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Fabrication of two-dimensional special photonic crystals by symmetry-lost beam interference lithography

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Abstract: An optical interference holographic setup with a symmetry-lost five or four-beam configuration is used to obtain two-dimensional special photonic crystals. By altering beam configuration and polarization combinations, novel structures can be achieved, such as tai chi-like, tadpole-like, and flag-like patterns. The experimental results with SU8 photoresist are the same with simulation. Process of two-dimensional special photonic crystals could provide an effective guidance for experimental design and fabrication of other complex structures, and thereby, promote the development and applications of novel photonic crystals.

Keywords: photonic crystal; interference lithography; symmetry-lost beams

1. Introduction

Photonic crystal (PC), a new band-gap structure, proposed in 1987 by Yablonovitch ^[1] and John ^[2], has significant application potentials in micro-nano photonic materials, based on its various interesting properties of localization, photonic band-gap, and light transmission. Two-dimensional (2D) PC has great potentials for surface lasing ^[3], optical waveguide ^[4, 5], and high-Q cavity laser ^[6]. Thus, a growing number of researchers are engaged in the research of theory and experiment on 2D PCs. At present, there are many techniques to fabricate photonic crystal, including direct laser writing ^[7], e-beam direct writing ^[8], electrochemical corrosion ^[9], nanoimprint ^[10], and interference lithography ^[11].

Interference lithography, a method combining the techniques of multiple-beam interference and photolithography to record the interference pattern in photoresist, has many applications in fabricating PCs, quasi-crystals and optical periodic structures ^[12-15]. It is a simple method to fabricate PC and has several major advantages than other techniques. Firstly, it's mask-free, low-cost and high-efficiency to manufacture large area PC. Secondly, the parameters of beam configuration, intensity, polarization, incident angle and azimuthal angle can be varied freely, resulting in various changes

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