Supporting Information for

Facile approach for periodic poling of MgO-doped lithium niobate with liquid electrodes

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Table S1. The concentrations of Mg and Nb elements measured via EPMA

Element	Mass%	Mol%
Mg	0.709	4.367
Nb	59.304	95.633

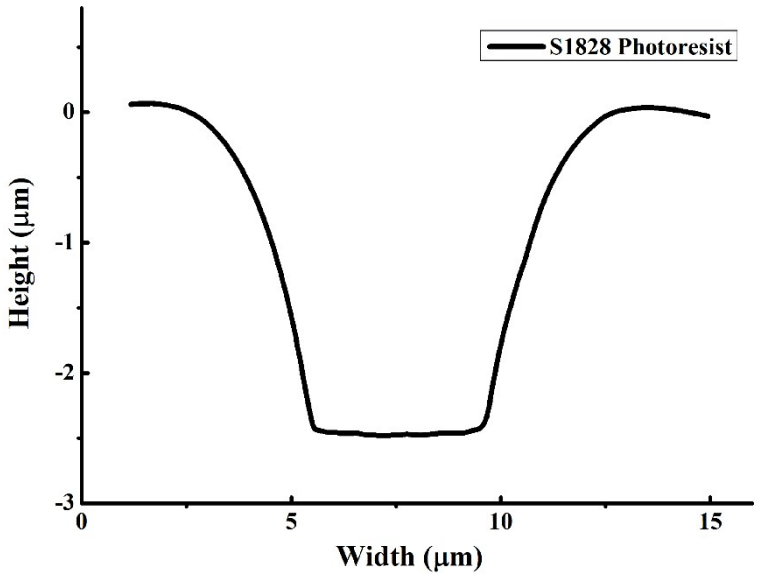

Figure S1. Typical profile of the trenches in the patterned photoresist after hard bake.

As shown in Figure S1, after hard bake, the thickness of the photoresist is ~2.5 μm, and the trench in the patterned photoresist has a high slope that is close to 90 degrees, both of which are beneficial for providing adequate fringing field for the domain nucleation.

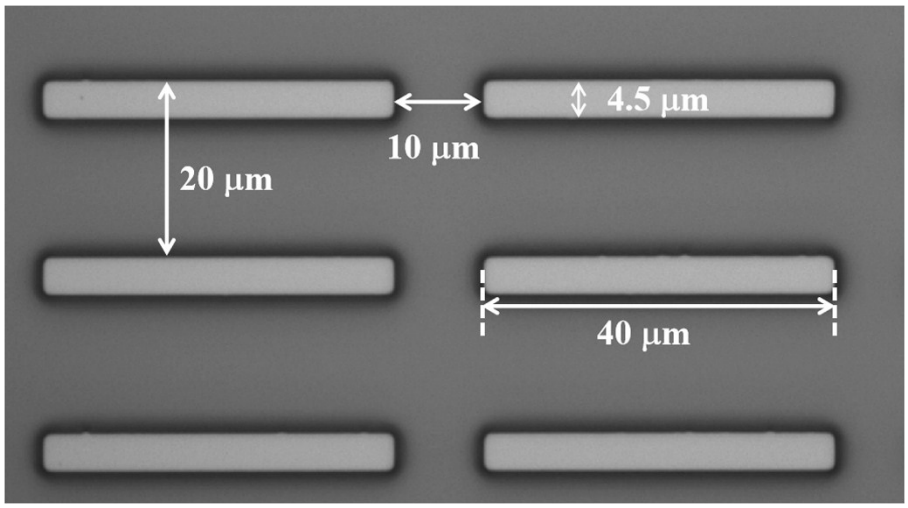

Figure S2. Optical microscope image of the patterned photoresist gratings on the +z surface of the Mg:LN wafer after hard bake.

As shown in Figure S2, the period of the patterned photoresist gratings is 20 μm. The width of the trenches (openings) is 4.5 μm, the mark-space ratio (the open area to the covered area) of the patterned gratings is around 30:70. The length of the trenches is 40 μm, with the spacing in the Y direction of 10 μm.

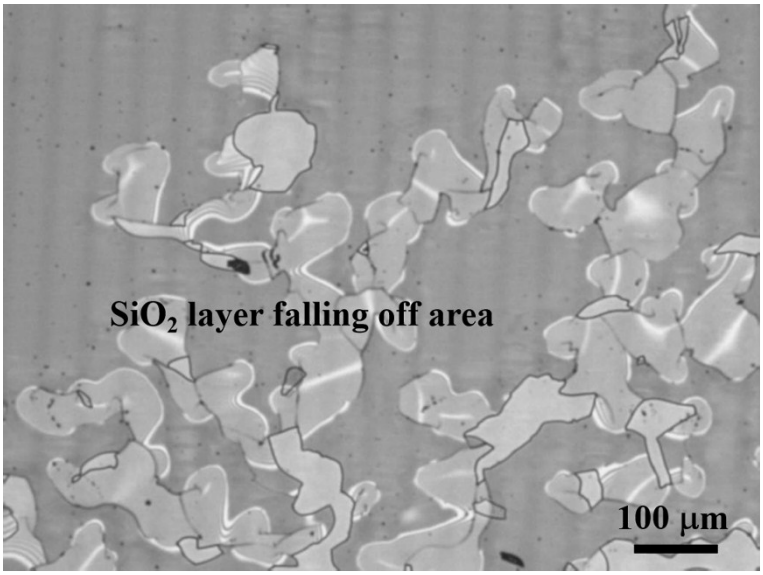

Figure S3. Optical microscope image of the -z surface of the PPMgLN sample after periodic poling, the thickness of the SiO_2 dielectric layer is 900 nm.

During the periodic poling process, the 900-nm-thick SiO_2 layer has fallen off from the -z surface of the Mg:LN wafer, as shown in Figure S3, the light-colored area is where the SiO_2 layer has fallen off.

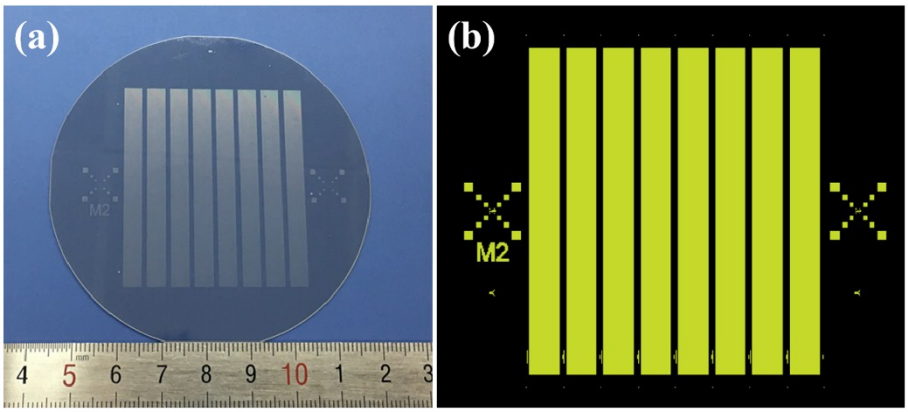

Figure S4. (a) Photograph of the product PPMgLN wafer. (b) Photomask designed for periodic poling.

As shown in Figure S4a and b, high-quality periodic poling following the pattern of the photomask has been realized in 5 mol.% Mg:LN wafers with the diameter of 76.2 mm.

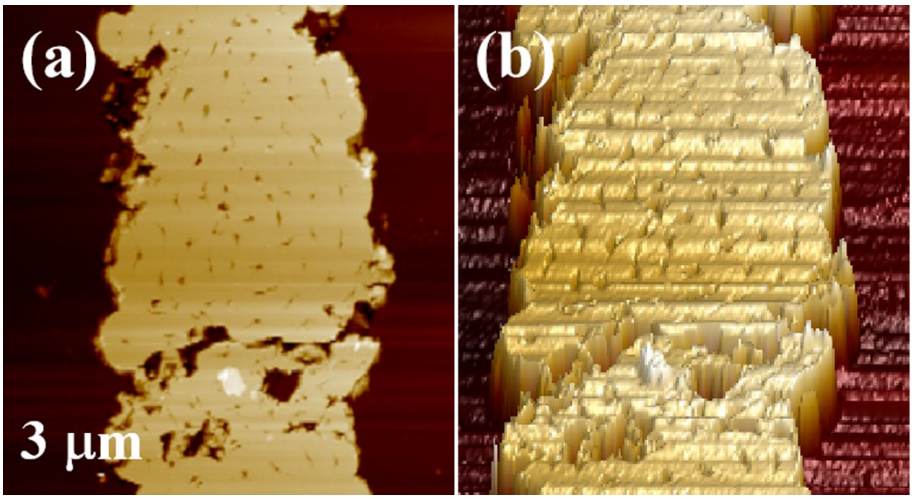

Figure S5. (a) Two-dimensional and (b) Three-dimensional AFM images of the inverted domains on the -z surface of the Mg:LN wafer after etching in hydrofluoric acid:

It is well known that the etching rate of $LiNbO_3$ with hydrofluoric acid is dependent on the crystal orientation, and the maximum etching rate is on the -z surface.[1] Based on this, the domain-inverted structures of the PPMgLN were permanently revealed by etching with hydrofluoric acid for ~15 minutes. As shown in Figure S5, the etching rate of the dark spots area is faster than that of the inverted domains, which indicated that the dark spots are the area where the domain inversion has not penetrated to the -z surface of the Mg:LN wafer.

References

[1] A. B. Randles, M. Esashi and S. Tanaka, *IEEE. T. Ultrason. Ferr.*, 2010, 57, 2372-2380.