

Synthesis and Characterization of Opal-Like Photonic Crystals Using Combined Methods

A.A. Akhmadeev^{1a} and M.Kh. Salakhov^{1,2}

¹*Kazan Federal University, Institute of Physics, 18 Kremlevskaya Str. Kazan 420008, Russia*

²*Tatarstan Academy of Sciences, 20 Bauman Str. Kazan 420111, Russia*

Abstract. We investigate the influence of various factors on the synthesis of photonic crystals. These materials are promising for the creation of various devices, as well as for the observation of new effects due to their unique properties. Photonic crystals were synthesized by self-assembly of colloidal silica particles with low deviation in size. The parameters of the photonic crystals were investigated by complementary techniques, including atomic force microscopy, optical spectrophotometry and other methods. It is shown that the measurement accuracy increases with the combined use of these techniques; the results of the study allow us to obtain samples with the desired properties.

Keywords: photonic crystal, colloidal particles

A photonic crystal (PC) is a material with a periodic spatial distribution of the refractive index having a photonic bandgap in the spectrum of electromagnetic states [1]. Currently there are numerous approaches to the creation of photonic crystals based on lithography, interference holography and self-assembly of colloidal particles. In particular, a method based on the self-assembly of colloidal particles with low deviation in size is cheap and simple to implement and allows to obtain a large number of samples of artificial opals for a short time. The samples produced by the majority of existing methods have various structural defects, which significantly affect their optical properties. Thus, our most important tasks are: investigation of the influence of synthesis conditions on the samples in order to improve the production methods and the improvement of methods for determining the characteristics of the photonic crystals. In addition, the improvement of the production method of PC could be crucial for the manifestation of a new quantum-electrodynamical effect predicted in earlier works [2]. In this study the photonic crystals were synthesized by self-assembly of colloidal particles of silicon dioxide. The parameters of the photonic crystals, such as the lattice period, particle size and effective refraction index were investigated by complementary techniques, including atomic force microscopy, optical spectrophotometry. It is shown that the measurement accuracy increases with the combined use of these techniques; the results of the study allow us to obtain samples with the desired properties.

References

1. E. Yablonovitch, Phys. Rev. Lett. **58**. P. 2059-2062. (1987)
2. R.K. Gainutdinov, M.A. Khamadeev, M.K. Salakhov, Phys. Rev. A. **85**, No 5. P. 0538362. (2012)

^a Corresponding author: Albert.Akhmadeev@kpfu.ru