

Laser-written three dimensional nonlinear photonic crystals

Feng CHEN (✉)

School of Physics, Shandong University, Jinan 250100, China

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Femtosecond laser writing is a powerful three dimensional (3D) engineering technique for materials processing. It has been used to modify the refractive index of dielectric materials (e.g., glass, crystals) to construct optical waveguides for diverse applications. Lithium niobate (LiNbO_3) is a multifunctional crystal with excellent nonlinear optical properties. Nonlinear photonic crystal (NPC) could control nonlinear optical interactions through quasi-phase matching (QPM) due to the periodical nonlinear coefficients. Although the 1D and 2D NPCs have been fabricated by electric-field poling, the implementation of 3D NPCs remains as a major challenge in nonlinear optics because of the limitation of traditional poling methods.

Wei et al.¹⁾ [1] demonstrated a new technique to fabricate 3D NPC in LiNbO_3 crystal by using femtosecond laser engineering of domain structures. Instead of the traditional domain inversion, the authors utilized femtosecond laser pulses to selectively erase the nonlinear coefficients in LiNbO_3 crystal, by which the domain structures of the whole crystal were modulated in a periodic way. This design was considered to satisfy the QPM mechanism as well. By using a Čerenkov-type second-harmonic (SH) confocal microscopy, the effective conversion efficiency based on laser-engineered LiNbO_3 was comparable to that of typical QPM processes. This work demonstrates the advantage of femtosecond laser 3D writing for materials processing, and paves a way to construct intriguing nonlinear optical platforms for controlling nonlinear interacting waves in 3D configuration.

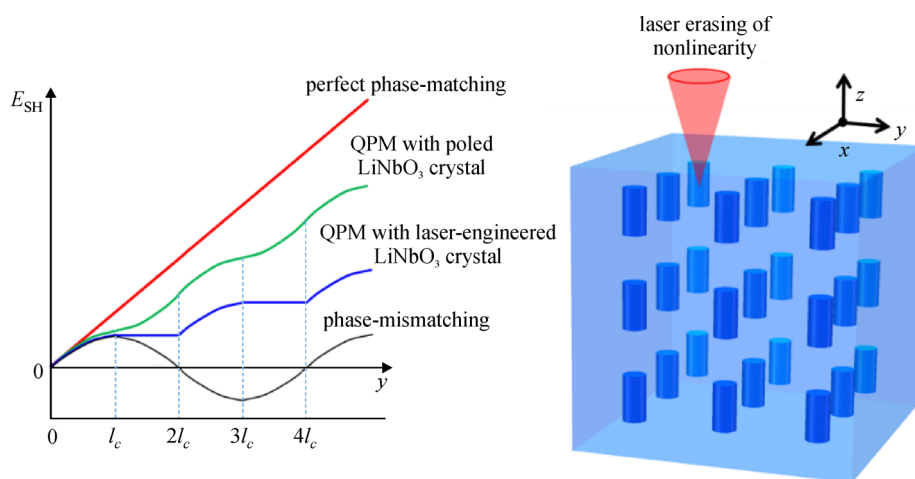


Fig. 1 QPM mechanism in the laser-engineered 3D LiNbO_3 crystal [1] (with permission from Springer Nature)

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E-mail: drfchen@sdu.edu.cn

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Reference

1. Wei D, Wang C, Wang H, Hu X, Wei D, Fang X, Zhang Y, Wu D, Hu Y, Li J, Zhu S, Xiao M. Experimental demonstration of a three-dimensional lithium niobate nonlinear photonic crystal. *Nature Photonics*, 2018, 12(10): 596–600



Feng Chen is a Professor at School of Physics, Shandong University, China. He received the degrees of Bachelor of Science and Doctor of Science (Ph.D.) from Shandong Normal University in 1997 and Shandong University in 2002, respectively. After he finished his doctoral dissertation he stayed at Shandong University as a Lecturer. Afterwards, he spent 2 years at

Clausthal University of Technology, Germany, from 2003 to 2005, as an Alexander von Humboldt Research Fellow. He became a

Professor at Shandong University in 2006. His research interests include fabrication of micro-nanoscale photonic structures, optical waveguides, ion beam modification of nanomaterials, laser writing, plasmonics, lasers, nonlinear optics, etc. He has more than 300 papers published in peer-reviewed journals, 2 book chapters, and holds 7 patents.

Feng Chen is a Fellow of Institute of Physics (IOP), UK, a Senior Member of Optical Society of America (OSA), a Senior Member of SPIE, and a Director Board Member of Chinese Physical Society. He also serves as Editorial Board Member of *Optical Engineering*, *Scientific Reports*, and *Chinese Optics Letters*, and an active reviewer for more than 50 peer-reviewed scientific journals. He has given invited talks in about 50 international conferences/workshops. He also serves as an international Project Proposal Reviewer for Swiss National Science Foundation (SNSF), Agence Nationale de la Recherche (ANR), and Australian Research Council (ARC).