2019「中技社科技獎學金」

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The study of advanced integrated laser and quantum photonics chips and devices

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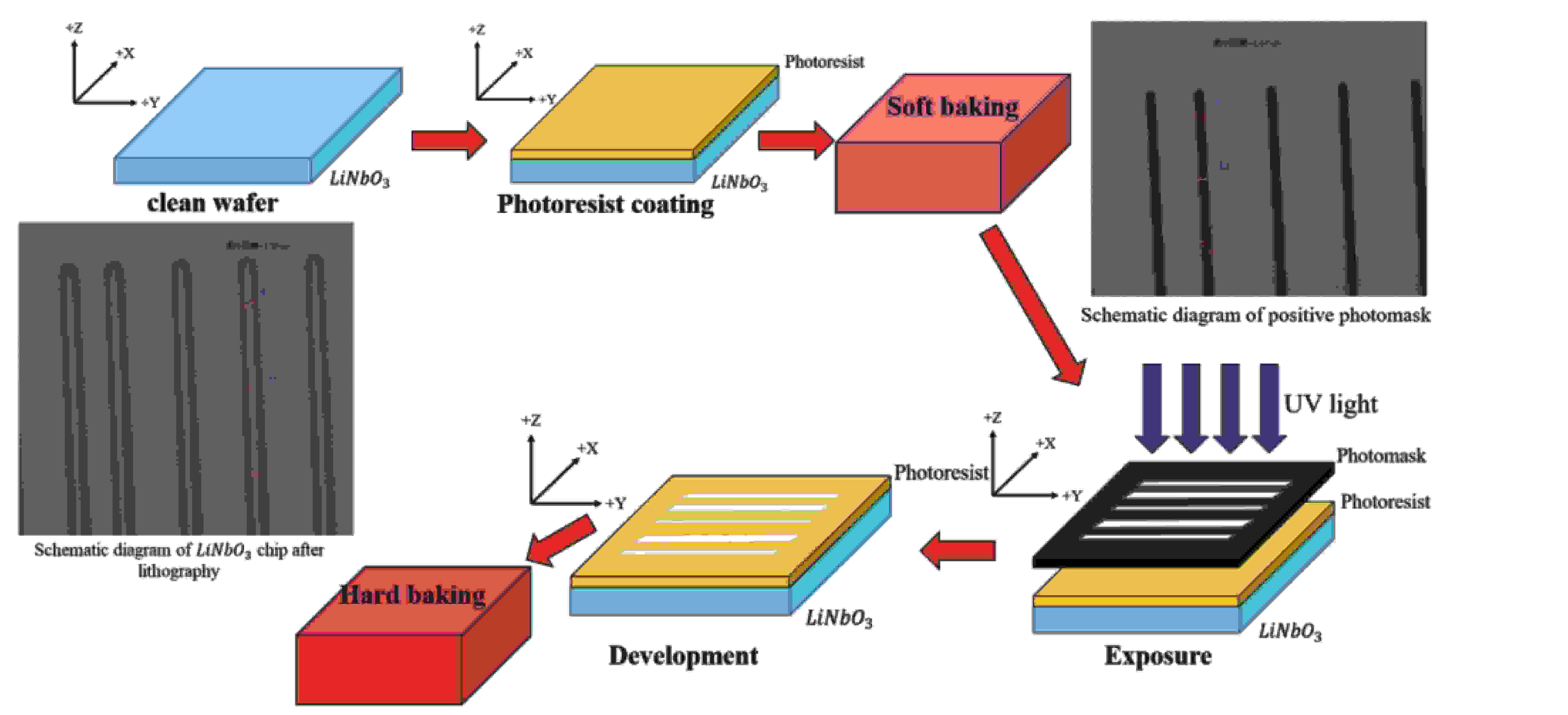
Introduction

By utilizing the E-O effect, we can apply y-field to modulate the polarization state, wavelength and bandwidth of OPO signals, or to select different cavity modes,... of the optical parametric signal. In this experiment, the multi-wavelength electro-optic polarization modulator and multi-wavelength optical parametric oscillator were successfully integrated into a single aperiodic poled lithium niobate chip, the multi-wavelength optical parametric oscillator and the electro-optical polarization modulator are designed at central wavelengths 1540 nm and 1550 nm in the optical communication band, which can generate a dual-wavelength optical parametric oscillator without an external electric field. When applying a y-direction electric field 360 V/mm and 790 V/mm, the 1540 nm and 1550 nm optical parametric oscillator signal modes can be selected respectively, and the bandwidths are 0.07 nm and 0.09 nm, respectively. The consistency of the simulation and the experimental results show that we have successfully realized a proof-of-principle electro-optic frequency selective integrated optical devices in the optical communication band. Three different Q-switch systems are applied to achieve different wavelengths at an electric field of 0 V/mm, 267 V/mm and 685 V/mm, respectively. We report the first multi-line optical parameter oscillator (OPO) whose spectrum can be electro-optically switched using an APPLN working as an optical parametric down converter (OPDC) and an EO spectral filter between 1540 nm, 1550 nm, and both wavelengths.

Fabrication

We fabricated the novel APPLN device in a 3-cm-long, 1-mm-wide, and 0.5-mm-thick z-cut LiNbO3 chip using the standard electric-field poling technique. The fabricated APPLN device was then positioned in a linear OPO resonator formed by a 10-cm radius-of-curvature meniscus dielectric mirror (pump side) and a plane-plane dielectric mirror (output coupler with ~94% reflectivity in 1.5-m band). The pump is a Q-switched 1064-nm laser.



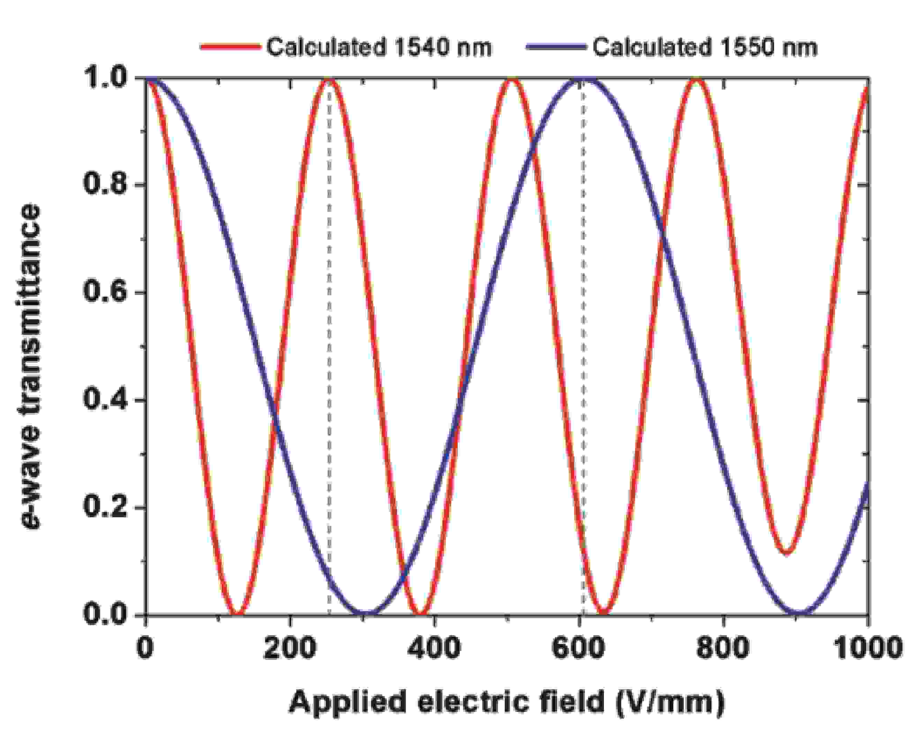


Fig. 2 Calculated round-trip e-wave transmission curves of the APPLN device versus the electric field Ey for e-polarized 1540 and 1550 nm input waves.

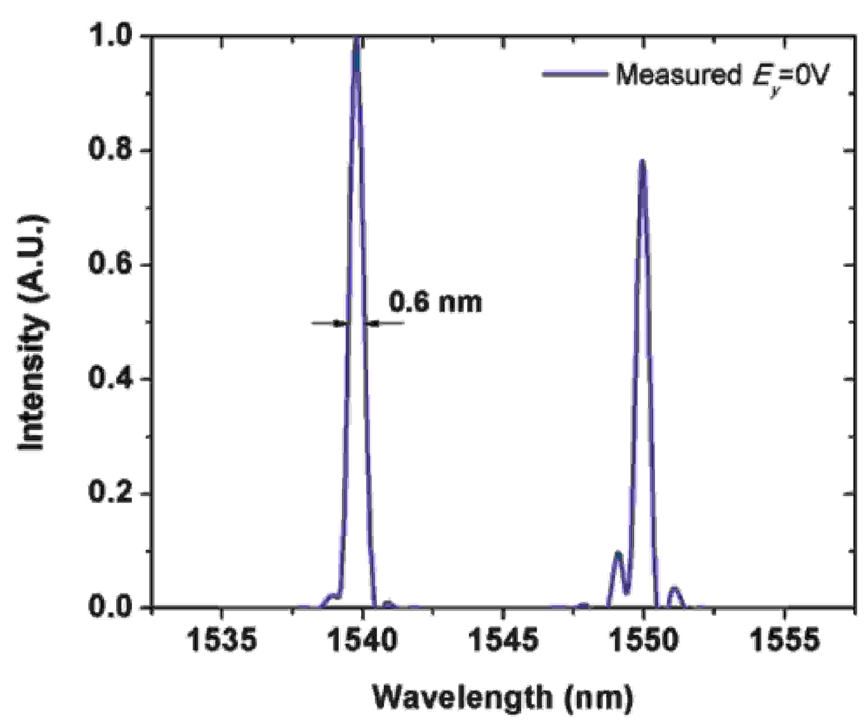


Fig. 3 Measured output spectrum of the dual-wavelength OPO at Ey=0 V/mm under a pump power of 9.6 kW.

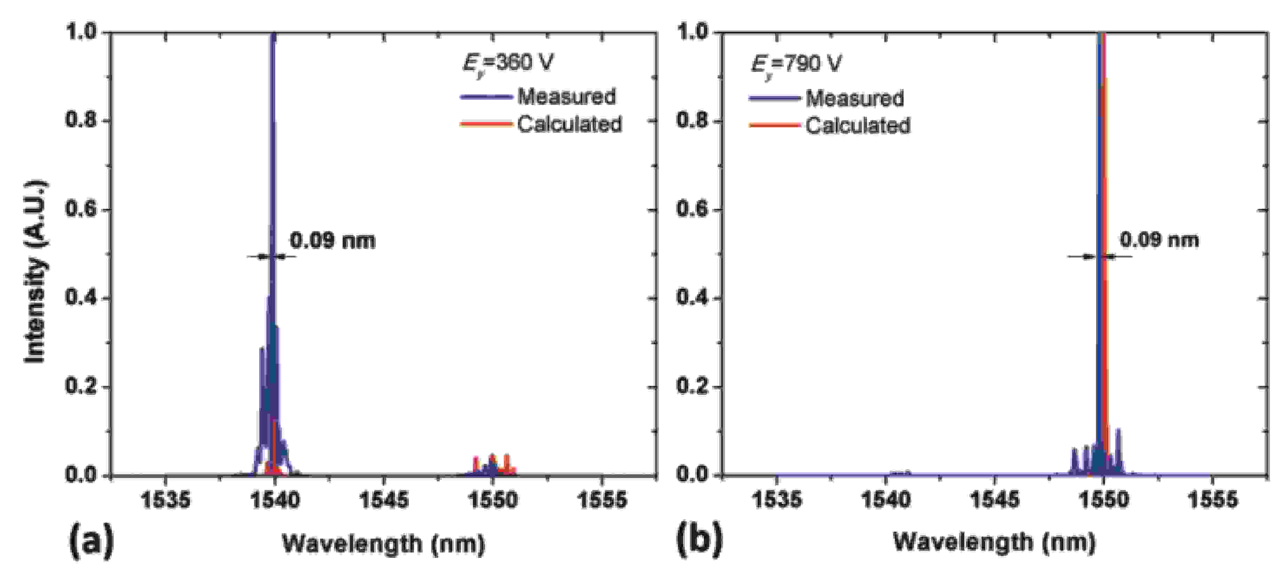


Fig. 4 Measured (blue lines) and calculated (red lines) output spectra of the OPO when the APPLN is applied with external electric fields of Ey= (a) 360 and (b) 790 V/mm.

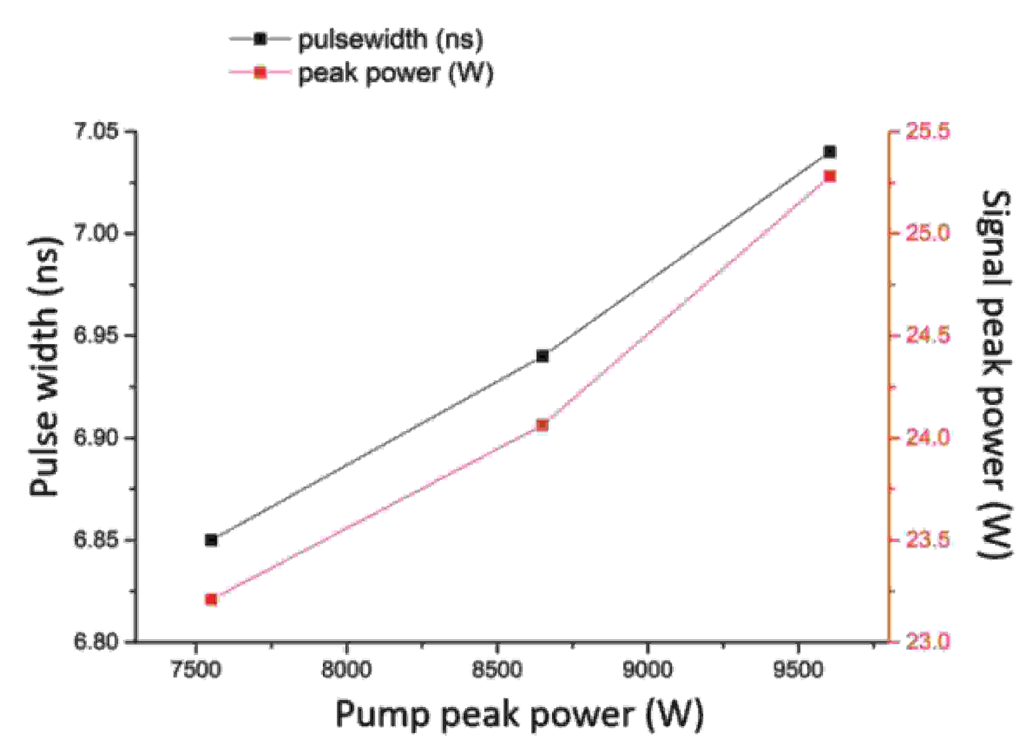


Fig. 5 Measured output signal peak powers and pulse widths from the OPO versus pump power.

Conclusion

The APPLN performs functionalities of both an OPDC and an EO PMC in a 1064-nm pumped dual-wavelength OPO to enable a unique gain-spectrum suppression or narrowing mechanism in which fast EO switching of the signal wavelengths can be achieved. When the APPLN is applied with Ey=360, 790, or 0 V/mm, the OPO signal can be switched to 1540 nm, 1550 nm, or both wavelengths, respectively. The measured switchable signal spectra are in good agreement with simulations.

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