THE EFFECT OF THE THERMAL INFLUNCE ON THE MICROHARDNESS AND THE CRYSTAL EXPANSION OF BaF_2

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It was revealed, in BaF_2 crystals with grain-structure thermal influence is the reason of unstrengthening and hysteresis of the coefficient of thermal expansion.

It is observed that in the BaF_2 crystals, differing by the unit structure, the thermal influence leads to the disorder and the hysteresis character of the change of thermal expansion coefficient.

The crystals of barium ftoride are widely used in the capacity of the substrates for the epitaxial growth of compounds IV-VI seeing that of the uniqueness of the types of their crystal lattices and the nearness of the lattice constants. The epitaxy from the gas and liquid phases is usually carried out at the temperatures 300-500°C [1]. The activation of the structure-sensitive properties at such temperatures can influence on the perfection of the epitaxial layers and the state of the heteroboundary between them in the result of the borrowing of the defects from the substrates of BaF_2. The similar situation can appear at the use of BaF_2 in the capacity of buffer layers at the creation of the multi-layered structures also.

In the present paper the influence of the temperature factor on the structure-sensitive properties at the investigation of the microhardness and the thermal expansion of BaF_2 crystals has been studied.

The microhardness of the BaF_2 samples in the initial state was studying at the room temperature and after the heating till 450°C in the vacuum ~10-3mm.m.c., and the temperature dependence of the elongation ratio in the cycle heating-cooling till 600°C have been studied.

The measurements of the microhardness by Knoop were carried out on the device PMT-3 at the load ~20G. The measurement accuracy of the microhardness is <30%. The results of the microhardness measurements on the samples of the different form are presented in the table 1. From the table 1 it is seen, that sample of the prism form differs by the most microhardness. Its value is close to the literature value of the microhardness, which is equal to 82 kg/mm^2 [2]. The cycle of heating cooling in the temperature interval from room till 450°C, carried out with the velocity of he temperature change ~3gr/min, increases significantly the microhardness of the BaF_2 crystals. It is easy to propose, that given mode of the thermal influence leads to the crystal disorder the difference of the microhardness values in the samples of the different thickness connects with the forming character of the prolonged defects.

Table 1

The microhardness of the barium ftoride samples

Crystal form	Thickness, mm	Microhardness by Knoop, kg/mm^2	
		Initial state	After heating till 450ºC
1. Round plane	1	75	60
2. Beam	3	80	65
3. Rod	1	75	65

The thermal expansion of the samples of sizes 3x5x12mm^3 was investigated in the temperature interval 20-600ºC on the vacuum dilatometer with the inductive gauge. The heating of the samples was carried out with the velocity 3grad/min. The measurement accuracy of elongation ratio was 3%. The results of the measurements are given in the fig.1.

From the figure it is seen, that values of the relative aspect ratio, defined at the similar heating and cooling temperatures strongly differ, essentially in the temperature

interval 20-400ºC. At the repeating of the cycle heating-cooling, the difference of the values of the elongation ratio decreases. In the given temperature interval the decrease was 30% approximately. When the measurements are carried out in the mode of the continuous heating and cooling, this difference becomes more significant. If the crystals will be subjected to the additional following annealing at 450ºC during 30 minutes, the difference of the values of the elongation ratio would be decrease on 50%.

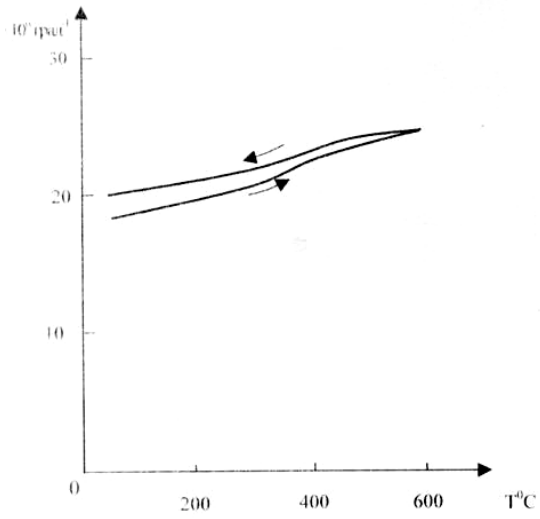

Fig.1. The dependence of the aspect ratio in the BaF_2 crystals in the cycle heating-cooling.

On the basis of the obtained results from the known ratio $\alpha=\Delta l/l\Delta T$, the values of the thermal expansion coefficient were defined. The results of the definition at the different temperatures are presented in the fig.2. From the fig.2, it is seen, that thermal expansion coefficient has the hysteresis character in the cycle heating-cooling also, and is equal to $18\cdot10^{-6}$ grad^{-1} in the initial state and after the cycle heating-cooling has the values $20\cdot10^{-6}$ grad^{-1}.

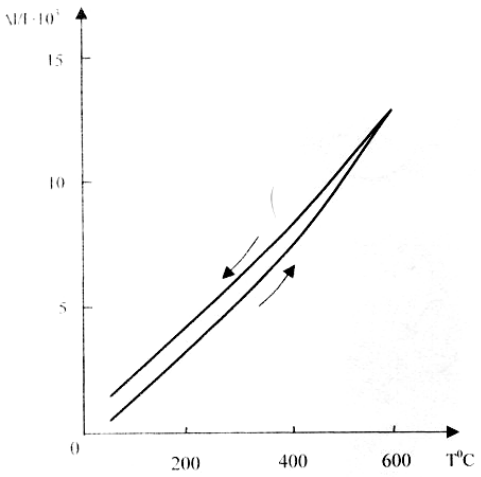

Fig.2. The temperature dependence of thermal expansion coefficient of BaF_2 crystals.

Thus, crystals of barium ftoride heating till 600ºC or the short-term extract at the temperatures ~400ºC becomes disordered, and at the same time appears the hysteresis character of the change of thermal expansion coefficient, essentially in the temperature interval from room till 450ºC. The last circumstance leads to the presence of permanent elongation ratio after cooling.

The above mentioned peculiarities, probably, connect with the relaxation of the nonhomogeneous interval stresses, leading to the creation and motion of the dislocations, essentially near block boundaries and consequently, to the crystal disorder. Such anomalies in the behaviour of thermal expansion coefficient were observed in the boron and calcite [3,4] and explained by the role of the twins and packing defects, interacting actively with he residual impurities at the thermal influence.

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BaF_2 KRİSTALLARININ MİKROBƏRKLİYİNƏ VƏ GENİŞLƏNMƏSİNƏ TERMİK HƏRƏKƏTİN TƏSİRİ

Blok quruluşu ilə fərqlənən kristallarında müəyyən edilmişdir ki, istilik təsiri termik genişlənmə əmsalının gisterezis xarakterli dəyişməsinə və möhkəmliyinin azalmasına gətirir.

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ВЛИЯНИЕ ТЕРМИЧЕСКОГО ВОЗДЕЙСТВИЯ НА МИКРОТВЕРДОСТЬ И РАСШИРЕНИЕ КРИСТАЛЛОВ BaF_2

Обнаружено, что в кристаллах BaF_2, отличающихся блочной структурой, температурное воздействие приводит к разупрочнению и гистерезисному характеру изменения коэффициента термического расширения .

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