CHANGE IN THE MOSSBAUER SPECTRUM OF Te^{125m} IN THE SEMICONDUCTOR PbTe FOLLOWING IRRADIATION IN A REACTOR

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To obtain an unsplit Mossbauer line of Te^{125} it is customary to use a tellurium compound with cubic structure, particularly PbTe [1]. We prepared such a source by irradiating a $PbTe^{124}$ sample (enrichment ≈80%) in a reactor neutron flux ≈2.3 x 10^{14} neut/cm^2sec for 45 days.

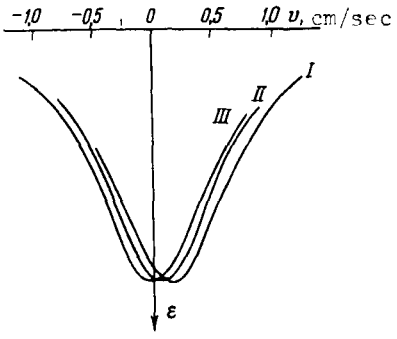

Fig. 1. Variation of the Mossbauer spectrum of a source Te^{125m} in PbTe with the time t after the end of irradiation: I - t = 20 days, II - t = 32 days, III - t = 50 days. The magnitude of the effect is normalized. Absorber - PbTe.

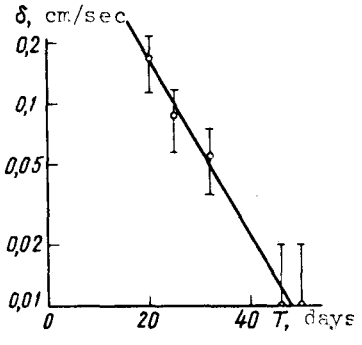

Fig. 2. Isomeric shift δ vs. the time t after the end of the irradiation. The plotted value of δ for the points t = 46 and t = 50 days is equal to half the measurement error.

It became clear in the course of the Mossbauer spectrum measurements that the source obtained in this manner has a clearly pronounced isomeric shift relative to the PbTe absorber; the shift decreased with time (Fig. 1). It is seen from Fig. 2 that the change in the isomeric shift during the measurement time is well described by the exponential function $\delta = \delta_0 \exp(-t/\tau)$, where $\tau = 10 \pm 3$ days.

We propose that the observed isomeric shift is due to structure defects produced when the sample is irradiated in the reactor. Since the magnitude of the chemical shift is

$$\delta = \frac{2}{5}\pi Z e^2 [R_{exc}^2 - R_0^2][|\psi_a(0)|^2 - |\psi_s(0)|^2]$$

[2], where R_{exc} and R_0 are the radii of the nucleus in the first-excited and ground states, while $|\psi_s(0)|^2$ and $|\psi_a(0)|^2$ are the s-electron densities at the nucleus in the source and absorber, respectively, we observed in this case that the ψ-function of the s-electrons is altered by the irradiation but returns to its initial value after annealing at room temperature. This is apparently connected with the radiation-induced distortion of the band struc-

ture of the semiconductor and the change in the probabilities of the s- and p-electron transitions to the conduction band.

To clarify the physical picture further, it is necessary, of course, to experiment more with various semiconductors, and to combine the investigations of the Mossbauer spectra with measurements of the electric properties.

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[1] E. P. Stepanov et al., Phys. Lett. 6, 155 (1963).

[2] L. R. Walker et al., Phys. Rev. Lett. 6, 98 (1961).