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Mathieu Salaun, Benoît Boulanger

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Elaboration of epitaxial Rubidium Titanyl Phosphate (RTP) thin films by Pulsed Laser Deposition (PLD)

Salaün Mathieu
Institut Néel
Univ. Grenoble Alpes, CNRS, Grenoble INP
Grenoble, France
mathieu.salaun@neel.cnrs.fr

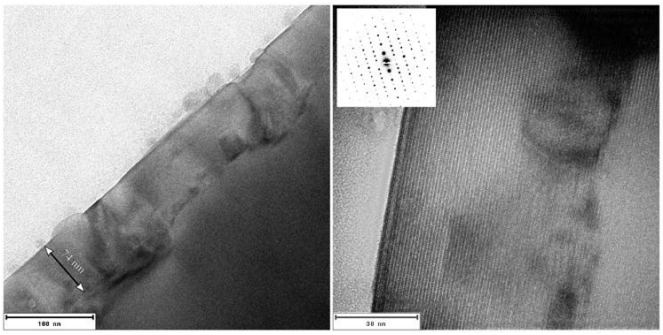
Boulanger Benoît
Institut Néel
Univ. Grenoble Alpes, CNRS, Grenoble INP
Grenoble, France

The *mm2* orthorhombic potassium titanyl phosphate crystal, *i.e.* $KTiOPO_4$ (KTP), is a famous biaxial nonlinear optical crystal widely used commercially for second harmonic generation (SHG) or optical parametric oscillation (OPO) pumped by a 1.064 µm Nd:YAG laser for example. Most of its applications are based on bulk single KTP crystals. However, there is a strong interest to elaborate submicrometric waveguides in the framework of integrated photonic devices. Among several waveguide-fabrication techniques such as proton exchange, ion implantation or dicing [1], a serious alternative is Pulsed Laser Deposition (PLD). Indeed, it was reported that type-II second-harmonic generation and sum-frequency mixing could be realized in uniform epitaxial $RbTiOPO_4$ (RTP) films over KTP channel waveguides prepared by PLD [2]. Such waveguides could be a serious alternative to efficient low energy nonlinear optical devices in particular for Telecom or spectroscopic applications.

PLD is a technique particularly well suited for growing single oxides films with complex chemical composition. This technique consists in a high energy laser ablation of a material with the same chemical composition than that of the desired layer. The plasma of the ablated material is then condensed on the substrate and heated to a temperature such as the aggregates can self-organise on the atomic lattice of the substrate leading to the epitaxial layer.

In this study, we performed epitaxial growth of the RTP phase on KTP single crystals by PLD. The target that has been used was a single RTP crystal.

Thanks to combined microscopies (SEM, AFM, TEM) and diffraction (X-ray, electron), we investigated the effect of the deposition parameters (PO2, Temperature, laser fluence) on the growth rate, as well as the morphology and crystal structure of the layer.



Cross-sectional image of a RTP layer deposited on (100) KTP. The measured thickness is about 70 nm and the layer has a strong monocrystalline character.

We were able to determine the conditions leading to the growth of an epitaxial layer of about 100 nm. We also observed that the crystallographic orientation of the substrate has a strong influence on the quality of the obtained layer. The choice of the deposition face is then of prime importance. Actually, we demonstrated that the natural face (100) gave rise to the most satisfactory growth.

References

[1] V. Boutou, A. Vernay, C. Felix, F. Bassignot, M. Chauvet, D. Lupinski, and B. Boulanger, Opt. Lett. 43(15), 3770–3773 (2018).

[2] Liu et al., J. Appl. Phys. 76 (12)