

# LiNbO<sub>3</sub> V-Groove Fabrication for Optical Fibre Pigtailling

(Student Paper)

Ercan Karagöz<sup>1,2</sup>, Evren Öztekin<sup>1,2</sup>, Mutlu Gökkavas<sup>1</sup>, Ekmel Özbay<sup>1,3</sup>

<sup>1</sup> Bilkent University, Nanotechnology Research Center, Ankara, Turkey

<sup>2</sup> Hacettepe University, Department of Nanotechnology and Nanomedicine, Ankara, Turkey

<sup>3</sup> Bilkent University, Department of Electrical and Electronics Engineering, Ankara, Turkey

*e-mail: ercan.karagoz@bilkent.edu.tr*

## ABSTRACT

This study aims fabrication of V-grooves in lithium niobate (LiNbO<sub>3</sub>) crystals for producing optical fibre carrier pigtails. Due to anisotropic thermal expansion of lithium niobate, it is important to use the lithium niobate based fibre optic carriers for pigtailling lithium niobate devices to achieve better thermal stability. V-groove fibre mounts on LiNbO<sub>3</sub> was produced using a computer controlled dicing saw with precise V-shaped diamond wheel.

**Keywords:** LiNbO<sub>3</sub>, V-groove, fibre pigtailling, packaging.

## 1. INTRODUCTION

Due to its unique electro-optical properties, lithium niobate has an important role in telecommunication and inertial navigation systems. Proper packaging of lithium niobate devices is essential for mechanical and thermal stability. Fibre carriers are commonly used for better mechanical stability of pigtailed lithium niobate devices. Also, to improve thermal stability of pigtailed lithium niobate devices, lithium niobate based fibre carriers can be used [1],[2],[3].

V-shaped grooves are generally used as precise fibre mounts for fibre carriers [4]. Unlike silicon or glass, lithium niobate is not suitable for V-groove wet etching or moulding process [5],[6],[7],[8]. In this study, lithium niobate based V-grooves are machined with a V-shaped diamond wheel by using a computer controlled dicing saw.

## 2. FABRICATION METHOD

X-cut lithium niobate wafers are used as fibre carrier material. With the help of a dicing saw, lithium niobate pieces are grooved using a V-shaped diamond wheel. To obtain a set of controlled variation of V-groove depths, multiple groove cuts in parallel order are done with different cutting depths. This set of V-grooves are analysed for optimum depth and shape. In order to determine optimum machining parameters, a dummy fibre is placed in machined set of parametrically varying V-groove samples, and the position of the fibre core is checked under an optical microscope.

Figure 1 shows illustration of the diamond wheel and different depth V-grooves on lithium niobate sample. Figure 2 shows SEM image of two parallel 45° V-grooves with same depth.

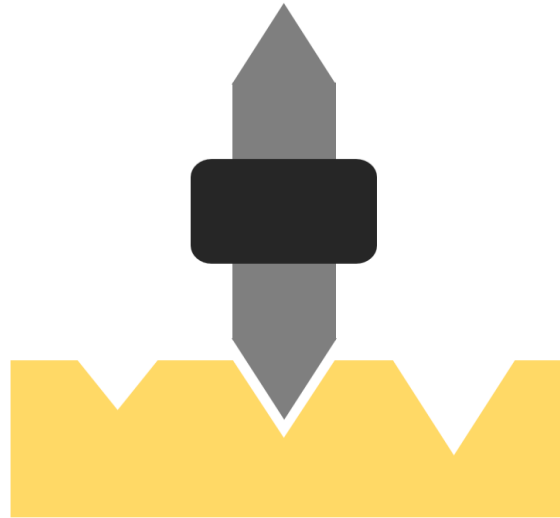


Figure 1. Illustration of V-shaped wheel and different depth V-groove cuts on lithium niobate sample.

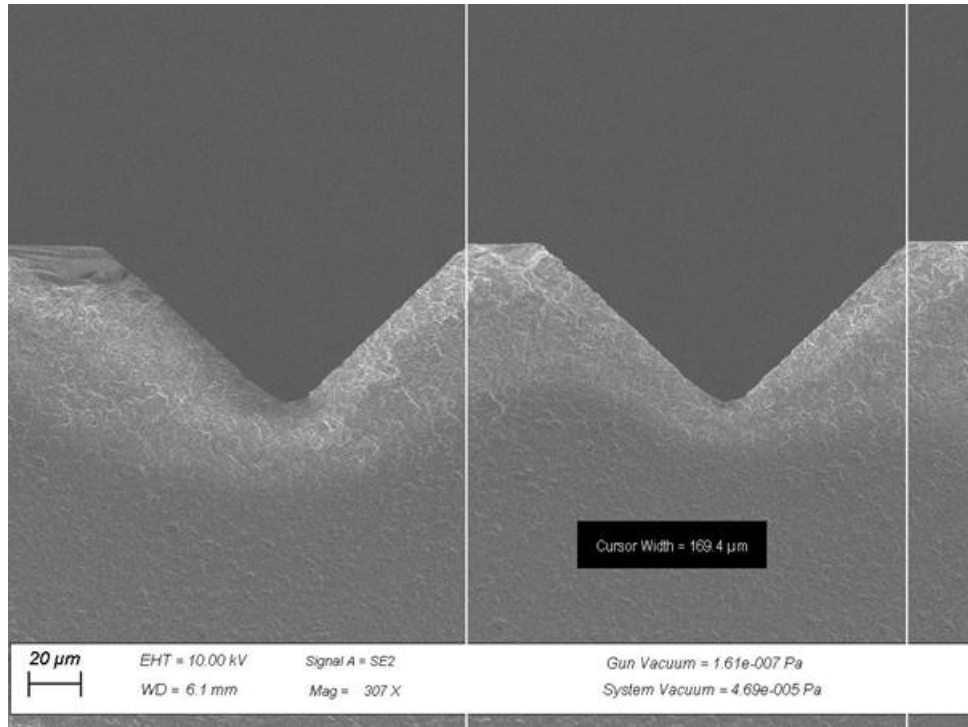


Figure 2. SEM image of  $\text{LiNbO}_3$  V-grooves.

After completion of the V-groove fibre mounts, fibres are placed in these V-groove mounts using an optical microscope. To fix the fibres, a UV curable epoxy is applied on top of the fibres and compressed with a separate lithium niobate lid. The sample is cured using a UV source and the sample surface with fibre-end is chemical-mechanical polished. Figure 3 shows an optical microscope image of the polished surface of a complete lithium niobate fibre carrier with an  $80\mu\text{m}$  polarization-maintaining (PM) optical fibre.

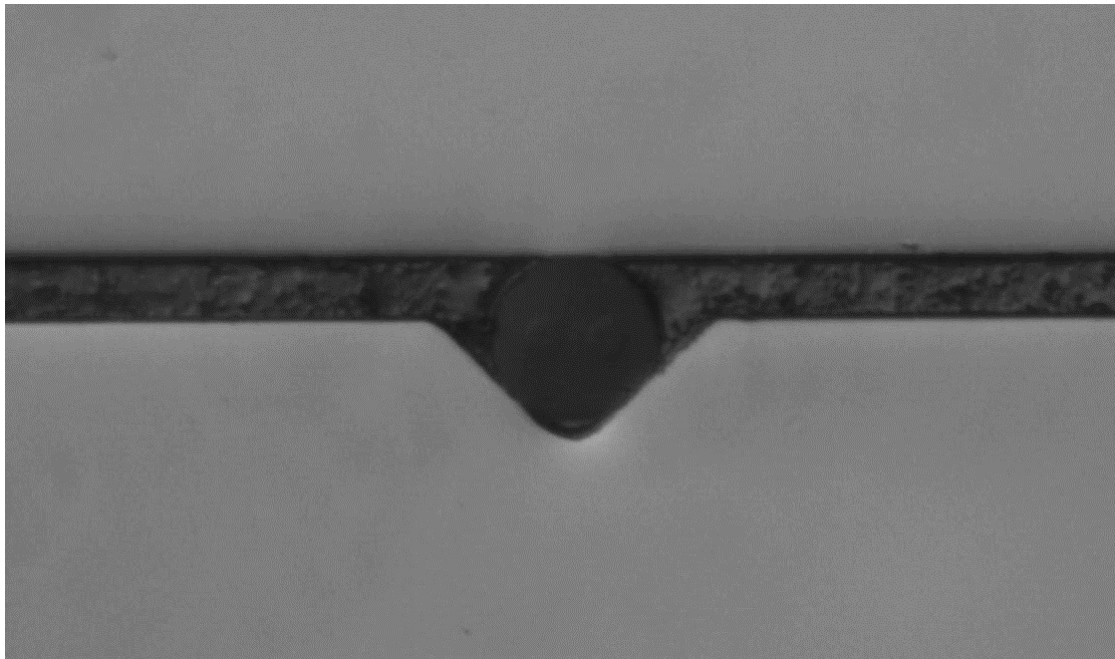


Figure 3. Optical microscope image of  $80\mu\text{m}$  PM fibre mounted in  $\text{LiNbO}_3$  V-groove.

### 3. CONCLUSIONS

Lithium niobate has an important role in integrated optics and V-grooves are essential as fibre alignment aids. Lithium niobate based V-groove fibre carriers are promising alternatives to silicon and glass counterparts for the purpose of achieving better thermal stability of lithium niobate integrated optic devices, based on the perfect matching of the anisotropic thermal expansion of the lithium niobate crystal.

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