

Ultrasonic investigation of fluorite-type BaF₂:Cu and BaF₂:Ni crystals

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The temperature dependences of the dynamic elastic moduli c_{β} in crystals of BaF₂ doped with Ni and Cu were studied with the use of ultrasonic technique. In BaF₂:Cu, anomalies were found which are typical for the Jahn-Teller effect (JTE) subject to the $T \otimes (e + t_2)$ problem with orthorhombic global minima of the adiabatic potential energy surface similar to what was observed in CaF₂:Cu²⁺ [1]. However, the peak in $\text{Im}[\Delta c_{\beta}(T)/c_{\beta}(T_0)]$ and anomalies in $\text{Re}[\Delta c_{\beta}(T)/c_{\beta}(T_0)]$ (where $T_0 = 4$ K) were much less in BaF₂:Cu. In BaF₂:Ni, there were no visible signs of the JTE although the crystals BaF₂:Cu and BaF₂:Ni were colored meaning the presence of sufficient amount of the 3d ions. EPR studies of BaF₂:Cu [2] indicated the off-centre position of the Cu ion which do not have the JT origin. So, we conclude that only a small amount of the dopants does substitute metal in cation positions in BaF₂:Cu. In BaF₂:Ni, there is not enough such Ni ions to be noticed in an experiment. The technique for evaluation the content of the impurities gives the total amount of the dopant while evaluation of most of the parameters of the JTE using the experimental data requires concentration of the JT complexes. The exception is the temperature dependence of relaxation time which provides information about the parameters of relaxation mechanisms. Namely these parameters can be used for comparison of the properties of the JT complexes in different host crystals and discussed in our poster. The study was supported by the Ministry of Science and Higher Education of the Russian Federation (Ural Federal University Program of Development within the Priority-2030 Program).

[1] M.N. Sarychev et al.; *JETP* **135** 473 (2022).

[2] M.M. Zaripov, V.A. Ulanov; *Fiz. Tverd. Tela* **31** 254 (1989) [*Sov. Phys. Solid State* **31** 1798 (1989)].