High-accuracy Sellmeier Equations for GaS\textsubscript{x}Se\textsubscript{1-x} (x=0, 0.09, 0.40, and 1)

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Abstract—This paper reports the high-accuracy Sellmeier equations for GaS\textsubscript{x}Se\textsubscript{1-x} (x=0, 0.09, 0.40, and 1) that provide excellent reproduction of the phase-matching angles for SHG to 5H of CO\textsubscript{2} laser radiation at 10.5910 \( \mu \)m in GaS\textsubscript{x}Se\textsubscript{1-x} (x=0, 0.40, and 1) [1] as well as SHG of a Ti:Al\textsubscript{2}O\textsubscript{3} laser-pumped BBO/OPG at 2.14-2.9 \( \mu \)m and CO\textsubscript{2} laser radiation at 9.2-10.7 \( \mu \)m achieved in GaS\textsubscript{x}Se\textsubscript{1-x} (x=0.09 and 0.41) [2,3].

Keywords—Sellmeier equations; Second harmonic generation

Since we have reported the high-accuracy Sellmeier equations for GaSe that provide excellent reproduction for harmonic generation of CO\textsubscript{2} laser radiation at 1.7652-10.5910 \( \mu \)m as well as DFG between a Nd:YAG laser and a Nd:YAG laser-pumped BBO/OPG in the 2.7-1618 \( \mu \)m range [1], we next have constructed the high-accuracy Sellmeier equations for GaS and GaS\textsubscript{0.4}Se\textsubscript{0.6} using the same method as described in [1]. They are expressed as

GaSe:
\[ n_2^2 = 10.6409 + 0.3788/(\lambda^2 - 0.1232) + 7090.7/(\lambda^2 - 2216.3) \]
\[ n_2^2 = 8.2477 + 0.2881/(\lambda^2 - 0.1669) + 4927.5/(\lambda^2 - 1990.1) \] (1)

GaS:
\[ n_2^2 = 10.1934 + 0.2331/(\lambda^2 - 0.0431) + 3837.5/(\lambda^2 - 1085.5) \]
\[ n_2^2 = 7.6401 + 0.1914/(\lambda^2 - 0.0623) + 2789.3/(\lambda^2 - 1051.3) \] (2)

GaS\textsubscript{0.4}Se\textsubscript{0.6}:
\[ n_2^2 = 10.1030 + 0.3202/(\lambda^2 - 0.1201) + 4074.0/(\lambda^2 - 1369.5) \]
\[ n_2^2 = 7.7615 + 0.2492/(\lambda^2 - 0.1381) + 3021.6/(\lambda^2 - 1311.6) \]
\[ (0.80 \ \mu m \leq \lambda \leq 10.5910 \ \mu m) \] (3)

In order to verify the validity of (1-3) as well as the following equations for GaS\textsubscript{0.09}Se\textsubscript{0.91} that are constructed from (1) and (2),
\[ n_2^2 = 10.6006 + 0.3651/(\lambda^2 - 1.1201) + 6451.7/(\lambda^2 - 1997.8) \]
\[ n_2^2 = 8.1930 + 0.2789/(\lambda^2 - 0.1623) + 4545/(\lambda^2 - 1824.2) \] (4)

we have calculated the phase-matching angles of GaS\textsubscript{x}Se\textsubscript{1-x} (x=0, 0.09, 0.4/0.41, and 1) for type-I SHG in the 1.8-11.0 \( \mu m \) range by using (1-4). The resulting tuning curves (K) are shown in Fig. 1 together with the tuning curve (M) given by the Sellmeier equations for GaS\textsubscript{0.09}Se\textsubscript{0.91} presented in [4]. Since the data points around 9.5862 and 10.5910 \( \mu m \) for GaS\textsubscript{0.09}Se\textsubscript{0.91} [2,3] are 1° and 2° higher than the more reliable values presented in [5], we can conclude that excellent agreement between theory and experiment is obtained in the 2.14-10.7 \( \mu m \) range.

Finally, we note that (1,2) are highly useful to construct the Sellmeier equations for GaS\textsubscript{x}Se\textsubscript{1-x} in the THz range.

Fig. 1 Phase-matching curves for type-I SHG in GaS\textsubscript{x}Se\textsubscript{1-x}. The solid (K) and dashed (M) lines are calculated with the Sellmeier equations of the present authors and Marchev et al [4]. Open circles: experimental points taken from [2,3]. Triangles: our experimental points.