Convential and Tunable Photonic Structures based on Silicon for Micro-Photonics and Optical Interconnects

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Abstract

This presentation is mainly focussed on the design, fabrication and characterisation of the conventional and tunable photonic devices based on grooved silicon, serving as one-dimensional (1D) photonic crystal. Depending on the lattice parameter, the structures possess not only a main photonic band gap in the region of 10-30 um, but also a number of secondary band gaps extended to the near infrared range of spectra. The possibility of PBG extension by introducing a silicon wall thickness disorder into the photonic structure have been shown theoretically and experimentally. The advantages of these photonic structures are as follows: the large refractive index contrast, in-plane moulding of the light flow, the possibility to fabricate a composite photonic structures by filling the grooves with a different compounds and compatibility with current semiconductor processing techniques. The optical properties of grooved Si structures were simulated using a transfer matrix method and band diagram method and have been verified experimentally using FTIR spectrometer in conjunction with IR microscope. The air spaces in the basic silicon-air matrices as well as in micro-cavity were then infiltrated with nematic liquid crystal E7. It is shown that the optical properties of the obtained composite 1D photonic crystals can be tuned by means of electro- and thermo-optical effects. Such a structures suit well for the various elements of the integrated optics, micro-photonics and can serve as a building blocks for optical interconnects.

Selected relevant publications:

1. V.A. Tolmachev, T.S. Perova, S.A. Grudinkin, V.A. Melnikov, E.V. Astrova, Yu.A. Zharova, Electro-tunable in-plane one-dimensional photonic structure based on silicon and liquid crystal, Appl.Phys.Lett., **90**, 011908-10 (2007).
2. E.V. Astrova, T.S. Perova, Ju.A. Zharova, S.A. Grudinkin, V.A. Tolmachev, and V.A. Melnikov, Electro-tunable one-dimensional photonic crystal structures based on grooved silicon infiltrated with liquid crystal, J.Lumines., **121**, 298-300 (2006).
3. V.A. Tolmachev, T.S. Perova, and K. Berwick, Design of 1D composite photonic crystals with an extended photonic band gap, J. Appl. Phys., **99**, 033507/1 – 033507/5 (2006).
4. A.V. Tolmachev, T.S. Perova, E.V. Astrova, J.A. Pilyugina, R.A. Moore, Experimental verification of photonic band gap extension for disordered 1D photonic crystal based on Si, Optics Communications, **259**, 104-106 (2006).
5. V.A. Tolmachev, T.S. Perova, and R.A. Moore, Method of Construction of Composite One-Dimensional Photonic Crystal with Extended Photonic Band Gaps, Optics Express, **13**, 8433 (2005).