Fabrication of all-garnet magneto-photonic crystals for optical and nonlinear-optical applications

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Photonic technology, dealing with photons as an alternative to electrons as carriers of information, replaces or supplements microelectronics in modern communication and informatics systems. One of the important issues regarding the application of photonic band gap (PBG) materials is the development of the magneto-photonic crystals [1] (MPC). MPC yield a mechanism for molding the flow of light flexible under external control impacts. In this work the design and fabrication of the one-dimensional MPC composed from Bi-substituted garnet films are presented. The giant enhancements of the Faraday rotation angle and the magnetization-induced second-harmonic generation [2] (MSHG), which are observed at the PBG edge, demonstrate the strong light-matter magnetic coupling in MPC and provide the prospects of these new magneto-optical materials for applications.

MPC are grown by the RF sputtering of alternating quarter-wavelength-thick layers of Bi-substituted yttrium-iron-garnet (Bi:YIG) and silicon oxide onto a fused quartz substrate. After sputtering of each Bi:YIG layer, the sample is annealed in air at 700^0C for residual oxidation and crystallization of garnet film. The studied MPC samples are consisted of 4 or 6 Bi:YIG layers with thickness of 95 nm and of 3 or 5 silicon oxide layers with thickness of 145 nm, respectively. The SEM images of the MPC cleavage show the sharp interfaces between layers and the high lateral quality of MPC. The coercitivity of MPC measured in vibrating sample magnetometer is about 30 Oe and is similar for both in-plane and normal magnetic-field application. The linear transmission spectroscopy shows the noticeable PBG centered near 900 nm with the spectral width of 150-200 nm and transmission coefficient inside PBG below 0.01. Spectroscopy of Faraday rotation demonstrates the enhancement of the polarization rotation angle till 1.2 degrees for wavelength of 1100 nm corresponding to the PBG edge. The intensity spectrum of MSHG measured in reflection in transversal Kerr effect reveals the 100-times enhancement at the PBG edge.

References

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