Novel Designs and Materials for Electro-Optically Tunable Photonic Crystals

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A long standing challenge in photonics is the implementation of a nanophotonic circuit into a noncentrosymmetric medium which exhibits a second order nonlinear optical susceptibility based on electronic displacement polarization [1]. The inherent quasi instantaneous response of the nonlinear polarization in such media generates the potential of ultrafast electrooptical submicrometer photonic devices with switching bandwidths well beyond 100GHz. Such functionalities will play a vital role in next generation computer technologies.

We first report on electro-optical modulation with a sub-1-V sensitivity in a photonic crystal slab waveguide resonator which contains a nanostructured second-order nonlinear optical polymer [2]. The electro-optical susceptibility in the core was induced by high electric-field poling. A square lattice of holes carrying a linear defect was transferred into the slab by electron-beam lithography and reactive ion etching, creating a photonic crystal slab-based resonator. Applying an external electric modulation voltage to electrodes leads to a linear electro-optical shift of the resonance spectrum and thus to a modulation of the transmission at a fixed wavelength based on the electronic displacement polarization in a noncentrosymmetric medium (Pockels effect). This effect is therefore inherently faster than other reported electro-optic modulation effects in nanophotonics.

In this contribution we will further report on our approach to enhance the functionality of the initial design. We demonstrate that even in low index material systems the Q factor of microresonators can be enhanced by orders of magnitude by tapering of the hole radius and/or position. We also were able to realize a photonic-bandgap microcavity in a ridge waveguide, thereby creating a 3D light confinement in a low index material system. Furthermore we have investigated the second order nonlinear optical susceptibility of new chromophores and polymer systems that are possible candidates to accomplish low voltage electrooptical modulation in our nanophotonic cicuits.

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[2] M. Schmidt, M. Eich, U. Hübner, R. Bucher, *Appl. Phys. Lett.* **87**, 121110 (2005)