# 2차원 비선형 광결정 제작 및 2, 3, 4차 조화파의 동시 생성

# Fabrication of two-dimensional nonlinear photonic crystals and simultaneous 2nd, 3rd and 4th harmonic generations

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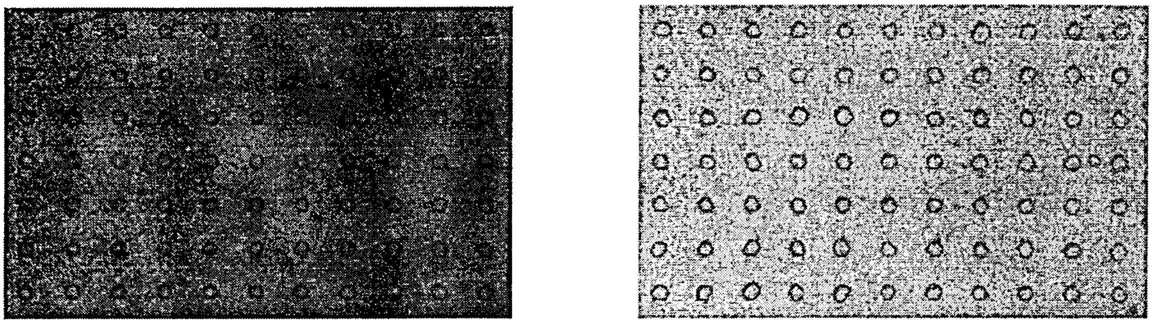
Periodic modulation of refractive index or linear optical susceptibility $\chi^{(1)}$ forms photonic crystal structures, which give rise to very interesting phenomena, such as photonic band gaps[1, 2]. Likewise, periodic modulation of second-order nonlinear optical susceptibility $\chi^{(2)}$ provides nonlinear photonic crystal structures[3, 4], which are very promising for wavelength conversion because of its high conversion efficiency and easy wavelength tunability. The nonlinear photonic crystal structures can be fabricated artificially by periodic poling of ferroelectric crystals. Since vector phase-matchings necessary for efficient generation of harmonic waves in various directions are available with an aid of reciprocal lattice vectors, it is possible to generate several multi-harmonics of a fundamental wavelength simultaneously in the two-dimensional nonlinear photonic crystals[4].

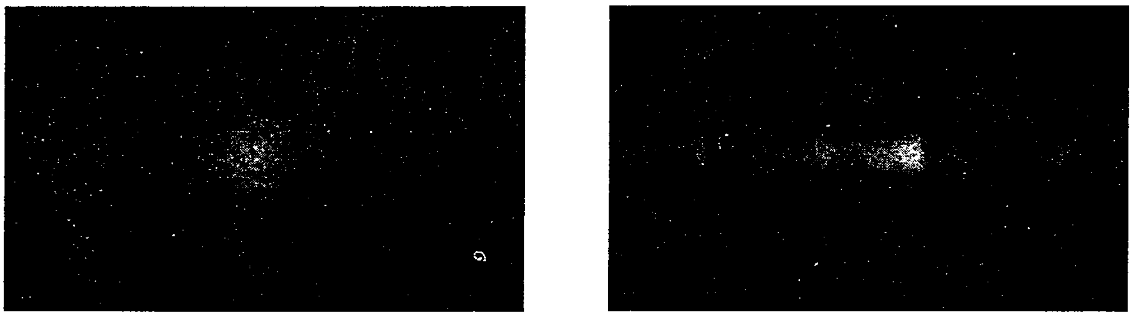
Two-dimensional nonlinear photonic crystals based on a lithium niobate ($LiNbO_3$) crystal were fabricated by an electrical poling technique. The $LiNbO_3$ crystals of a single domain were cut and polished in such a manner that the largest second-order nonlinear coefficient of $d_{33}$=27.2pm/V can be utilized[5]. The single domain $LiNbO_3$ crystal plates of 4 mm diameter and 0.2 mm thickness were electrically poled with a square lattice pattern of 19 μm periodicity. Fig. 1 shows the etched surface of both +c and −c faces of the fabricated $LiNbO_3$ nonlinear photonic crystal.

Second (775 nm), third (516.7 nm) and fourth (387.5 nm) harmonics were simultaneously generated by using an optical parametric oscillator, operating at 1550 nm wavelength with a pulse width of 20 ns (Fig.2). The phase-matching angles for multiple harmonic generations were theoretically calculated based on the nonlinear Bragg law. The nonlinear Ewald construction and the calculated phase-matching angles showed an excellent agreement with the experiments.



+C　　　　　　　　　　-C

Fig 1. Fabricated two-dimensional nonlinear photonic crystal based on $LiNbO_3$.



Second harmonic (775nm)　　　　　　　　　　Third harmonic (517nm)

Fig 2. Simultaneously generated second and third harmonic beams of the fundamental wavelength at 1550nm.

References

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