P12

Peculiarities of laser-processed photonic crystal-based waveguides for terahertz and sub-terahertz frequencies

Vincas Tamošiūnas[1,2], Simonas Indrišiūnas[3], Linas Minkevičius[1], Gediminas Račiukaitis[3], Irmantas Kašalynas[1] and Gintaras Valušis[1]

[1]Department of Optoelectronics, Center for Physical Sciences and Technology, Saulėtekio Ave. 3, LT-10257 Vilnius, Lithuania.
[2]Institute of Photonics and Nanotechnology, Vilnius University, Saulėtekio Ave. 3, LT-10257 Vilnius, Lithuania.
[3]Department of Laser Technologies, Center for Physical Sciences and Technology, Savanorių Ave. 231, LT-02300 Vilnius, Lithuania.
Email: vincas.tamosiunas@ff.vu.lt

Terahertz integrated electronic and hybrid electronic - photonic systems have undergone significant development during the past decade, thus opening new sensing, imaging and communication application possibilities, enabled by new architectures rather than the development of single devices [1]. Photonic crystal-based waveguides and resonant cavities can be efficiently employed for beam steering and sensing applications in such systems [2].

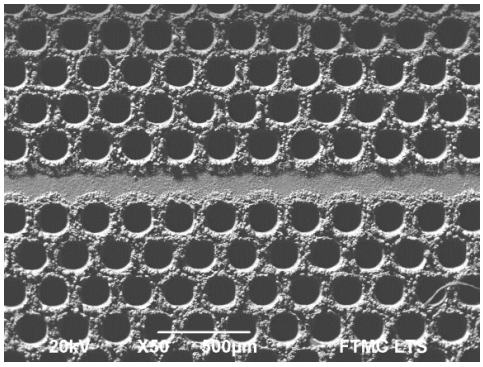

Fig. 1 SEM (scanning electron microscope) image of laser-processed PC-based waveguide.

In this paper, we report on properties and peculiarities of photonic crystal (PC) based waveguides manufactured using laser ablation techniques. These fabrication techniques possess remarkable flexibility to produce complex three-dimensional shapes, such as multi-level Fresnel lenses [3]. However, beam delivery peculiarities require special attention when designing deep and narrow structures, such as anti-reflective and phase-correcting metamaterial layers [4].

Comprehensive series of numerical simulations were applied to optimise PC structures for laser processing of highly resistive silicon (HR-Si) wafer for target frequencies of 0.15 THz and 0.3 THz. Test structures were ablated to confirm the validity of the proposed design. Image of one such structure is presented in Fig. 1. Results of our investigations revealed the broader beam confinement control possibilities of laser – processed waveguides in comparison with ones obtained by reactive ion etching techniques.

REFERENCES

[1] K. Sengupta, T. Nagatsuma, and D. M. Mittleman; *Nature Electronics* **1** (2018) pp. 622–635.
[2] O. Kazuma, K. Tsuruda, S. Diebold, S. Hisatake, M. Fujita, and T. Nagatsuma; *J. Infrared Milli. Terahz. Waves* **38** (2017) pp. 1085–1097.
[3] S. Indrišiūnas, H. Richter, I. Grigelionis, V. Janonis, L. Minkevičius, G. Valušis, G. Račiukaitis, T. Hagelschuer, H.-W. Hübers, and I. Kašalynas; *Opt. Lett.* **44** (2019), pp. 1210–1213.
[4] M. Tamošiūnaitė, S. Indrišiūnas, V. Tamošiūnas, L. Minkevičius, A. Urbanowicz, G. Račiukaitis, I. Kašalynas, G. Valušis; *IEEE Trans. Terahertz Sci. Technol.* **8** (2018), pp. 541–548.