Strontium Fluoride (SrF_2)

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Strontium fluoride offers a wide range of transparency, from the ultraviolet to the long-wave infrared (0.13 to 11 μm), with low reflectance loss and low dispersion. This combination of broad transparency and low dispersion is rare in optical-window materials used in infrared systems. Like BaF_2, it allows experimenters to conveniently perform initial system alignment in the visible and then switch to the IR with only minor correction of the optical components. Furthermore, strontium fluoride has good surface hardness (Knoop scale 150 kg/mm^2) and is not hygroscopic. It has a flexure strength between those of CaF_2 (90 MPa) and BaF_2 (27 MPa).

Strontium fluoride is a cubic crystal with the fluorite structure, space group $Fm3m$ (O_h^5), with four formula units per unit cell. The lattice constant is 5.7996 Å, giving a theoretical density of 4.277 g/cm^3. The strontium arrangement in strontium atoms occupy the 4(a) sites ($m3m$ or O_h symmetry), and the fluorine atoms occupy the 8(c) sites ($\bar{4}3m$ or T_d symmetry). Melting point is 1750 K.

Ultraviolet reflectance of bulk SrF_2 was measured by Gunia *et al.* [1] up to 20 eV at room temperature and liquid-helium temperature. Rubloff [2] measured the room-temperature reflectance up to 30 eV. Unfortunately, these measurements are not corrected to optical constants. However, similar measurements from 10 to 35 eV by Nisar and Rekhi [3] have been reduced to optical constants using the Kramers–Kronig relation. These data are listed in Table I and plotted in Fig. 1.

The Urbach tail represents absorption below the band gap, defining the end of transparency. The room-temperature absorption coefficient was determined from transmission measurements by Tomiki and Miyata [4] in the spectral range from 9.3 to 9.8 eV and fitted to the functional form

$$\beta_{abs}(E, T) = \beta_{1,0}\exp[\sigma_0(T)(E - E_0)/k_BT], \qquad (1)$$

where β_{abs} is the absorption coefficient (typically in units of cm^{-1}), $\beta_{1,0}$ is

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a scaling coefficient (in units of cm^{-1}), E_g is the band-gap energy at absolute zero temperature (typically given in units of eV), k_B is Boltzmann's constant, and T is temperature in Kelvins. The exponential factor $\sigma_s(T)$ is given by the equation

$$\sigma_s(T) = \alpha_0 \frac{2k_B T}{E_p} \tanh \frac{E_p}{2k_B T}, \tag{2}$$

where E_p is an effective acoustic-phonon energy of the material. The Urbach tail parameters for SrF_2 are $\beta_{UD} = 1.35 \times 10^9\ cm^{-1}$, $E_p = 10.670$ eV, $\alpha_0 = 0.60$, and $E_p = 0.044$ eV. The room-temperature (295 K) values for k in Table I and Fig. 1 for this spectral region are generated using Eqs. (1) and (2).

The room-temperature (25° C) index of refraction from the ultraviolet to the infrared (0.22 to 11.5 μm) has been measured by Feldman *et al.* [5] using a prism and the minimum-deviation technique. A Sellmeier model of the form

$$n^2(\lambda, T) = 1 + \sum_i \frac{k^2 d\alpha_i(T)}{k^2 - \lambda_i^2(T)} \tag{3}$$

is used to represent the data accurately. Model parameters are listed in Table II. A comprehensive analysis on a variety of data sets was performed by Li [6]. A Sellmeier formula was also generated covering the range from 0.15 to 14 μm at $T = 20°$ C. The Li model parameters are also listed in Table II. Because the Sellmeier model has a physical basis, the extrapolation to higher frequencies beyond the experimental limit is justified. The values for n in Table I and Fig. 1 for the spectral regions indicated are generated by the appropriate formula. A temperature-dependent Sellmeier model covering the range from 100 to 450 K has been developed by Tropf [7]. Near-room-temperature thermo-optic coefficients measured at different wavelengths are listed in Table III [5, 8–10]. Notice that the thermo-optic coefficients are negative. This gives SrF_2 some athermal performance as an optical element. An athermal material has the property that

$$\frac{d(n(T)L(T))}{dT} = 0.$$

The value of the optical-path derivative as given earlier for SrF_2 is 6.9×10^{-6} nL per Kelvin at visible and near infrared wavelengths. Thus, SrF_2 is useful for optical designs that require insensitivity to temperature.

Laser-calorimetry data [11] at DF (3.8 μm) and HF (2.7 μm) laser wavelengths indicate low-level absorption in roughly the middle of the transparency range of SrF_2. Material obtained from Optovac had absorption-

coefficient values of 2.0×10^{-4} cm^{-1} at the DF laser wavelength and 1.4×10^{-4} cm^{-1} at the HF laser wavelength. The corresponding k values are listed in Table I and plotted in Fig. 1. The low-level absorption and the near ideal performance of SrF_2 make it a candidate window material for high-power laser applications.

The multiphonon absorption (multiple-quanta lattice vibrations) edge marks the end of infrared transparency. Absorption-coefficient measurements by Deutsch [12] are represented by the simple formula

$$\beta_{MP}(\nu) = \beta_0 \exp\left(-\gamma \frac{\nu}{\nu_0}\right), \tag{6}$$

where for SrF_2, $\beta_0 = 22,348$ cm^{-1} and $\nu_0/\gamma = 90.4$ cm^{-1} at room temperature. The values of k in the spectral range from 830 to 1300 cm^{-1} in Table I and Fig. 1 are obtained from this formula. The data cover the three-phonon to four-phonon regions. Temperature-dependent experimental data on the absorption coefficient is described in Lipson *et al.* [13]. A temperature-dependent multiphonon model has been developed by Thomas *et al.* [14] and applied to SrF_2. Measurements in the two-phonon region are reported by Kaiser *et al.* [15]. The experimental results are listed in Table I and plotted in Fig. 1.

The one-phonon (one-quanta fundamental lattice vibrations) region is opaque and therefore characterized by reflectance measurements. A room-temperature reflectance measurement is reported by Kaiser *et al.* [15]. The classical-oscillator model is often used to fit the reflectance data and then to derive the optical constants. The classical-oscillator model is expressed in terms of the relative permittivity, $\epsilon(\nu,T)$, as given by[1]

$$\epsilon(\nu,T) = \epsilon_\infty(T) + \sum_i \frac{\Delta\epsilon_i(T)\nu_i^2(T)}{\nu_i^2(T) - \nu^2 + j\Gamma_i(\nu,T)\nu}, \tag{5}$$

where $\Delta\epsilon_i(T)$, $\Gamma_i(\nu,T)$ and $\nu_i(T)$ are the ith-mode strength, linewidth, and long-wavelength transverse optical frequency, ν_{TO_i}, respectively. The sum on i is over all transverse optical modes. For SrF_2, there is only one allowed infrared-active vibrational mode based on group theory of a perfect lattice. This is formally stated as

$$\Gamma = F_{1u}(IR) + F_{2g}(R).$$

The first mode is infrared active (mode 1 in Table IV), and the second mode is Raman active (286 cm^{-1} [16]). Table IV lists the classical-oscillator model parameters used to fit the experimental data. More than one mode is needed

[1] The exponent was the engineering convention for a time harmonic field of $\exp(-j\omega t)$. To convert to the convention commonly used in the physics notes, use $i = -j$.

to account for impurities and defects in real materials. Also, the high-frequency edge of the reflectance spectrum must include two-phonon contributions (see mode 2 in Table IV). Unfortunately, the value of ϵ_∞ used by Kaiser *et al.* [6] not consistent with the value from the Sellmeier models mentioned previously, and the sense [6] true for the static dielectric constant. For this reason the model parameters have been modified to agree with these limiting values and still match the reflectance spectrum. These modified values are listed in Table IV. The n and k values in Table I and Fig. 1 are generated by Eq. (5) and the modified parameters in Table IV.

Below ν_{TO}, the index of refraction, n, [6] determined by extrapolation of the classical-oscillator model with reasonable accuracy. The absorption coefficient [6,8] been measured by Bosomworth (17). Table I [6,8] Fig. 1 list and display the resulting values. The values are above the one-phonon red wing because multiphonon difference bands are also included in this spectral region.

The static-dielectric-constant data [6] the sum of all the strengths of higher-frequency oscillators including vibrational and electronic. Using Eq. (5), the static dielectric constant, $\epsilon_s(T) = \epsilon'(0,T)$, becomes

$$\epsilon_s(T) = \epsilon_\infty(T) + \sum_i \Delta\epsilon_i(T). \tag{6}$$

Based on the parameters listed in Table IV, we expect the value of ϵ_s to be between 6.14 and 6.5. Experimental results, obtained from capacitance bridges operating from 1 kHz to 1 MHz, produce values [6,9] from 6.45 to 6.48, with most results closer to the higher value [18–21]. The corresponding refractive index value [6] $n_s = 2.543$. The static-index values incorrectly are located at 1×10^4 μm; however, there is little difference in the value of n_s [6] the measured wavelength and the plotted wavelength.

Whenever possible, physically based models are used to represent experimental measurements in Table I and Fig. 1. The models tend to reduce noise and allow interpolation and extrapolation to obtain meaningful results where no experimental data exists. In some cases, the models discussed in this section also allow temperature-dependent data to be obtained.

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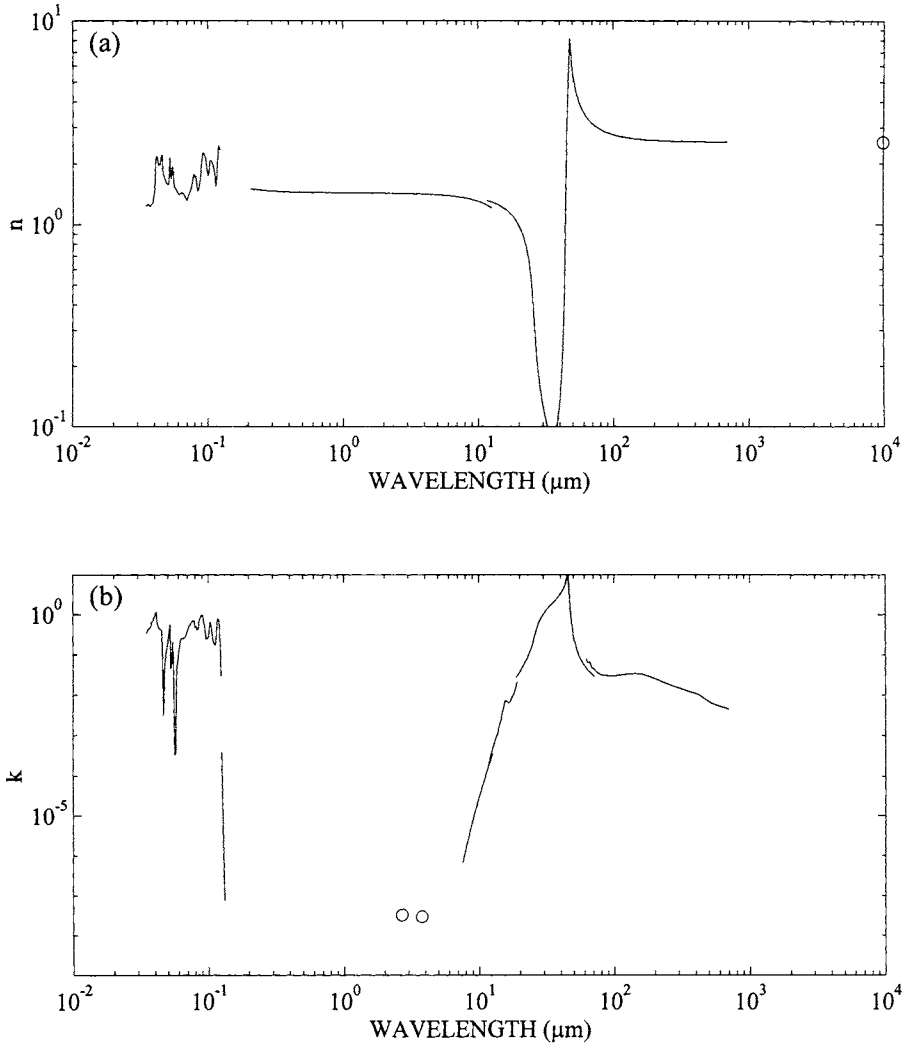

Fig. 1. (a) Log–log plot of the room-temperature index of refraction, n, for SrF_2 versus wavelength in microns. (b) Log–log plot of the room-temperature extinction coefficient, k, for SrF_2 versus wavelength in microns. Isolated data points are indicated with a symbol.

TABLE I

Values of n and k for Strontium Fluoride from Various References[a]

eV	cm^{-1}	μm	n	k
35.00	[illegible]	0.03454	1.242	0.3412 [5]
35.24	284300	0.03518	1.230	0.3963
34.04	[illegible]	0.03640	1.241	0.4157
34.58	278900	[illegible]	1.260	0.4291
33.63	271000	0.03687	1.236	0.4596
33.15	267300	0.03740	1.225	0.5536
32.07	[illegible]	0.03761	1.237	0.5995
32.77	263900	0.03790	1.241	0.6380
32.12	[illegible]	0.03861	1.272	0.6971
31.98	263900	0.03878	1.278	0.7206
31.84	256000	0.03894	1.293	0.7873
31.21	251700	0.03973	1.408	0.9067
31.03	250000	0.03996	1.448	0.9606
30.90	249200	0.04015	1.480	1.011
30.74	248000	0.04033	1.579	1.064
30.58	247400	0.04043	1.684	1.115
30.34	245100	0.04080	1.931	1.157
30.33	244700	0.04087	2.051	1.112
30.30	244400	0.04092	2.075	1.063
30.26	244100	0.04097	2.100	1.007
30.21	243600	0.04106	2.137	0.9536
30.13	243000	0.04115	2.164	0.8345
30.06	242300	0.04127	2.146	0.8107
29.97	241700	0.04137	2.143	0.7403
29.86	240800	0.04152	2.100	0.6764
29.76	240000	0.04167	2.156	0.6386
29.64	239000	0.04184	2.140	0.5901
28.80	232300	0.04298	1.931	0.4333
28.58	230500	0.04338	1.871	0.4671
28.35	228700	0.04373	1.934	0.4137
28.15	227000	0.04405	1.999	0.4252
27.68	223300	0.04479	2.180	0.4066
27.43	221200	0.04520	2.193	0.1579
27.33	220400	0.04537	2.207	0.07946
27.08	218200	0.04584	2.005	0.00511
26.97	215000	0.04597	1.279	0.00483
26.47	213500	0.04684	1.700	0.00755
26.05	210100	0.04760	1.707	0.0397
25.26	203700	0.04909	1.604	0.1595
25.03	201700	0.04953	1.886	0.1877
24.50	198100	0.05058	1.398	0.2505
24.42	196900	0.05078	1.966	0.3769
24.26	195200	0.05124	1.613	0.4236
24.00	193600	0.05165	1.999	0.3621

(continued)

[a] References given in brackets.

TABLE I (*Continued*)

Strontium Titanate

eV	cm⁻¹	μm	n	k
23.99	193500	0.05169	2.049	0.5311
23.99	193000	0.05180	2.110	0.4475
23.77	191700	0.05217	2.129	0.4940
23.50	189500	0.05276	1.748	0.4500
23.30	187100	0.05354	1.540	0.3006
22.72	184600	0.05420	1.820	0.2040
22.75	183500	0.05449	1.910	0.1022
22.64	182600	0.05476	1.925	0.0627
22.44	181000	0.05528	1.933	0.00857
22.23	179300	0.05403	1.942	0.00063
21.77	175600	0.05695	1.925	0.00087
21.35	172700	0.05750	1.497	0.02136
21.29	173700	0.05525	1.472	0.03455
20.98	169000	0.05916	1.447	0.0627
20.20	162900	0.06133	1.409	0.2047
19.73	159000	0.06291	1.434	0.2546
19.45	157000	0.06370	1.431	0.2353
19.17	154000	0.06400	1.431	0.2530
18.84	152400	0.06575	1.419	0.2518
18.45	148900	0.06713	1.387	0.2730
18.21	146900	0.06800	1.464	0.3070
17.78	143300	0.06965	1.319	0.3907
17.59	141800	0.07050	1.319	0.4496
17.40	140400	0.07114	1.369	0.4867
17.25	139200	0.07184	1.403	0.5240
17.05	137400	0.07280	1.411	0.5455
16.83	135700	0.07365	1.437	0.5801
16.34	131800	0.07590	1.454	0.6087
16.13	130100	0.07690	1.509	0.6626
15.92	128400	0.07790	1.700	0.6637
15.76	127200	0.07865	1.709	0.5844
15.71	126700	0.07892	1.745	0.4449
15.09	128800	0.07005	1.764	0.5015
16.64	126700	0.07035	1.742	0.4731
16.43	124400	0.08042	1.708	0.5124
16.20	122600	0.08150	1.757	0.4817
15.15	122200	0.08186	1.706	0.4011
14.30	115900	0.08378	1.561	0.4348
14.45	115000	0.08472	1.452	0.3755
14.37	117900	0.08508	1.466	0.6443
14.20	116000	0.08625	1.520	0.3740
14.27	115400	0.08665	1.584	0.3967
14.79	114200	0.08736	1.601	0.8853
14.07	113500	0.08814	1.672	0.9229
14.00	112900	0.08858	1.756	0.9630
13.74	110800	0.09023	.6095	0.6530

TABLE I (Continued)

Strontium Fluoride

eV	cm^{-1}	μm	n	k
13.60	109700	0.09116	2.185	0.5553
13.53	109100	0.09160	2.225	0.5077
13.45	108500	0.09221	2.245	0.6814
13.38	107900	0.09268	2.254	0.6182
13.31	107300	0.09317	2.341	0.5852
13.11	105800	0.09454	2.284	0.5540
13.04	105200	0.09512	2.165	0.5064
12.34	99530	0.1005	1.738	0.2748
12.28	99040	0.1010	1.729	0.3342
12.24	98750	0.1013	1.720	0.3540
12.19	98360	0.1017	1.765	0.4590
12.14	97930	0.1021	1.800	0.5359
12.09	97540	0.1025	1.818	0.6044
12.02	97290	0.1032	1.891	0.6913
11.92	96120	0.1040	2.039	0.5856
11.87	95700	0.1045	2.089	0.5012
11.81	95240	0.1050	2.090	0.5922
11.71	94460	0.1059	2.043	0.5736
11.58	93390	0.1071	2.024	0.5815
11.45	92320	0.1083	2.045	0.5626
11.32	91270	0.1096	1.923	0.6062
11.09	89460	0.1118	1.867	0.6087
10.91	88010	0.1136	1.658	0.2072
10.84	87400	0.1143	1.629	0.2621
10.79	87000	0.1149	1.382	0.3263
10.76	86770	0.1152	1.554	0.3036
10.72	86460	0.1157	1.540	0.4374
10.67	86050	0.1162	1.572	0.6511
10.64	85830	0.1165	1.626	0.4730
10.58	85330	0.1172	1.765	0.7409
10.52	84850	0.1178	1.825	0.6914
10.30	83060	0.1206	2.415	0.4706
10.26	83000	0.1209	2.423	0.8086
10.27	82860	0.1207	2.449	0.6409
10.25	82630	0.1210	2.449	0.6914
10.24	82570	0.1211	2.641	0.4282
10.21	82360	0.1214	2.434	0.3620
10.17	82030	0.1219	2.402	0.2947
10.15	81900	0.1221	2.384	0.2536
10.10	81460	0.1228	2.270	0.1654
10.05	81060	0.1234	2.534	0.1017
10.01	80730	0.1239	2.513	0.0293
9.919	80000	0.1250	1.745 [6]	0.0003835 [6]
9.801	79050	0.1265	1.735	8.702E-5
9.724	78430	0.1275	1.725	2.126E-5
9.649	77820	0.1285	1.716	4.623E-6

(continued)

TABLE I *(Continued)*

Strontium Fluoride

eV	cm^{-1}	μm	n	k
9.574	77220	0.1295	1.707	1.174E-6
9.501	76630	0.1305	1.699	2.922E-7
9.429	76050	0.1315	1.691	7.428E-8
8.266	66670	0.150	1.594	
7.085	57140	0.175	1.534	
6.199	50000	0.200	1.504	
5.510	44440	0.225	1.486	
5.904	47619	0.21	1.49513 [5]	
4.959	40000	0.25	1.47336	
3.999	32258	0.31	1.45725	
3.542	28571	0.35	1.45131	
3.024	24390	0.41	1.44556	
2.755	22222	0.45	1.44309	
2.431	19608	0.51	1.44029	
2.254	18182	0.55	1.43906	
2.032	16393	0.61	1.43740	
1.907	15384	0.65	1.43675	
1.746	14084	0.71	1.43560	
1.653	13333	0.75	1.43527	
1.531	12346	0.81	1.43435	
1.362	10989	0.91	1.43343	
1.228	9901.0	1.01	1.43269	
1.117	9009.0	1.11	1.43206	
1.025	8264.5	1.21	1.43151	
0.9464	7633.6	1.31	1.43100	
0.8793	7092.2	1.41	1.43051	
0.8211	6622.5	1.51	1.43003	
0.7701	6211.2	1.61	1.42956	
0.7251	5847.9	1.71	1.42909	
0.6850	5524.9	1.81	1.42861	
0.6491	5235.6	1.91	1.42812	
0.6168	4975.1	2.01	1.42761	
0.5876	4739.3	2.11	1.42709	
0.5610	4524.9	2.21	1.42656	
0.5367	4329.0	2.31	1.42601	
0.5145	4149.4	2.41	1.42544	
0.4940	3984.1	2.51	1.42485	
0.4750	3831.4	2.61	1.42424	
0.4590	3703.7	2.70		3.20E-8 [11]
0.4575	3690.0	2.71	1.42361	
0.4412	3558.7	2.81	1.42296	
0.4261	3436.4	2.91	1.42228	
0.4119	3322.3	3.01	1.42159	
0.3987	3215.4	3.11	1.42087	
0.3862	3115.3	3.21	1.42013	
0.3746	3021.1	3.31	1.41937	

TABLE I *(Continued)*

Strontium Fluoride

eV	cm^{-1}	μm	n	k
0.3636	2932.5	3.41	1.41858	
0.3532	2849.0	3.51	1.41778	
0.3434	2770.1	3.61	1.41694	
0.3342	2695.4	3.71	1.41609	
0.3260	2631.6	3.80		2.90E-8 [11]
0.3254	2624.7	3.81	1.41521	
0.3171	2557.5	3.91	1.41430	
0.3092	2493.8	4.01	1.41337	
0.3017	2433.1	4.11	1.41242	
0.2945	2375.3	4.21	1.41144	
0.2877	2320.2	4.31	1.41044	
0.2811	2267.6	4.41	1.40941	
0.2749	2217.3	4.51	1.40835	
0.2689	2169.2	4.61	1.40727	
0.2633	2123.1	4.71	1.40617	
0.2578	2079.0	4.81	1.40503	
0.2525	2036.7	4.91	1.40388	
0.2475	1996.0	5.01	1.40269	
0.2426	1956.9	5.11	1.40148	
0.2380	1919.4	5.21	1.40024	
0.2335	1883.2	5.31	1.39898	
0.2292	1848.4	5.41	1.39768	
0.2250	1814.9	5.51	1.39636	
0.2210	1782.5	5.61	1.39502	
0.2171	1751.3	5.71	1.39364	
0.2134	1721.2	5.81	1.39223	
0.2098	1692.1	5.91	1.39080	
0.2063	1663.9	6.01	1.38934	
0.2029	1636.7	6.11	1.38785	
0.1997	1610.3	6.21	1.38633	
0.1965	1584.8	6.31	1.38478	
0.1934	1560.1	6.41	1.38320	
0.1905	1536.1	6.51	1.38159	
0.1876	1512.9	6.61	1.37995	
0.1848	1490.3	6.71	1.37828	
0.1821	1468.4	6.81	1.37658	
0.1794	1447.2	6.91	1.37485	
0.1769	1426.5	7.01	1.37308	
0.1744	1406.5	7.11	1.37128	
0.1720	1387.0	7.21	1.36946	
0.1696	1368.0	7.31	1.36759	
0.1673	1349.5	7.41	1.36570	
0.1651	1331.6	7.51	1.36377	
0.1629	1314.1	7.61	1.36181	
0.1608	1297.0	7.71	1.35981	
0.1588	1280.4	7.81	1.35778	

(continued)

TABLE I (Continued)

Strontium Fluoride

eV	cm⁻¹	μm	n	k
0.1567	1264.2	7.91	1.33572	
0.1548	1248.4	8.01	1.33562	
0.1531	1234.6	8.1	1.3317 [8]	1.70335E-8 [12]
0.1442	1162.8	8.6	1.3405	4.61E-6
0.1362	1098.9	9.1	1.3283	3.53E-6
0.1292	1041.7	9.6	1.3151	1.73E-5
0.1228	990.1	10.1	1.3060	3.12E-5
0.1170	943.4	10.6	1.2854	5.48E-5
0.1117	900.9	11.1	1.2845	9.30E-5
0.1069	862.1	11.6	1.2905	0.00159
0.10634	857.7	11.65	1.3159	0.000173 [15]
0.10039	809.7	12.35	1.3005	0.000361
0.09774	787.5	12.70	1.2821	0.000362
0.09526	768.3	13.02	1.2865	0.000381
0.09346	753.8	13.27	1.2706	0.000780
0.09151	738.0	13.55	1.2865	0.000855
0.08991	725.2	13.79	1.2611	0.00120
0.08838	712.8	14.03	1.2353	0.00159
0.08485	684.4	14.61	1.2373	0.00252
0.08200	661.4	15.12	1.2306	0.00450
0.07944	640.7	15.61	1.2055	0.00719
0.07867	634.5	15.76	1.1979	0.00702
0.07796	628.7	15.91	1.1828	0.00705
0.07686	619.9	16.13	1.1640	0.00682
0.07584	611.7	16.35	1.1767	0.00842
0.07465	602.0	16.61	1.0659	0.00919
0.07280	587.2	17.03	1.1254	0.00693
0.06859	553.2	18.08	1.0991	0.0107
0.06486	523.1	19.12	1.0442	0.0198
0.06447	520	19.23	1.006[a]	0.0297[a]
0.06323	510	19.61	0.953	0.0331
0.06199	500	20.00	0.901	0.0370
0.06075	490	20.41	0.904	0.0436
0.05951	480	20.83	0.834	0.0470
0.05827	470	21.28	0.801	0.0589
0.05703	460	21.74	0.854	0.0612
0.05579	450	22.22	0.822	0.0708
0.05455	440	22.73	0.754	0.0828
0.05331	430	23.26	0.719	0.0977
0.05207	420	23.81	0.653	0.111
0.05083	410	24.39	0.528	0.146
0.04959	400	25.00	0.466	0.189
0.04835	390	25.64	0.366	0.251
0.04711	380	26.32	0.283	0.378
0.04587	370	27.03	0.219	0.519
0.04463	360	27.78	0.120	0.660

[a] Results obtained from modified classical-oscillator parameters in Table IV.

TABLE I (Continued)

Strontium Fluoride

eV	cm^{-1}	μm	n	k
0.04309	350	28.57	0.136	0.000
0.04215	340	29.41	0.137	0.040
0.04908	330	30.30	0.123	1.087
0.03906	320	31.25	0.120	1.243
0.03846	310	32.20	0.0998	1.413
0.03720	300	33.33	0.0925	1.587
0.03596	290	34.40	0.0861	1.818
0.03472	280	35.71	0.0874	2.071
0.03348	270	37.04	0.0923	2.379
0.03224	260	38.46	0.106	2.770
0.03100	250	40.00	0.130	3.304
0.02976	240	41.67	0.168	4.121
0.02852	230	43.48	0.646	3.809
0.02728	220	45.45	5.166	10.930
0.02604	210	47.62	8.152	1.093
0.02480	200	50.00	5.525	0.272
0.02356	190	52.63	4.334	0.136
0.02232	180	55.56	3.904	0.0855
0.02108	170	58.82	3.694	0.0598
0.01984	160	62.50	3.608	0.0465
0.01860	150	66.67	3.527	0.0440
0.01736	140	71.43	3.498	0.0397
0.01612	130.0	76.92	3.476	0.0382 [17]
0.01595	128.7	77.71	3.472	0.0376
0.01588	128.0	78.13	3.471	0.0376
0.01580	127.4	78.48	3.469	0.0375
0.01572	126.8	78.86	3.468	0.0374
0.01564	126.1	79.24	3.467	0.0373
0.01556	125.5	79.63	3.466	0.0372
0.01548	124.8	80.08	3.465	0.0371
0.01540	124.2	80.52	3.464	0.0370
0.01532	123.5	80.96	3.463	0.0369
0.01524	122.9	81.37	3.462	0.0368
0.01516	122.2	81.83	3.461	0.0367
0.01508	121.6	82.24	3.460	0.0366
0.01500	120.9	82.70	3.459	0.0365
0.01492	120.3	83.13	3.458	0.0364
0.01484	119.7	83.56	3.457	0.0363
0.01476	119.0	84.03	3.456	0.0362
0.01468	118.4	84.46	3.455	0.0361
0.01460	117.7	84.96	3.454	0.0360
0.01452	117.1	85.40	3.453	0.0359
0.01444	116.5	85.84	3.452	0.0358
0.01436	115.8	86.36	3.451	0.0357
0.01428	115.2	86.81	3.450	0.0356
0.01420	114.5	87.34	3.449	0.0355
0.01412	113.9	87.80	3.448	0.0354
0.01404	113.2	88.34	3.447	0.0353
0.01396	112.6	88.81	3.446	0.0352
0.01388	111.9	89.35	3.445	0.0351
0.01380	111.3	89.82	3.444	0.0350
0.01372	110.6	90.41	3.443	0.0349
0.01364	110.0	90.91	3.442	0.0348
0.01356	109.3	91.50	3.441	0.0347
0.01348	108.7	92.00	3.440	0.0346
0.01340	108.0	92.59	3.439	0.0345
0.01332	107.4	93.11	3.438	0.0344
0.01324	106.8	93.64	3.437	0.0343
0.01316	106.1	94.26	3.436	0.0342
0.01308	105.5	94.79	3.435	0.0341
0.01300	104.8	95.40	3.434	0.0340
0.01292	104.2	95.96	3.433	0.0339
0.01284	103.5	96.62	3.432	0.0338
0.01276	102.9	97.18	3.431	0.0337
0.01268	102.2	97.85	3.430	0.0336
0.01260	101.6	98.43	3.429	0.0335
0.01252	100.9	99.11	3.428	0.0334
0.01244	100.3	99.70	3.427	0.0333
0.01236	99.6	100.4	3.426	0.0332
0.01228	99.0	101.0	3.425	0.0331
0.01220	98.3	101.7	3.424	0.0330
0.01212	97.7	102.4	3.423	0.0329
0.01204	97.0	103.1	3.422	0.0328
0.01196	96.4	103.7	3.421	0.0327
0.01188	95.7	104.5	3.420	0.0326
0.01180	95.1	105.2	3.419	0.0325
0.01172	94.5	105.8	3.418	0.0324

(continued)

TABLE I *(Continued)*

Strontium Fluoride

eV	cm^{-1}	μm	n	k
0.01102	88.9	112.5	2.710	0.0312
0.01044	84.2	118.8	2.690	0.0318
0.00978	78.9	126.8	2.670	0.0331
0.00924	74.5	134.2	2.655	0.0333
0.00872	70.3	142.2	2.642	0.0335
0.00824	66.5	150.4	2.630	0.0330
0.00769	62.0	161.3	2.618	0.0327
0.00720	58.1	172.2	2.608	0.0304
0.00664	53.6	186.6	2.598	0.0275
0.00595	48.0	208.4	2.587	0.0239
0.00534	43.1	232.1	2.578	0.0204
0.00481	38.8	258.0	2.571	0.0176
0.00359	29.0	344.8	2.559	0.0127
0.00293	23.7	422.7	2.554	0.0101
0.00239	19.3	519.0	2.550	0.0062
0.00178	14.4	697.0	2.547	0.0045
0.0	0.0	∞	2.543 [21]	0.0

TABLE II

Room-Temperature Sellmeier Model Parameters

ith mode	$\Delta\epsilon_i$	λ_i
Feldman *et al.* model		
1	0.67805894	0.05628989
2	0.37140533	0.10801027
3	3.8484723	34.649040
Li model		
1	0.33973	0.0
2	0.70970	0.09597
3	0.1788	26.03
4	3.8796	45.60

TABLE III

Thermo-optical Coefficients of Strontium Fluoride

Wavelength (μm)	dn/dT (10^{-6}/K)	Measurement temperature (°C)	Reference
0.3250	−10.8	37	[8]
0.4416	−11.6	37	[8]
0.4579	−12.0	20	[5]
0.6328	−12.4	20	[5]
	−12.0	37	[8, 9]
1.15	−12.6	20	[5]
	−12.7	37	[8, 9]
3.39	−12.4	20	[5]
	−13.0	37	[8, 9]
10.6	−9.8	20	[5]
∞	265	7–47	[10]

TABLE IV

Room-Temperature Classical Oscillator Model Parameters

Mode number i	ν_i (cm^{-1})	$\Delta\epsilon_i$	Γ_i/ν_i	Reference
1	217	4.0	0.0170	[16]
2	316	0.07	0.25	
$\epsilon_\infty = 2.07$				
Modified				
1	217	4.3	0.017	[see text]
2	360	0.6	0.25	
$\epsilon = 2.05$				