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PHYSICAL CHEMISTRY

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Abstract

Full Text

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CHANGE IN THE PHASE COMPOSITION OF GLASS-CERAMICS UNDER THE ACTION OF γ RAYS

(Presented by Academician N. N. Semenov, 10 March 1964)

In studying the effect of γ rays on glass-ceramics of the lithium aluminosilicate system, we discovered a new effect, consisting in the fact that γ radiation is capable of exerting a direct influence on the phase composition of glass-ceramics.

A transparent glass-ceramic whose crystalline phase we identified as β -eucryptite was irradiated with γ rays from a Co^{60} source.

Fig. 1. X-ray diffraction patterns of glass-ceramic A: **A** —unirradiated; — irradiated with a dose of 10^2 r; — irradiated with a dose of 10^3 r; — irradiated with a dose of 10^5 r.

Irradiation doses were 10^2 , 10^3 , and 10^5 r. X-ray diffraction patterns of the unirradiated glass-ceramic and after irradiation with different doses were obtained on a URS-50 apparatus using copper radiation (Fig. 1). Recording of a standard sample shows the constancy of the conditions for obtaining the X-ray diffraction patterns. Already at the first irradiation dose, 10^2 r, two phenomena are noticeable in the X-ray diffraction pattern (Fig. 1,). First, the intensity of the β -eucryptite lines increased, which indicates an increase in its amount. The ratio of the line intensities in the X-ray diffraction pattern—

max of the unirradiated and irradiated glass-ceramics is 0.8–0.85. Second, the line corresponding to an interplanar spacing of 3.49 \AA began to split, and a peak corresponding to $d = 3.34 \text{ \AA}$ appeared, which corresponds to the most intense line of α -quartz. This maximum is expressed extremely weakly in Fig. 1, , and it might be overlooked; but on the X-ray diffraction pattern of the glass-ceramic irradiated with 10^3 r (Fig. 1,), it is quite clearly visible, since the intensity of this maximum has increased noticeably. Upon further irradiation, the intensity

Fig. 2. X-ray diffraction patterns of glass-ceramic B: A —unirradiated, — irradiated with a dose of 10^5 r

Figure 2: Fig. 2. X-ray diffraction patterns of glass-ceramic B: A —unirradiated, —irradiated with a dose of 10^5 r

of the β -eucryptite lines does not change.

Fig. 2. X-ray diffraction patterns of glass-ceramic B: **A** —unirradiated, — irradiated with a dose of 10^5 r

On the X-ray diffraction pattern of the glass-ceramic irradiated with 10^5 r (Fig. 1,), a maximum is visible corresponding to $d = 4.25 \text{ \AA}$, i.e., to the second most intense line of α -quartz. The same effect was also observed by us in another glass-ceramic of similar composition.

The X-ray diffraction patterns of the second glass-ceramic, unirradiated and irradiated with a dose of 10^5 r, are shown in Fig. 2. It is possible that the effect observed is explained as follows: α -quartz is also present in the unirradiated glass-ceramic, but in an amount not detectable by X-ray phase analysis. In support of this assertion is also the “step” on diffraction pattern 2, A, corresponding to the line $d = 3.34 \text{ \AA}$, which is easily overlooked.

Under the action of irradiation, the amount of the crystalline phase—the principal phase and α -quartz—increases; i.e., the energy of the γ -rays leads to the phase transition glass \rightarrow crystal. The increase in the crystalline phase probably occurs not through the precipitation of new crystallites, but as a result of the growth of crystals already present.

In connection with the observed effect, the question arises whether the phase transition occurs as a result of local heating in the glass-ceramic upon absorption of γ -rays, or whether it takes place at room temperature and we are dealing here with a new mechanism of crystal formation in glass.

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Note: Figure translations are in progress. See original paper for figures.

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