Effect of nanoscale defects on photo conductivity and optical absorption of silicosillenite crystals

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Intoduction:*:* Photorefractive crystals silicosillenite of $Bi_{12}SiO_{20}$ (BSO) are successfully used in various fields of functional electronics [1].

Purpose: Modification of the properties of BSO by creating nanosized nonstoichiometric defects for the purpose of their application in nanoelectronics.

Methods**:** The research the effect of nonstoichiometric defects caused by an excess or deficit of Bi ions (in BSO + Bi or BSO-Bi crystals, respectively) on the surface photoconductivity, edge optical absorption and vibrational spectra of BSO.

Results:

The stoichiometric composition BSO contains 14.3 mol. % SiO_2 and 85.7 mol% Bi_2O_3. We made a SiO_2 deficit (10 mol. %) and an excess of SiO_2 (17 mol. %) due to the correspon- ding excess or deficiency of Bi_2O_3 in the charge. BSO, BSO+Bi and BSO-Bi crystals were grown by the Czochralski method

It is found that nonstoichiometric defects manifest themselves near the edge of fundamental optical absorption and in vibrational IR absorption spectra. In BSO+Bi and BSO-Bi crystals, they cause an increase and, accordingly,a weakening of absorption and photoconductivity relative to BSO in the light photon energy range 2.5–3.5 eV (Fig.1).

The results are presented in the form of spectral dependen- ces of the relative photoconductivity $\sigma^{Ph} = (\sigma_i - \sigma_0)/\sigma_0$, where σ_i and σ_0 are the surface conductivities during illumination and in the dark, respectively, on the energy of light quanta hv.

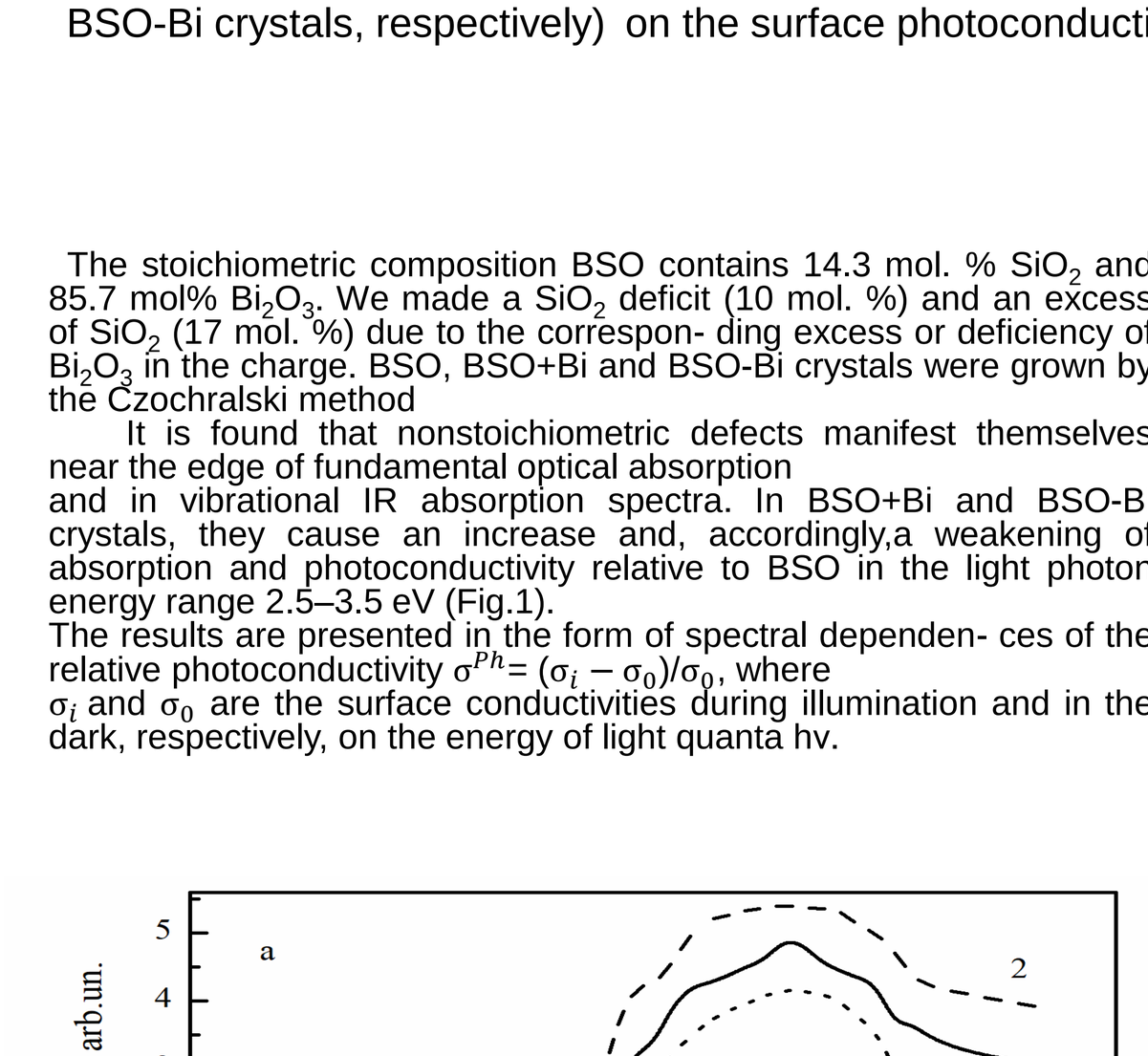

Fig. 1. The spectral dependences of photoconductivity of BSO (a, 1; b, 1), BSO + Si (a, 2; b, 2) and BSO − Si (a, 3; b, 3) crystals before (a) and after annealing in vacuum (b).

The IR absorption spectra of BSO + Bi and BSO-Bi crystals in the region of two phonon processes differ from the BSO spectra by a change in the intensity ratio of two main peaks with frequencies ω_1 = 1603.1 and ω_2 = 1656.7 cm^{-1}. In BSO + Bi crystals, the peak intensity with ω_1 is higher, and in BSO-Bi crystals, with ω_2. In addition, in BSO+Bi crystals, both peaks have a larger spectral broadening

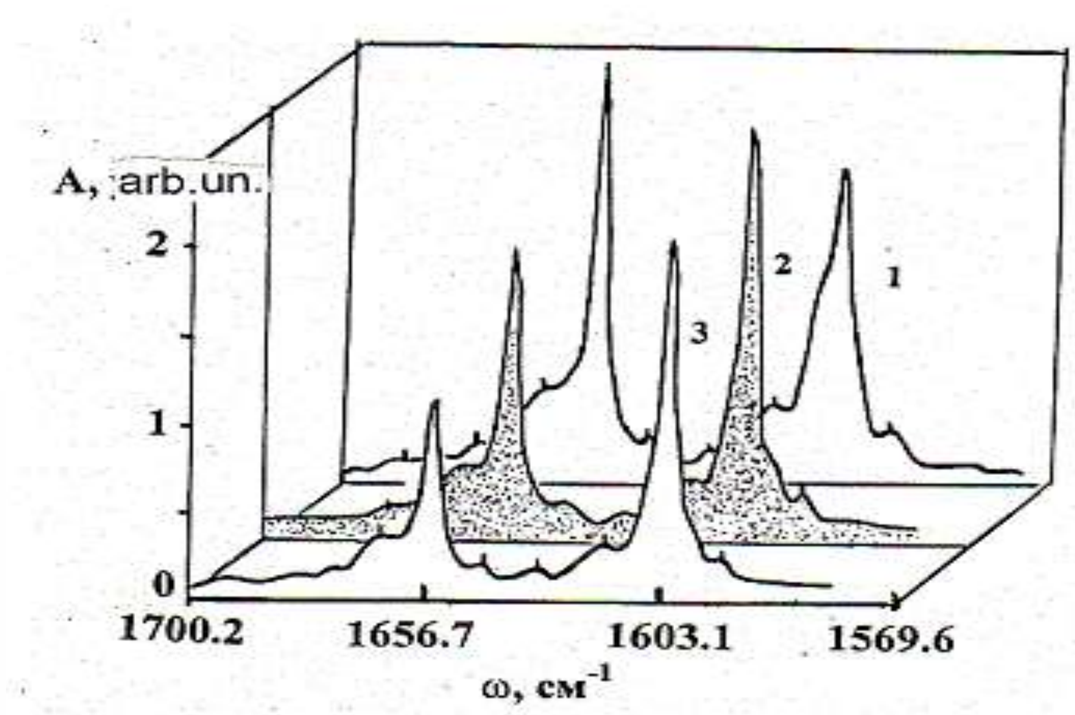

Fig.2. IR-absorption spectra of crystals BSO-Bi (1), BSO (2) and BSO+Bi (3) in the vibration region of the tetra= gedronSiO_4. T= 20 K.

Analysis of the results allows us to propose a model of nanoscale defects of nonstoichiometry BSO in the form of oxygen SiO_4 tetrahedra with partial substitution of Si ions by anti-structural Bi ions and charge compensation in the oxygen sublattice.

Reference

1.*Gunter P., Huignard J.* Photorefractive Materials and Their Applications. Part1. Springer Science+Business Media New York –2006.

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