

Large aperture periodically poled Rb:KTiOPO₄ crystals for optical parametric frequency conversion

Materials of the KTiOPO₄ (KTP) group are excellent nonlinear gain media used for various frequency conversion applications. They have wide transparency range, high optical damage threshold, are optically homogeneous and easy to produce. Furthermore, the ferroelectric nature of those materials allows using the highest nonlinear coefficient the material is capable to provide by involving domain engineering and quasi-phase matching techniques.

Frequency conversion involving periodically poled KTP (PPKTP) is usually limited to relatively low energy applications mainly due to small (typically 1 mm) crystal apertures available. The goal of this mini-project was to fabricate large aperture (5 mm) high quality periodically poled KTP crystals for high power optical frequency conversion.

There are two main technological difficulties arising in large aperture material periodic poling: the high voltage needed to overcome the coercive field of the material, and the ferroelectric domain broadening during the growth of large aspect ratio domain structures. To address those problems the bulk Rb-doped KTP (RKTP) material was chosen as the best candidate for large aperture ferroelectric domain engineering. This material has similar transmission and power handling properties to those of KTP, however orders of magnitude lower ionic conductivity makes it an excellent choice for fabrication of high aspect ratio domain gratings.

Within the framework of this mini-project the following work was done:

- Two 30 x 20 x 5 mm RKTP wafers were purchased from the budget of the mini-project.
- The wafers were cut in smaller pieces and polished to an optical finish in house.
- A new sample holder was designed and manufactured for the Karl Suss MJB3 mask aligner in order to be able to make photolithography on 5 mm thick samples.
- The poling circuit was upgraded to be able to supply high voltage (>20 kV) pulses necessary for 5 mm thick periodically poled RKTP (PPRKTP) fabrication. The in-house upgrade was built by Leif Kjellberg (Acreo AB).
- Large aperture (5 mm) high quality PPRKTP crystals with period of $\Lambda = 38.86 \mu\text{m}$ were fabricated using the short electric field pulse periodic poling technique

(fig. 1). To the best of our knowledge this is the world record of fabrication of thick periodically poled crystals of KTP family.

- Insight on ferroelectric domain inversion and large aspect ratio domain dynamics was obtained, which will be crucial in further poling process improvements.
- The results obtained within the ADOPT mini project will be summarized in a manuscript for Optics Express.

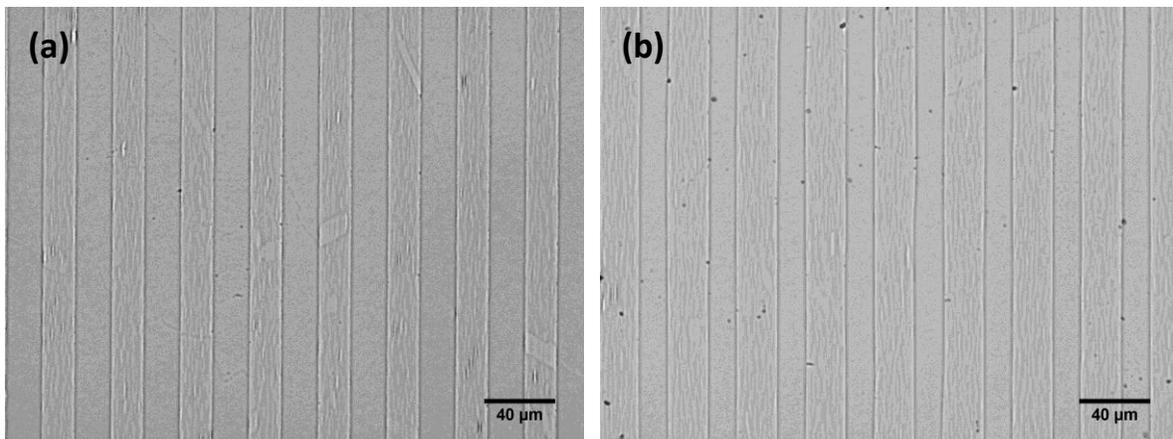


Fig. 1. Images of the domain structures revealed by chemical etching on (a) patterned face, (b) unpatterned face of fabricated large aperture PPRKTP.

Future work will consist of high power OPO based on the fabricated large aperture PPRKTP crystals demonstration and large aperture PPRKTP crystals with shorter periods fabrication.