Dispersion of Refractive Indices in Cs_2CdBr_4 and Cs_2HgBr_4 Crystals

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Received: 18.02.2005

Abstract

Dispersion of the refractive indices in Cs_2CdBr_4 and Cs_2HgBr_4 crystals has been experimentally obtained for the visible spectral range. The dispersion curves have been extrapolated towards the UV and IR ranges on the basis of single-term Sellmeier formula.

PACS: 78.20.Ci

Key words: refractive indices, Sellmeier formula, Cs_2CdBr_4 and Cs_2HgBr_4 crystals

Introduction

As it has been shown in our previous reports [1,2], Cs_2CdBr_4 and Cs_2HgBr_4 crystals have high values of acoustooptic figures of merit: M_2=126.5×10^{-15}s^3/kg for Cs_2HgBr_4 and M_2=366.9×10^{-15}s^3/kg for Cs_2CdBr_4. These large M_2 coefficients peculiar for the above crystals are associated with relatively low magnitudes of the transverse acoustic waves velocities (v_4=804.9m/s for Cs_2HgBr_4 and v_4=843m/s for Cs_2CdBr_4 [3]). We have confirmed the high value of acoustooptic diffraction efficiency experimentally. For example, we have obtained η=27.8% for Cs_2CdBr_4 at the driving electric signal power P_{el}=12W, 16.6% for Cs_2HgBr_4 at P_{el}=10W, as well as 40% for Cs_2HgCl_4 at P_{el}=4W [2]. The crystals are transparent in a wide enough spectral range (e.g., 0.27–25μm in case of Cs_2HgBr_4 and 0.35–25μm for Cs_2CdBr_4 [2]. It means that the mentioned crystals can be used for acoustooptic operating of laser radiation in a wide spectral range and, in particular, the infrared (IR) range that covers the telecommunication windows. Unfortunately, the dispersion of the refractive indices and the optical anisotropy have been studied earlier only for Cs_2HgCl_4 crystals [4], although these optical parameters are very important for further consideration of the acoustooptic interaction. Hence, the present paper is devoted to experimental studies for the refraction dispersion in Cs_2CdBr_4 and Cs_2HgBr_4 crystals.

Experimental

The refractive indices dispersion has been studied by the index-matching method. Alpha-monobromine naphthalene with kerosene or iodine methene have been used as index-matching liquids. The crystal plates with the orientation parallel to the principal crystallographic planes and the average thickness of few milimeters have been prepared from the bulk single crystals grown with the Bridgeman method. The Cs_2CdBr_4 and Cs_2HgBr_4 crystals belong to the point group of symmetry *mmm*, so the two plates with different principal orientations have been needed for determining all the three refractive indices for each compound. The accuracy of determination of the refractive indices has not been worse than 10^{-3}.

Results and Discussion

The dispersion of the refraction indices for Cs_2CdBr_4 and Cs_2HgBr_4 crystals experimentally obtained in the visible spectral range is shown in Fig. 1. As one can see, the dispersion exhibits a normal character.

Using these data it is possible to make extrapolation of the dispersion curves towards the ultraviolet (UV) and the IR spectral ranges, while basing on the single-term Sellmeier formula

$$n_i^2 = 1 + \frac{A_i \lambda^2}{\lambda^2 - \lambda_{0i}^2}, \qquad (1)$$

where λ is the light wavelength in vacuum, λ_{0i} the wavelength corresponding to the absorption band and A_i the fitting coefficient. On the basis of Eq. (1) and the refractive indices dispersion obtained experimentally, one can determine the coefficients A_i, and the absorption band wavelength λ_{0i} which are equal to A_a =1.649, λ_{0a}=149nm; A_b=1.614, λ_{0b}=155nm; A_c=1.605, λ_{0c}=154nm for Cs_2CdBr_4 and A_a =1.573, λ_{0a}=161nm; A_b=1.619, λ_{0b}=181nm; A_c=1.306, λ_{0c}=154nm for Cs_2HgBr_4 crystals. Thus approximated spectral dependences of the refractive indices are shown in Fig.2, 3. Of

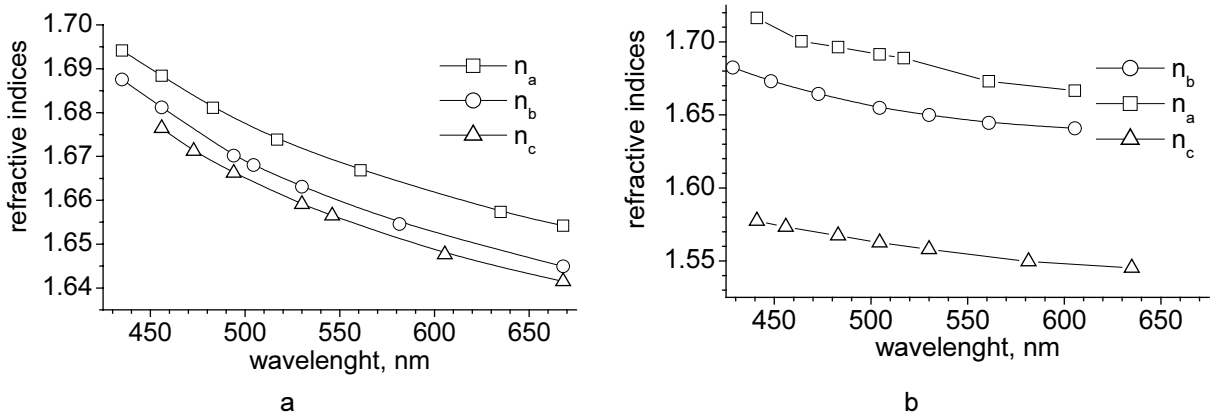

Fig. 1. Dispersion of refractive indices for Cs_2CdBr_4 (a) and Cs_2HgBr_4 (b) crystals in the visible spectral range.

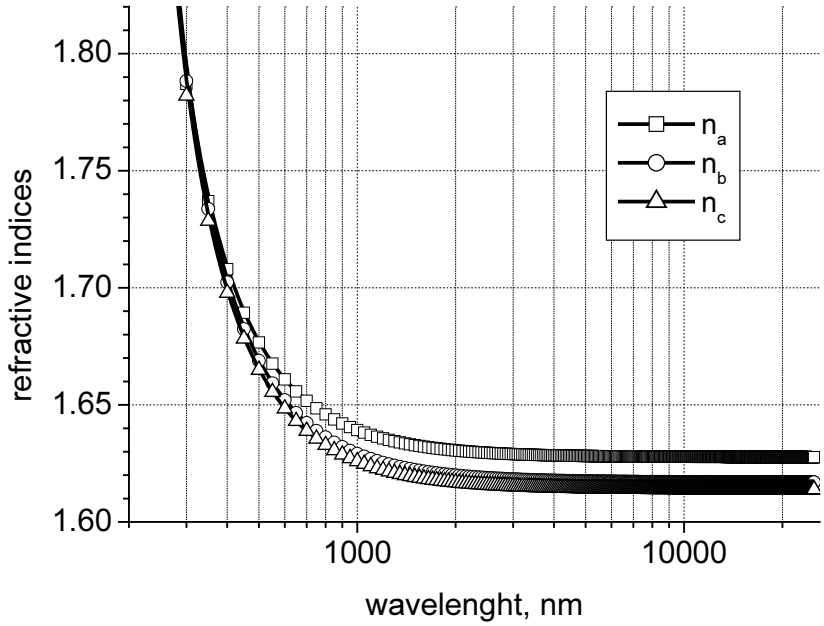

Fig. 2. Dispersion of refractive indices for Cs_2CdBr_4 crystal in the wide spectral range obtained using the Sellmeier formula approximation.

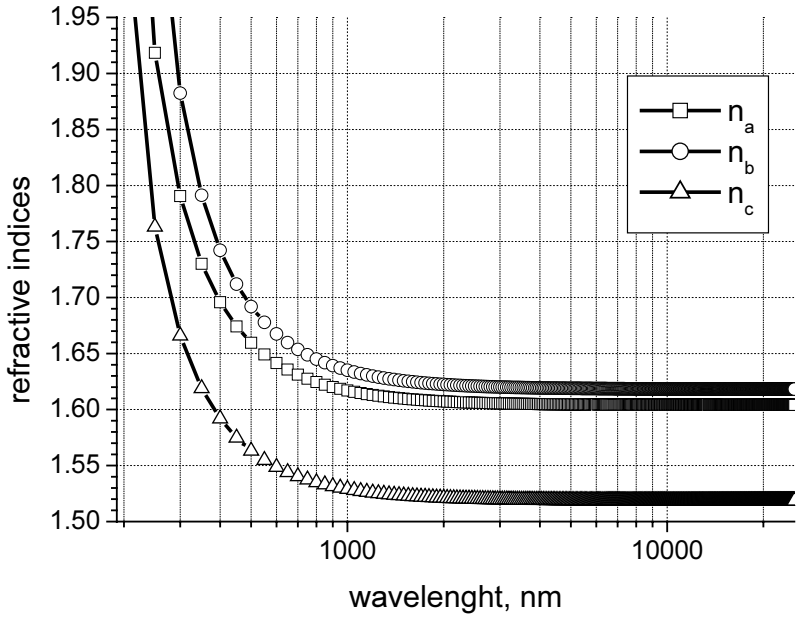

Fig. 3. Dispersion of refractive indices for Cs_2HgBr_4 crystal in the wide spectral range obtained using the Sellmeier formula approximation.

course, a number of the oscillators and their characteristic wavelengths is larger than one. As a result, the approximation of the refractive indices on the basis of single-term Sellmeier formula and without the wavelengths λ_{ok} of the oscillators experimentally defined for different eigen-polarizations of light has rather qualitative character.

Conclusions

The dispersion of the refractive indices of Cs_2CdBr_4 and Cs_2HgBr_4 crystals has been experimentally obtained for the visible spectral range. The dispersion curves have been fitted to the single-term Sellmeier formula and thus extrapolated towards the UV and IR spectral ranges.

Acknowledgement

The authors are thankful to Ministry of Education and Science of Ukraine (the Project 0103U000703) for financial support of the present study.

References

1. Krupych O., Girnyk I, Trach I., Martynyuk-Lototska I., Vlokh R., Vlokh O. Ukr. J. Phys. Opt. **5** (2004) 8.
2. 2.Martynyuk-Lototska I., Dudok T., Trach I., Vlokh R. Ukr. J. Phys. Opt. **5** (2004) 77.
3. Kityk A.V., Zadorozhna A.V., Shchur Ya.I., Martynyuk-Lototska I.Yu., Burak Ya., Vlokh O.G. Aust. J. Phys. **51** (1998) 943.
4. 4.Kaidan M.V., Zadorozhna A.V., Andrushchak A.S., Kityk A.V. Appl. Opt. **41** (2002) 5241.