X-RAY AND γ-RAY DETECTORS BASED ON MERCURY DIODIDE CRYSTALS

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In this paper we present the results of investigations of the spectrometric and operational parameters of uncooled x-ray and γ-ray detectors based on HgI₂ [1]. Detectors fabricated thus far can work in both x-ray and γ-ray spectrometers and radiometers. Their sensitive area is 5–50 mm², depending on the size of the crystal. The operating voltage of a detector is determined by the thickness of the detector and can range from 500 to 2000 V. The detector current in the operating regime is 10⁶–10⁻¹² A, depending on the area of the contacts.

When used in a spectrometric mode the detector was connected to a Langur standard spectrometric apparatus with a PU-2-5 charge-sensitive preamplifier and an NTA-1024 multichannel analyzer. To reduce the noise of the recording apparatus at a γ-ray quantum energy of less than 30 keV the input field-effect transistor of the preamplifier was carefully selected. The least energy equivalent of the noise for zero capacitance at the preamplifier input and with the detector connected through an isolating capacitance was 1.0 keV for HgI₂ (0.71 keV with respect to Ge).

Connection of the detector directly to the gate of the field-effect transistor enabled the preamplifier noise to be reduced to 810 eV (574 eV with respect to Ge). The characteristic apparatus spectra of some γ-sources obtained without collimation of the radiation by using detectors with an area of 10 and 50 mm² with different preamplifiers are given in Figs. 1 and 2.

Typical and optimal values of the energy resolution and the peak/background ratio obtained during spectrometry of some γ-sources are given in Table 1.

Figure 3 shows the dependence of the mean counting rate of the detector on its operating voltage when used in a radiometric regime for various levels of discrimination. The γ-ray source used was ⁵⁷Co with a copper filter 0.35 mm thick to attenuate the low-energy part of the spectrum (6.4 and 14.4 keV).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>γ-quantum energy, keV</th>
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<tbody>
<tr>
<td></td>
<td>3.9</td>
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<tr>
<td>Energy resolution, keV</td>
<td>1.2</td>
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<tr>
<td>Peak/background ratio</td>
<td>7</td>
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</tbody>
</table>

*The first value is the typical characteristic and the second is the optimal.

Fig. 1. Apparatus spectra of $^{55}$Fe (a), $^{109}$Cd (b), $^{241}$Am (c), and $^{57}$Co (d) $\gamma$-sources, measured with HgI$_2$ detectors at 300°C (here and in the other figures, N is the number of counts and G is the generator).

Fig. 2. Apparatus spectrum of $^{241}$Am $\gamma$-source, measured at 300°C with a detector with a sensitive area of 50 mm$^2$.

Fig. 3. Typical counting characteristics of HgI$_2$ detectors at various levels of discrimination (numbers next to curves).

Fig. 4. Dependence of the slope of the plateau of the detector counting characteristic on the level of discrimination.