

Liquid phase epitaxy of $\text{KTa}_{1-x}\text{Nb}_x\text{O}_3$ (KTN)

Autor(en): **Gutmann, R. / Hulliger, J. / Fischer, U.**

Objekttyp: **Article**

Zeitschrift: **Helvetica Physica Acta**

Band (Jahr): **62 (1989)**

Heft 6-7

PDF erstellt am: **12.05.2024**

Persistenter Link: <https://doi.org/10.5169/seals-116136>

Nutzungsbedingungen

Die ETH-Bibliothek ist Anbieterin der digitalisierten Zeitschriften. Sie besitzt keine Urheberrechte an den Inhalten der Zeitschriften. Die Rechte liegen in der Regel bei den Herausgebern.

Die auf der Plattform e-periodica veröffentlichten Dokumente stehen für nicht-kommerzielle Zwecke in Lehre und Forschung sowie für die private Nutzung frei zur Verfügung. Einzelne Dateien oder Ausdrucke aus diesem Angebot können zusammen mit diesen Nutzungsbedingungen und den korrekten Herkunftsbezeichnungen weitergegeben werden.

Das Veröffentlichen von Bildern in Print- und Online-Publikationen ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. Die systematische Speicherung von Teilen des elektronischen Angebots auf anderen Servern bedarf ebenfalls des schriftlichen Einverständnisses der Rechteinhaber.

Haftungsausschluss

Alle Angaben erfolgen ohne Gewähr für Vollständigkeit oder Richtigkeit. Es wird keine Haftung übernommen für Schäden durch die Verwendung von Informationen aus diesem Online-Angebot oder durch das Fehlen von Informationen. Dies gilt auch für Inhalte Dritter, die über dieses Angebot zugänglich sind.

Ein Dienst der *ETH-Bibliothek*

ETH Zürich, Rämistrasse 101, 8092 Zürich, Schweiz, www.library.ethz.ch

Liquid Phase Epitaxy of $\text{KTa}_{1-x}\text{Nb}_x\text{O}_3$ (KTN)

R. Gutmann, J. Hulliger and U. Fischer*

Institute of Quantum Electronics, ETH-Hönggerberg, CH-8093 Zürich, Switzerland

**PSI, c/o HPK, ETH-Hönggerberg, CH-8093 Zürich, Switzerland*

Abstract: KTN layers of several μm thickness were grown on [100] and [110] orientated KTaO_3 substrates from diluted high temperature KF solutions. A versatile apparatus for evaluating new flux systems for liquid phase epitaxy has been developed.

1. Introduction

Thin monocrystalline layers of KTN are of interest for integrated optics due to outstanding electro-optical and nonlinear-optical properties of KTN bulk crystals. The solid solution system of KTN [1] shows a perovskite structure and 3 ferroelectric phase changes between $m\bar{3}m$, $4mm$, $mm2$ and $3m$ [2]. The Curie temperature T_C for the phase change from cubic to tetragonal can be adjusted from 700 K to 10 K through the variation of the chemical composition x . For temperatures near T_C high dielectric constants, large electro-optic and nonlinear-optic effects have been measured for bulk crystals [3].

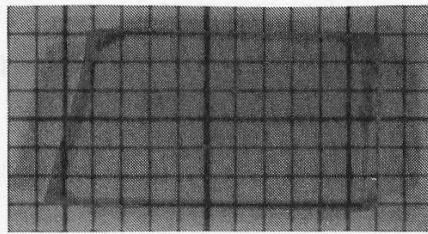
Liquid phase epitaxy (LPE) allows to work close to the thermodynamic equilibrium at temperatures far below the melting point of pure compounds and in a quasi-stationary flow regime of a solvent. Under these conditions epitaxial layers of good quality can be expected.

2. Experimental

In the course of mapping appropriate growth conditions for LPE, a versatile equipment was developed for *in situ* molten salt studies, based on visual observation and DTA [4]. Exploratory growth experiments from a $\text{K}_2\text{O}/\text{Ta}_2\text{O}_5/\text{Nb}_2\text{O}_5/\text{KF}/\text{KCl}$ flux gave transparent and blue coloured monocrystalline KTN layers of several μm thickness on small [100] and [110] orientated KTaO_3 substrates. For optical applications discolouration is necessary. This was achieved by annealing the as grown layers for 24 h at 950 °C in an O_2 -atmosphere (Fig. 1) or by adding small amounts of ZrO_2 or HfO_2 to the flux. Growth parameters for final layers, obtained by an enlarged LPE equipment, are listed in Tab. 1. Para- and ferroelectric KTN layers (300 K) could reproducibly be grown by LPE.

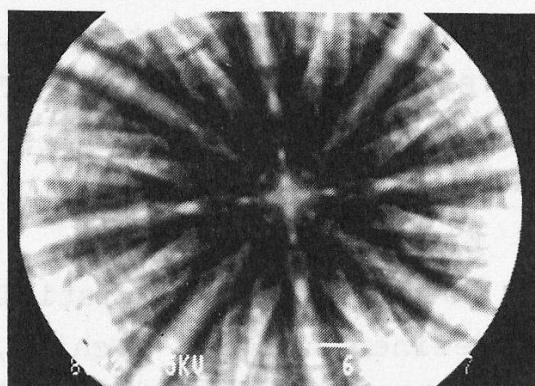
Tab. 1. Growth parameters for LPE

Flux	KTa _{1-x} Nb _x O ₃ (0.68 < x < 0.85)	4 - 8	mole%
	KF or KF/KCl	96 - 92	mole%
Additives for discolouration	ZrO ₂ , ZrF ₄ , HfO ₂	< 0.5	mole%
Substrates	KTaO ₃ (cubic)	orientations: size:	[100] and [110] < 8 x 12 mm ²
Atmospheres	N ₂ , O ₂ , Ar, air		
Growth temperatures	870 - 930 °C		
Supercoolings	30 - 100 °C		
Substrate rotation	~ 30 rpm		
Growth times	5 - 30 min		
Layer thicknesses	2 - 45 μm		

Fig. 1. KTN layer after annealing in O₂

3. Characterization

Scanning electron microscopy (SEM) showed rather flat morphologies for growth on [100] and pronounced facets on [110] orientated substrates. Energy dispersive X-ray spectroscopy (EDX) and electron microprobe analysis traced the Nb content of the layers ($0.27 < x < 0.46$). Rutherford backscattering spectrometry (RBS) and secondary ion mass spectrometry (SIMS) revealed a constant chemical composition of the layers. Electron channeling (Fig. 2) and 2θ X-ray diffraction indicated monocrystalline KTN layers. Lattice misfits smaller than 0.75 % are found for cubic layers.

Fig. 2. Electron channeling of a KTN layer on [100] KTaO₃.

Acknowledgements

The authors would like to thank P. Wägli for the SEM and EDX analysis, Dr. G. Bednorz for the use of an X-ray diffractometer and Dr. M. Chaussidon for the SIMS analysis. This work has been supported by the Swiss National Science Foundation (NFP 13: Micro- and Optoelectronics).

References

- [1] A. Reismann, S. Triebwasser and F. Holtzberg, *J. Amer. Ceram. Soc.* 77 (1955) 4228.
- [2] S. Triebwasser, *Phys. Rev.* 144 (1959) 63.
- [3] H. J. Scheel and P. Günter, in E. Kaldus (Ed.), *Crystal Growth of Electronic Materials*, Elsevier, Amsterdam 1985.
- [4] J. Hulliger and R. Gutmann, to be presented at ICCG - 9, Sendai, Japan, 1989.