Structural and Chemical Characterization of $KTiOAsO_4$(001) Optical Surface Modified by Ar^+ Ion Beam Bombardment

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Abstract – The modification of polished (001) surfaces of potassium titanyl arsenate, $KTiOAsO_4$ (KTA) by 1.5 keV Ar^+ ion irradiation has been investigated using reflection high energy electron diffraction (RHEED) and X-ray photoelectron spectroscopy (XPS).

1. Introduction

Potassium titanyl arsenate, $KTiOAsO_4$ (KTA), is a representative member of a large isostructural family with the $KTiOPO_4$ (KTP) structure-type. KTA has been recognized as an excellent nonlinear optical crystal for nonlinear optical and electro-optical device applications. KTA possesses high nonlinear optical coefficients, appropriate birefringence and a wide range of transparency; thus, it is considered as a most promising material for nonlinear optical applications in the infrared spectral range.

The lower absorption in the 3–5 μm spectral regions when compared with KTP makes KTA an important material for mid-IR optical parametric oscillation applications [1, 2].

At room temperature KTA has orthorhombic crystal structure, $Pna2_1$ space group, $a_0 = 0.1314$ nm, $b_0 = 0.0658$ nm, $c_0 = 0.1079$ nm, $Z = 8$ [3].

The crystal structure of KTA (001) surface is shown in Fig. 1.

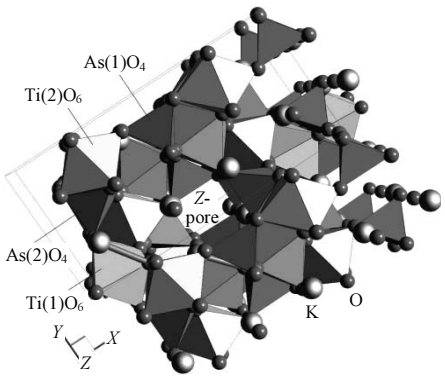

Fig. 1. Crystal structure of KTA(001) surface

2. Experiment

The effect of 1.5 keV Ar^+ ion irradiation on the (001) surfaces of potassium titanyl arsenate, $KTiOAsO_4$ (KTA), has been investigated using reflection high energy electron diffraction (RHEED) and X-ray photoelectron spectroscopy (XPS). Crystalline state of initial KTA(001) surface prepared with mechanical polishing is shown in Fig. 2.

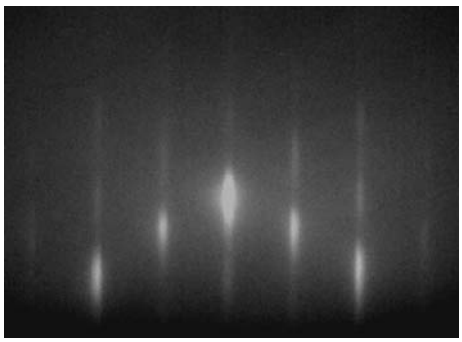

Fig. 2. RHEED pattern recorded for optical KTA (001) surface

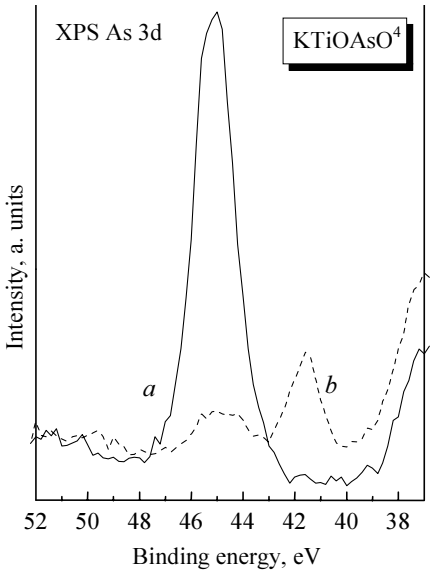

Fig. 3. XPS spectrum of As 3d line before (*a*) and after (*b*) ion bombardment

The (001) KTA surface is very sensitive to 1.5 keV Ar^+ ion-irradiation and induce significant structural modification in the top surface layers. The <As–O> bonds in the KTA crystal lattice are relatively less stable when compared to <Ti–O> bonds and reduction of As^{5+} ions with the formation of As^0 and partial As loss from the top surface occurs with Ar^+ ion-irradiation.

This effect is detected with XPS as it is shown in Fig. 3.

The formation of unstable layer with chemically active and passive arsenic states may be a factor reducing the optical parameters and durability of nonlinear optical devices involving KTA.

References

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