PROBE DEVICES BASED ON TIBr CRYSTALS

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Probes

Medical
• detecting cancer during surgery
• nuclear medicine and radiation safety

Technical
• nuclear material verification
• field and industrial gamma spectroscopy

Detector materials
• CdTe / CZT
• Scintillator – photodiode
Detectors

Detector requirements

• Ability to work at room temperatures
• The efficiency of the detector must be high
• Detector should be small
• Good energy resolution
Perspective detector material

Thallium bromide $\text{TIBr}$

- Density = 7.56 g/cm³
- High atomic number Tl=81;Br=35
- Band gap = 2.68 eV
- Resistivity = $10^{12}$ Ω cm
- $\mu T_e = 5 \times 10^{-4}$ cm²V⁻¹
- $\mu T_h = 2 \times 10^{-6}$ cm²V⁻¹
TlBr ingots

Crystal - `Bridgeman-Stockbarger´ method

Detectors fabrication:

• Slicing
• Dicing
• Polishing
• Etching
• Annealing
• Contact vacuum deposition
• Photolithography
Detectors based on TlBr

Dimensions 5x5 mm².
Thickness – 2mm
Diameter of contacts – 4 mm
Gold contacts thickness-0.1 μm
Investigation of the spectrometric performance

Spectrum of Fe-55 radionuclide obtained by TIBr-based detectors

Resolution 1.1 keV
5.9 keV

Spectrum of Am-241 radionuclide obtained by TIBr-based detectors

Resolution 1.8 keV
59.6 keV
Investigation of the spectrometric performance

Resolution 3.6 keV
122 keV

Resolution 14 keV
662 keV

Spectrum of Co-57 radionuclide obtained by TIBr-based detectors

Spectrum of Cs-137 radionuclide obtained by TIBr-based detectors
Probe devices based on CdTe and TiBr

<table>
<thead>
<tr>
<th>Energy (keV)</th>
<th>CdTe/CZT</th>
<th>TiBr</th>
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<tbody>
<tr>
<td>5.9</td>
<td>0.3</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>(with -40 °C only)</td>
<td></td>
</tr>
<tr>
<td>59.6</td>
<td>1.0</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>(with -40 °C only)</td>
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</tr>
<tr>
<td>122</td>
<td>4.7</td>
<td>3.6</td>
</tr>
<tr>
<td>662</td>
<td>10 - 14</td>
<td>14.0</td>
</tr>
</tbody>
</table>
Efficiency of TIBr detectors with different thickness
Photography of probes
Probe system design
Confirmed in probes:

**Technical probe:**
- 59.6 keV – 1.8 keV
- 122 keV – 3.6 keV
- 662 keV - 14 keV

**Medical probe:**
- 122 keV – 3.6 keV
- 662 keV – 14 keV
Conclusion

- TIBr crystals are promising material for medical and technical probes fabrication
- First probe prototypes are fabricated
- The spectrometric performance of TIBr detectors is comparable with the CdTe/CZT ones
- Registration efficiency of such probes on energy 662 keV is about 1.5 times higher than probes based on CdTe/CZT at the same energy and detector thickness
Thank you for attention

Questions?