nanophotonic architectures. The following talks supported this vision by discussing photonic crystals exploiting plasmonic and magnetic excitations.

The enormous impact on the field made by novel material structuring techniques, such as two-photon polymerization, was well illustrated by the work of Georg von Freymann (University of Kaiserslautern) presented on the last day of the conference. By executing precise control on the degree of structural disorder and by bringing the quasi-crystal ordering, a systematic study of the optical response was made possible. Fundamental cross-correlations can be established between the effects of controllably introduced disorder in self-assembled opal-like materials, as presented by Cefe López (Spanish Research Council) and those observed from crystals, quasi-crystals, and disordered structures realized by laser writing techniques.

We were honored by the speech of Yasuhiko Arakawa (University of Tokyo), who opened an exciting session on photonic crystal cavities. From his talk and follow-up presentations we learned about recent advances in quantum electrodynamics of active nanocavities such as the design of high quality factor microresonators, special characterization techniques, coupling devices and studies of "photonic molecules".

Traditional discussion of recent findings in preparation and studies of self-assembled photonic crystals was also supported by this Conference. The audience was impressed by the methods of large scale preparation based on roll-to-roll self-assembly of polymeric core-shell particles, presented by Andrew Haines (University of Cambridge), which certainly advances these traditionally lab scale materials closer to commercialization. A series of talks on fundamental studies, like that given by Mikhail Limonov (Ioffe Institute of St. Petersburg) on the transition from 2D to 3D diffraction in colloidal crystals, or that devoted to modification of absorption by plasmonic nanoparticles, complemented this session.

With the active participation of the members of the FP7 European Project "FoxTail" a full session was newly introduced on the subject of photonic-phononic crystals. We were acquainted to this field in the opening talk by Vincent Laude. The relevance and technological potential of controlling the acousto-optic interaction in periodic lattices was highlighted in the different presentations on the subject.

The poster session on Wednesday 18 April was very lively, with a number of interesting papers on various fundamental and applied aspects of photonic crystal research. We are glad that many poster presentations, as well as oral ones, are represented by manuscripts in this volume.

In summary, the year 2012 Photonic Crystal Materials and Devices Conference (8425) became a forum for exchange of the latest information and establishing scientific collaborations. The quality of presented papers, stimulating discussions, and wide international attendance with many young faces in the audience, bring confidence in the future of this field.

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