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Fachbereich Physik, Universität Osnabrück[1])

Refractive Indices of $Sr_{0.61}Ba_{0.39}Nb_2O_6$ Single Crystals

By

D. KIP[2]), S. AULKEMEYER, K. BUSE, F. MERSCH, R. PANKRATH, and E. KRÄTZIG

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Photorefractive $Sr_xBa_{1-x}Nb_2O_6$ crystals are promising for many applications [1], e.g. for volume holographic storage [1] and self-pumped phase conjugation [3]. The transition temperature from the ferro- into the paraelectric phase depends on the mole fraction x [4], which enables tailoring of the photorefractive properties. However, crystals grown from the congruently melting composition with $x = 0.61$ show the best quality and visible striations can be completely avoided. Investigation of $Sr_{0.61}Ba_{0.39}Nb_2O_6$ crystals and development of devices made from $Sr_{0.61}Ba_{0.39}Nb_2O_6$ often require precise knowledge of the refractive indices [5, 6]. In 1968 Venturini et al. [7] measured the refractive indices of $Sr_xBa_{1-x}Nb_2O_6$ crystals with the compositions $x = 0.25$, 0.50, and 0.75. Values for crystals of the congruently melting composition $Sr_{0.61}Ba_{0.39}Nb_2O_6$ can only be obtained by interpolation of these data. – In this contribution measurements of the refractive indices of single domain $Sr_{0.61}Ba_{0.39}Nb_2O_6$ crystals are presented.

$Sr_{0.61}Ba_{0.39}Nb_2O_6$ has a tungsten-bronze structure and is ferroelectric (point group 4mm) at room temperature. A nominally pure crystal is grown in the crystal-growth laboratory of the Physics Department of the University of Osnabrück using the Czochralski technique. Growth temperature and pulling rate are 1480 °C and 0.7 mm/h. A triangular prism is cut from the crystal. The **c**-axis is oriented perpendicular to the two parallel surfaces using a {100} growth face as a reference. All sides were polished to optical quality. Heating the crystal to 110 °C and cooling down to room temperature with an applied electric field of 600 kV m^{-1} yields a single domain sample. By the minimum deviation method the refractive indices are determined with an absolute accuracy better than ±0.002. We chose different lines of an Ar^+ laser and a HeNe laser for illumination of the prism. All measurements are carried out at room temperature ($T = 22\,°C$) and the light intensity is kept low (of the order of Wm^{-2}) to avoid heating of the sample.

Fig. 1 shows the dispersion of extraordinary n_e and ordinary n_o refractive indices. The curves are fits of the Sellmeier equation [8]

$$n^2(\lambda) - 1 = A + \frac{B\lambda^2}{\lambda^2 - C} \tag{1}$$

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[1]) D-49069 Osnabrück, Germany.

[2]) e-mail: dkip@physik.uni-osnabrueck.de.

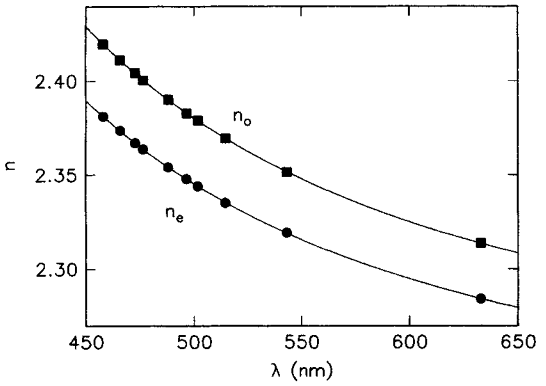

Fig. 1. Refractive indices n_e and n_o of $Sr_{0.61}Ba_{0.39}Nb_2O_6$ crystals for extraordinarily and ordinarily polarized light vs. light wavelength λ at room temperature ($T = 22\,°C$). The symbols are measured values and the solid lines fits to the Sellmeier equation (1) with the parameters of Table 1

Table 1

Fits of the Sellmeier equation (1) to the measured extraordinary (n_e) and ordinary (n_o) refractive indices yield the listed parameters A, B, and C

	A	B	$C\,(10^{-14}\,m^2)$
n_e	1.667	2.188	5.690
n_o	1.711	2.248	5.982

Table 2

Extraordinary (n_e) and ordinary (n_o) refractive indices and birefringence ($n_e - n_o$) for some frequently used laser wavelengths λ at room temperature ($T = 22\,°C$)

λ (nm)	n_e	n_o	$n_e - n_o$
488.0	2.354	2.390	−0.036
514.5	2.335	2.370	−0.035
532.0	2.325	2.358	−0.033
632.8	2.284	2.314	−0.030

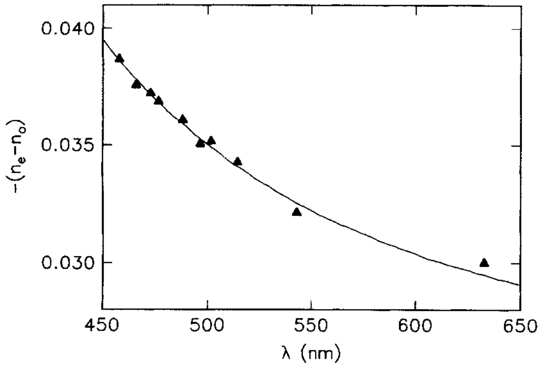

Fig. 2. Birefringence ($n_e - n_o$) vs. light wavelength λ at room temperature ($T = 22\,°C$). The symbols are measured values and the solid line is calculated from the Sellmeier equation (1) with the parameters of Table 1

to the experimental values with the parameters A, B, and C given in Table 1. Table 2 summarizes the refractive indices for some frequently used laser wavelengths. The birefringence values are also presented in Table 2, and Fig. 2 shows the spectral dependence of the birefringence. The Sellmeier equation (1) describes the experimental values very well and for this reason intermediate values may be interpolated with high reliability.

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