Photonic Crystals: Optical Materials for the 21st Century

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Progress in photonics is closely connected to development of optical materials which allow controlling the flow of light. Photonic Crystals represent a novel class of materials which elevates the concept of steering of light to a new level: A spatially periodic varying index of refraction leads to the formation of a photonic bandstructure that may exhibit ranges of frequencies for which ordinary propagation of electromagnetic radiation is forbidden. As a consequence, these artificial materials profoundly influence the propagation characteristics of light as well as the radiation dynamics of optically active materials embedded in Photonic Crystals.

In this talk I will introduce the basic physical concepts of Photonic Crystals. This will be followed by a discussion of some of the most promising fabrication techniques of these materials. Based on this, I will give illustrative examples of both experimental and theoretical characterizations of Photonic Crystals. Finally, I will discuss selected applications of Photonic Crystals from the fields of integrated photonics and also highlight possibilities to localize light in nonperiodic systems. Especially it is shown that adhering to some restrictions in the acceptable lattice transformations one can achieve omnidirectional photonic bandgaps for an entire sub-class of such structures. We demonstrate, designing an efficient arbitrary-angle waveguide bend, that curvilinear-lattice photonic crystals can be employed for the creation of original types of nano-photonic devices.