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Optically assisted chemical surface microstructuring of $LiNbO_3$

S. Mailis, G. W. Ross, L. Reekie, J. A. Abernethy, I. E. Barry, R. W. Eason,

Optoelectronics Research Centre, University of Southampton, Southampton, SO17 1BJ

tel:++44 (0)2380 593144 fax:++44(0)2380 593142, email:sm@orc.soton.ac.uk

I. Nee, M. Müller, K. Buse

Universität Osnabrück, FB Physik, Barbarastr. 7, D49069 Osnabrück, Germany

Abstract

Optically assisted surface microstructuring of iron doped and undoped $LiNbO_3$ based on preferential etching has been achieved by optical addressing, either laser induced surface damage or optically induced space charge field .

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Optoelectronics Research Centre, University of Southampton, Southampton, SO17 1BJ
tel:++44 (0)2380 593144 fax:++44 (0)2380 593142, email:sm@orc.soton.ac.uk
I. Nee, M. Müller, K. Buse
Universität Osnabrück, FB Physik, Barbarastr. 7, D49069 Osnabrück, Germany

The wide range of optical properties of lithium niobate crystals make this material very attractive for many applications such as electro-optic modulators and switches, nonlinear optical frequency converters, optical waveguide amplifiers, lasers and so forth. It is considered as a universal candidate for optical integrated circuits since both passive and active components can be combined on the same chip.

For these reasons, surface patterning of lithium niobate crystals can be very useful for many applications such as Bragg reflectors and gain flattening filters. Several techniques have been proposed for the fabrication of such structures but they either are very complicated [1] or of limited quality and not easily controllable since they are based on direct laser ablation alone[2].

Preferential wet etching of lithium niobate surface is reported here, based on two distinct methods of optical treatment of the material's surface.

a) Excimer laser-induced surface damage followed by wet etching with a mixture of HF-HNO_3 acids, where an excimer laser is used for "printing" an interference pattern on the surface of $LiNbO_3$ in the form of periodic damage on the high intensity areas of the interference fringes. Wet etching following the exposure of the material's surface preferentially attacks the affected areas leading to higher etch rates thus revealing the grating and also removing the debris produced by the ablation procedure. The method can be applied to any crystallographic orientation.
b) The second method is applied to +z face of iron doped lithium niobate which has been thermally fixed to produce an ionic charge distribution created by two-beam interference. Again, preferential etching occurs revealing the space charge field pattern. Clearly the etching procedure is affected by the fixed ionic space charge distribution since the grating has been revealed in both developed and undeveloped crystals.

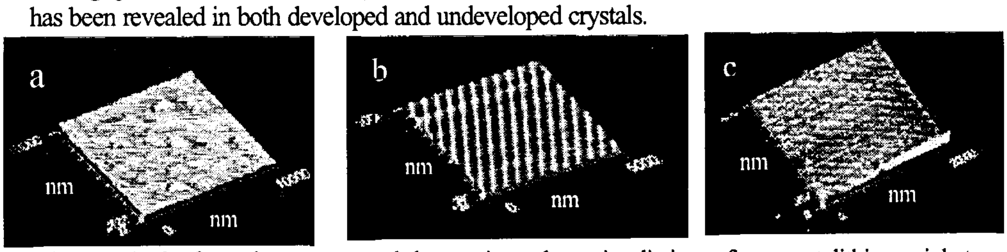

Figure: a) Surface damage caused by excimer laser irradiation of a z-cut lithium niobate sample and b) the same area after wet etching c) surface grating produced on the +z face of iron doped lithium niobate by selective etching due to the presence of an ionic space charge distribution. For both b) and c) the grating periods achieved are ~350 nm-500 nm.

The methods have been applied to fabricate grating structures onto titanium indiffused lithium niobate channel waveguides and preliminary spectral filtering results will be presented.

References

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