ZnGeP₂ CRYSTALS FOR PARAMETRIC FREQUENCY CONVERSION OF MIDDLE IR LASER RADIATION

**Description**

ZnGeP₂ single crystals are intended for laser frequency conversion between two spectral regions and can be used for:

- creation of optical parametric oscillators (OPO), coherent radiation sources tunable in the range of 2.5÷12 μm at laser pumping with wavelength of about 2 μm;
- generation of CO- and CO₂-lasers radiation harmonics;
- generation of radiation with heterodyne (sum and difference) frequencies of CO, CO₂ and other middle IR range lasers radiation (1÷11 μm).

**Technical specifications**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syngony</td>
<td>Tetragonal</td>
</tr>
<tr>
<td>Crystal structure</td>
<td>Chalcopyrite</td>
</tr>
<tr>
<td>Lattice parameters, nm</td>
<td>a = 0.5465, b = 1.0710</td>
</tr>
<tr>
<td>Microhardness, GPa</td>
<td>6.0 ± 0.2</td>
</tr>
<tr>
<td>Density, g/cm³</td>
<td>4.158</td>
</tr>
<tr>
<td>Melting point, °C</td>
<td>1027</td>
</tr>
<tr>
<td>Transparency range, μm</td>
<td>0.7÷12</td>
</tr>
<tr>
<td>Birefringence</td>
<td>0.04</td>
</tr>
<tr>
<td>Nonlinear coefficient d₃₆, pm/V</td>
<td>75 ± 8</td>
</tr>
</tbody>
</table>

ZnGeP₂ single crystals grown by Vertical Bridgman technique on seeds of different orientations

**Technical appraisal and economic benefits**

ZnGeP₂ crystals produced at the Institute of Monitoring of Climatic and Ecological Systems SB RAS have more attractive price than similar crystals produced by other organizations in the Russian Federation and abroad.

**Application areas**

Applying the high-resolution spectroscopy methods, coherent radiation sources tunable in 2÷11 μm spectral range can solve a number of applied problems:

- monitoring of industrial and anthropogenic emissions to the atmosphere;
- identification and monitoring of concentration of various toxic gas mixtures and gaseous products or industrial discharge in power engineering, chemistry, and petroleum industry;
• separation of isotopes (oxygen, carbon, and uranium);
• creation of indicating systems for monitoring of pipeline breaking;
• design of warning systems for explosive mixtures (methane);
• control and certification of high-purity gases used in microelectronics and semiconductor engineering;
• monitoring and control of special technological processes, for example, annihilation of toxic agents.

Development stage
Developmental small-scale production.

Patent situation
Some technological operations in the process of ZnGeP$_2$ crystals production are protected by RF patents.

Commercial offers
• contracts for production and delivery of ZnGeP$_2$ nonlinear-optical elements;
• marketing agreements;
• contracts for further researches in technology of nonlinear-optical materials;
• development and production of optical devices and systems based on application of high-resolution spectroscopy methods and methods in nonlinear optics.

Estimated cost
US$ 3,500–10,000 for 1 cm$^3$ depending on volume of delivery and optical quality requirements.

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