Radiation defects in BaFBr crystals irradiated with krypton ions

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Annotation

BaFBr crystals used today as ionizing radiation detectors have a number of advantages over conventional x-ray films, such as high sensitivity, wide dynamic range and high spatial resolution. In our work, we consider defects in the BaFBr crystal created under the influence of 147 MeV krypton ions, up to fluences: 10^{10}ion/cm^2, 10^{11}ion/cm^2, 10^{12}ion/cm^2, and 10^{13}ion/cm^2.

Introduction

At the moment, in the modern world, the study of the fundamentals of manufacturing various types of detectors for recording and measuring ionizing and nuclear radiation is one of the significant problems that special attention is paid to solving. In the BaFBr crystal, the image created by ionizing as well as nuclear radiation remains stable in the dark for a long time at room temperature, which is successfully used to create imaging plate (IP). BaFBr crystals used today as ionizing radiation detectors have a number of advantages over conventional x-ray films, such as high sensitivity, wide dynamic range and high spatial resolution [1]. In this paper we consider defects in the BaFBr crystal created under the influence of krypton ions at an irradiation energy of 147 MeV as well as the dependence of specific ionization energy losses on the mileage. The absorption bands of the irradiated and non-irradiated crystal are identified.

Figure 2. Non-irradiated BaFBr crystal.

Figure 3. BaFBr crystal irradiated with ^{84}Kr ions with 147 MeV energy and 10^{12} ion/cm^2 fluence.

Methods and materials

The BaFBr crystal under study is a mixed single crystal of alkaline earth halogens of the layered type. The plate-shaped samples prepared for irradiation were approximately 1 mm thick (Fig. 2). Irradiation was performed at the DC-60 heavy ion accelerator (Nursultan, Kazakhstan) with high-energy krypton ions with an energy of 147 MeV (Fig. 3) to fluences: 10^{10}ion/cm^2, 10^{11} ion/cm^2, 10^{12} ion/cm^2, and 10^{13} ion/cm^2 (table 1). Using a spectrophotometer designed to measure absorption in the ultraviolet and visible regions of the spectrum (SPECORD 210 PLUS), optical absorption spectra were measured in the range of 200-1000 nm.

Results and discussion

Figure 1 shows the optical absorption spectra of BaFBr crystals. The absorption bands of crystals at 240 and the band at 485 nm subsequently behave the same at fluences 10^{10} - 10^{13} ion/cm^2 of the ^{84}Kr ion. It is known that the oxygen centers O^{--} give several absorption bands in the ultraviolet range up to the exciton edge [2,3]. The absorption band of 240 nm in BaFBr crystals is associated with O^{--} - vacant defects [4]. Therefore, these ultraviolet bands in the crystals can occur due to oxygen defects. Spectroscopic studies of E. Radzhabov and V. Otroshok these oxygen centers are shown to be oxygen ions associated with anionic vacancies [5]. In the work of Koschnick F. K. et. al, the band at 485 nm in the optical absorption spectrum corresponds to the F (F-) center [6].

Table 1. The parameters of irradiation

Ion	Energy, MeV	Fluence, ion/cm²	S_e кэВ/нм	S_n кэВ/нм	R, мкм
$^{84}Kr^{14+}$	147	10^{10}-10^{13}	12,04	1,363	17,87

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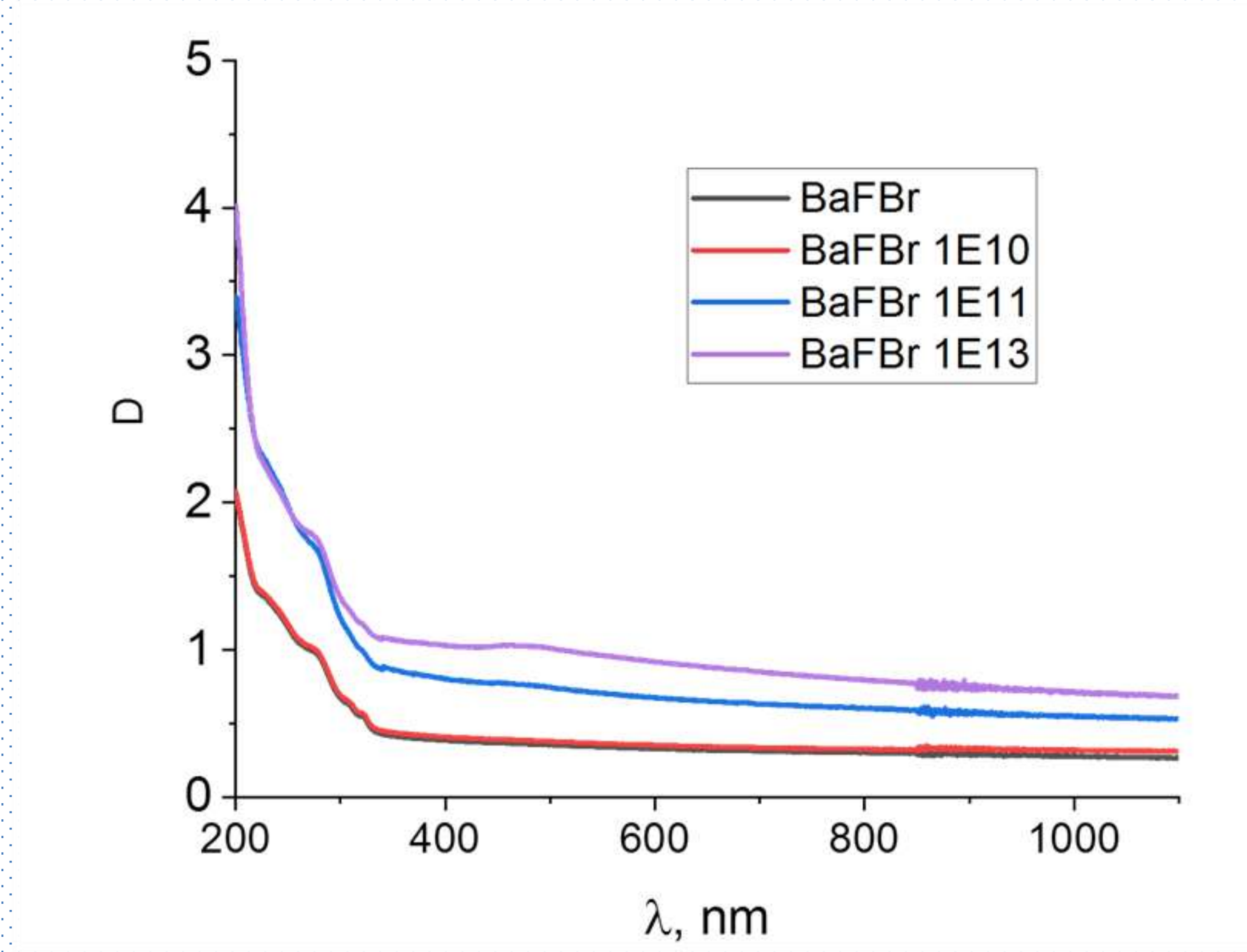

Figure 1. Optical absorption spectra of BaFBr crystals unradiated and irradiated with 147 MeV Kr ions, depending on the fluence.

Conclusion

This experiment contributes to a growing body of research showing the formation of defects in a BaFBr crystal created under the influence of ionizing radiation, the dependence of specific ionization energy losses on the run is shown, and the absorption bands of irradiated and non-irradiated crystals are identified. Further research could fruitfully continue the consideration of radiation defect formation in BaFBr crystals, since these crystals are successfully used for creating memory screens (imaging plate - IP), and are also used in various fields of science and technology.

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