Bending and splitting of self-collimated beams in two-dimensional photonic crystal slabs

Sun-Goo Lee, Sang Soon Oh, Jae-Eun Kim, and Hae Yong Park^{*} Department of Physics, Korea Advanced Institute of Science and Technology, Taejon 305-701, Korea

Chul-Sik Kee Advanced Photonics Research Institute, Gwangju Institute of Science and Technology, Gwangju 500-712, Korea

Recently, the anomalous light propagation inside photonic crystals such as superprism [1], self-collimation [2], and negative refraction phenomena [3], has been intensively studied. In particular, there have been several works to realize an optical integrated circuit using self-collimated beams [4,5]. However, the lack of understanding on bending and splitting mechanism for self-collimated beams has rendered this optical integrated circuits unpractical yet.

In a recent study [6], we found theoretically that by using line defects bending and splitting of self-collimated beams can be efficiently controlled in ideal two-dimensional photonic crystals. For practical applications, however, systematic studies in two-dimensional photonic crystal slabs must be preceded. In this work, we present a computational study on the self-collimated propagation and the line defect derived beam bending and splitting phenomena in two-dimensional silicon based photonic crystal slabs supported by SiO₂ cladding. We first present an analysis of photonic band structures. Then we report simulation results obtained using the finite-difference time-domain method. Quantitative relation between the radius of defect holes and the power ratio of two split self-collimated beams is intensively discussed.

*Email: hypark@kaist.ac.kr

- [1] H. Kosaka, T. Kawashima, A. Tomita, M. Notomi, T. Tamamura, T. Sato, and S. Kawakami, *Phys. Rev. B*, **58**, 10096 (1998).
- [2] H. Kosaka, T. Kawashima, A. Tomita, M. Notomi, T. Tamamura, T. Sato, and S. Kawakami, *Appl. Phys. Lett.*, **74**, 1212 (1999).
- [3] S. Foteinopoulou, E. N. Economou, and C. M. Soukoulis, *Phys. Rev. Lett.*, **90**, 107402 (2003).
- [4] X. Yu and S. Fan, Appl. Phys. Lett., 83, 3251 (2003).
- [5] D. W. Prather, S. Shi, D. M. Pustai, C. Chen, S. Venkataraman, A. Sharkawy, G. J. Schneider, and J. Murakowaki, *Opt. Lett.* **29**, 50 (2004).
- [6] S. -G. Lee, S. S. Oh, J. -E. Kim, H. Y. Park and C. -S. Kee. in preparation.