High-accuracy Sellmeier equations for LiInS$_2$ and its applications to the nonlinear optics in LiIn(S$_{x}$Se$_{1-x}$)$_2$

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Abstract—This paper reports the high-accuracy Sellmeier equations for LiInS$_2$ that provide excellent reproduction of our new experimental results for second-harmonic (SHG) and sum-frequency generation (SFG) in the 0.8018-10.5910μm range as well as the published difference-frequency generation (DFG) data points for cw Ti:Al$_2$O$_3$ lasers in the 6.5851-6.9896μm range. In addition, the feasibility of 90° phase-matched type-2 SFG between 10.5910 and 5.2955μm in LiIn(S$_{x}$Se$_{1-x}$)$_2$ is briefly reported.

Keywords—Phase-matching, Sellmeier equations, SHG, SFG

Since we have recently published the following high-accuracy Sellmeier equations for LiInSe$_2$[1],

\[ n^2 = 5.79323 + 0.21461/\lambda^2 - 0.08391 + 466.11/\lambda^2 - 617.02 \]  
\[ n^2 = 6.01426 + 0.23387/\lambda^2 - 0.08872 + 495.14/\lambda^2 - 622.67 \]  
\[ n^2 = 6.19362 + 0.23879/\lambda^2 - 0.08957 + 628.13/\lambda^2 - 664.90 \]

(0.717μm≤λ≤10.5910μm)

We next have constructed the high-accuracy Sellmeier equations for LiInS$_2$ in order to evaluate the phase-matching properties of LiIn(S$_{x}$Se$_{1-x}$)$_2$[2].

The experiments were carried out with two LiInSe$_2$ samples cut normal to three principal axes and θ=54.3° (=35.7°) in the xy (ba) plane. By using the CO$_2$ laser at 10.5910μm (Coherent DEOS, Model EOM-10) and its SHG and THG and a Nd:YAG laser-pumped AgGaS$_2$/OPO as the pump source, we have measured the phase-matching angles for SHG and SFG in the 0.8018-10.5910μm range at 20°C.

The results obtained with the CO$_2$ laser are summarized in Table 1 together with the theoretical values calculated with the following best fitted Sellmeier equations.

\[ n^2 = 6.702764 + 0.13853/\lambda^2 - 0.05712 + 2164.01/\lambda^2 - 942.06 \]  
\[ n^2 = 7.09598 + 0.14240/\lambda^2 - 0.06514 + 2511.13/\lambda^2 - 988.03 \]

(2)

Table 1. Phase-matching angles for SHG and SFG of CO$_2$ laser radiation at 10.5910μm in LiInS$_2$

<table>
<thead>
<tr>
<th>Wavelength (μm)</th>
<th>Measured Phase-Matching Angle (deg)</th>
<th>Calculated Phase-Matching Angle (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2955μm</td>
<td>(0°=90, θ=61.0)</td>
<td>(0°=90, θ=61.47)</td>
</tr>
<tr>
<td>3.5303μm</td>
<td>(0°=90, θ=50.0)</td>
<td>(0°=90, θ=50.01)</td>
</tr>
<tr>
<td>SFG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.5910μm</td>
<td>(0°=61.3, θ=0)</td>
<td>(0°=17.19, θ=0)</td>
</tr>
<tr>
<td>5.2955μm</td>
<td>(0°=90, θ=55.6)</td>
<td>(0°=90, θ=56.76)</td>
</tr>
<tr>
<td>3.5303μm</td>
<td>(0°=90, θ=43.3)</td>
<td>(0°=90, θ=43.47)</td>
</tr>
<tr>
<td>2.1182μm</td>
<td>(0°=90, θ=65.3)</td>
<td>(0°=90, θ=65.50)</td>
</tr>
<tr>
<td>2.6478μm</td>
<td>(0°=10.4, θ=90)</td>
<td>(0°=13.39, θ=90)</td>
</tr>
</tbody>
</table>

a) λ$_{o}$+1λ$_{e}$<2λ$_{o}$.

b) The superscripts of the interacting wavelengths denote the polarization directions.

References


