Magnesium Fluoride (MgF_2)

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Magnesium fluoride is a tetragonal material with TiO_2 (rutile) structure. The space group is D_{4h}^{14} or $P4_2/mnm$. The unit cell contains two formula units (six atoms). Dimensions of the cell (at 27 °C) are 0.4623 nm along the a axis and 0.3052 nm along the c axis [1, also see 2]. Theoretical density is 3.177 g/cm^3 and melting point is 1528 ± 3 K [2]. A melting point of 1543 K is also reported [3].

Magnesium ions occupy octahedral sites with D_{2h} point symmetry. Six fluorine ions at sites with C_{2v} symmetry surround each magnesium ion. Fluorine-ion positions in the unit cell are known from X-ray diffraction measurements [1, 2].

A wide transparency range from 0.13 to 8 μm [2], good mechanical properties, and low optical index of refraction make magnesium fluoride a desirable material for coatings and interference filters. MgF_2 is a positive uniaxial material, with its highest birefringence in the UV. Except for lithium fluoride, MgF_2 has the shortest wavelength cutoff of any common optical material.

Magnesium fluoride occurs naturally as the mineral sellaite [3]. Single-crystal MgF_2 [3, 4] is widely used for windows, lenses, polarizers, and other optical components. Optical-quality, hot-pressed polycrystalline MgF_2 is also used for optical components, particularly in the infrared. IRTRAN 1 [5] is a trade name for hot-pressed MgF_2 made by Kodak; KO-1 is an equivalent Soviet material [6]. Olson and McBride [7] compare properties of IRTRAN 1 and single-crystal magnesium fluoride.

MgF_2 has been used as a divalent-ion host material for solid-state lasers. Vanadium, nickel, and cobalt have been used as dopants to produce tunable solid-state lasers in the infrared [8, 9].

The UV and IR transparency of magnesium fluoride lends itself to many applications. MgF_2 has been used as a window material for UV detectors in space applications [10, 11]. The birefringence is used to polarize light in the UV [12–14]. One such polarizer, operating from the UV to the IR, has

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been constructed [15]. The low index of MgF_2 in the IR led to its use as a Soleil compensator in the IR [16]. Magnesium fluoride is also used as a thin film to coat aluminum mirrors for enhanced reflectivity in the vacuum UV [17, 18]. Because of the relatively low index, magnesium fluoride is also used as an antireflection coating for lenses and as a low-index layer in dielectric interference filters.

Magnesium fluoride has a band gap of approximately 11.8 eV. Optical constants from the UV through the XUV have been measured for single-crystal magnesium fluoride [19–22]. The lowest-energy electronic feature of the magnesium fluoride spectrum is an exciton peak centered near 11.8 eV [20, 21]. This is due to an exciton peak at 11.6 eV for the extraordinary component and at 12.2 eV for the ordinary component [22]. The exciton peak obscures the UV absorption edge in this region, measured at 10.9 eV [20]. Although an absorption band beginning at 1320 Å has been observed, the transmission does not drop significantly until 1150 Å (10.8 eV) [2], which is close to the measured absorption edge. The interband transitions begin near 12.2 eV [21], at 12.4 eV for the extraordinary and 12.8 eV for the ordinary ray [22]. The extraordinary-ray absorption curve has structure at 18.5 eV and the ordinary ray at 15 and 20.5 eV [22]. Broad absorption structure near 20.8 eV is attributed to interband transitions [20]. These transitions are believed to arise from transitions from the upper valence band of fluorine ($2p^6$) to the conduction band of magnesium (3s + 3p) [21]. A peak at 24.5 eV is attributed to a plasmon [20, 21]. The plasmon peak is composed of an extraordinary-ray component at 24.3 eV and an ordinary-ray component at 24.6 eV [22]. Structure seen in the absorption coefficient from 27–40 eV is attributed to interband transitions $2s^2$ level of the fluorine ion to the conduction band [19, 21]. In the 40–56 eV region, two absorption peaks exist: an absorption peak at 47.5 eV caused by a double plasmon and a peak at 54.6 eV attributed to an exciton [19]. Structure from 56–62 eV is attributed to transitions of $2p^6$ electrons of magnesium to the conduction band [19].

Refractive-index data for the MgF_2 transparent region from the UV through the IR are given by many sources [2, 12, 23–27]. Dodge [27] fitted index data (at 19°C) to a Sellmeier-type dispersion relationship of the form

$$n_o^2-1=\frac{2.5903553\times10^{10}}{(230{,}459.90)^2-\nu^2}+\frac{4.4543708\times10^{9}}{(105{,}692.13)^2-\nu^2}+\frac{4.0838897\times10^{5}}{(420.28101)^2-\nu^2} \qquad (1a)$$

and

$$n_e^2-1=\frac{3.0458728\times10^{10}}{(271{,}426.78)^2-\nu^2}+\frac{6.1303694\times10^{9}}{(110{,}178.73)^2-\nu^2}+\frac{4.4070693\times10^{5}}{(420.66305)^2-\nu^2} \qquad (1b)$$

where ν is the frequency in wave numbers. Equation 1 represents electronic resonances with the first two terms and all IR resonances with the third term. These terms fall in the middle of the measured electronic transitions and lattice vibrations, respectively. The overall accuracy of index calculated from Eq. 1 is quoted as better than 2×10^{-5} over the 1400–50,000 cm^{-1} range.

Change in the index of refraction with temperature, pressure, and stress is available. Thermo-optic data are given by many sources [2, 28–30] without good agreement; data from the National Bureau of Standards [28] are considered comprehensive, cover a wide temperature range, and agree well with recent measurements of the temperature dependence of optical dispersion [30]. The elastic properties of MgF_2 have been reported in the form of elastic constants, photoelastic constants, and piezoelectric constants [31, 32].

Optical properties of thin films of magnesium fluoride have been studied extensively. Much disparity exists between published data due to variations of the conditions and method of preparation of the sample under study [33–37]. In addition, thin-film properties usually do not match single-crystal properties [19, 20]. Consequently, this article concentrates on properties of single crystals.

Radiation damage of MgF_2 is described elsewhere [38]. Studies of radiation effects on the absorption of magnesium fluoride have revealed absorption bands in the UV. Three prominent absorption peaks at 117, 260, and 370 nm develop, which can be attributed to the formation of F centers by radiation [38]. No observations of IR absorption due to radiation have been reported [38]. The characterization of the fluorescence of MgF_2 has also been undertaken [38, 39].

Absorption at the IR edge of transparency is dominated by multiphonon absorption [40]. A model of multiphonon absorption [41] has been developed and confirmed with experimental data over a wide temperature range. Model constants for the ordinary ray of MgF_2 are given by Thomas and Joseph [42].

The fundamental (one-phonon) lattice vibrations occur in the 290–625 cm^{-1} spectral region. Group theory predicts the following phonon modes for MgF_2 [43–46]:

$$\Gamma = A_{1g} + A_{2g} + A_{2u} + B_{1g} + B_{2g} + 2B_{1u} + E_g + 3E_u, \tag{2}$$

where the A_{2g} and B_{1u} modes are optically inactive, the A_{2u} ($\mathbf{E} \parallel c$) and E_u ($\mathbf{E} \perp c$) modes are IR-active, and the remaining modes are Raman-active. Table I lists the IR modes as determined by Barker [44], Thomas and Joseph [42], and Giudson and Benoit [46]. Locations of the Raman modes are given by Porto *et al.* [45] at 92 (B_{1g}), 295 (E_g), 410 (A_{1g}), and 515 (B_{2g}) cm^{-1}.

Table I also lists both the transverse and longitudinal optical frequenches. The transverse optical frequencies are the mode locations; the maximum longitudinal-mode frequency is an important parameter in the multiphonon-absorption model [41], since it designates the maximum phonon frequency.

At frequencies below the lowest-frequency transverse optical mode, absorption decreases and the material becomes transparent. The magnitude of absorption is thought to be a combination of contributions from both the tail of the fundamental lattice vibrations and various multiphonon difference bands. The index of refraction now also includes the effect of lattice vibrations. Estimates of low-frequency absorption made from the tail wing of the fundamental modes (Table I) for MgF_2 are about 60% of the ordinary-ray imaginary index of refraction and 95% of the extraordinary-ray values determined by Bystrov et al. [47] in the 10–25 cm^{-1} region. Measurements of two different sintered samples of polycrystalline MgF_2 by Steel and Simonds [48] showed yet higher absorption.

The low-frequency index of refraction of magnesium fluoride is given by Fontanella et al. [49] at 1000 Hz and by Bystrov et al. [47] for the 300–700 GHz range. These data agree with each other and with the data in Table I except for the slightly higher extraordinary-ray value given by Fontanella et al. [49]. No temperature-dependent low-frequency index data were found, but pressure dependence is given by Lüty et al. [50].

Table II was constructed from measurements reported in the literature as well as model predictions [51]. Real-index data (n) from 10–83 eV and imaginary-index (k) data from 11–83 eV are taken from several sources [19–22]. The measurements by Hanson et al. [19], Williams et al. [20], and Stephan et al. [21] did not distinguish between ordinary- and extraordinary-ray components. These data can be considered to be an "average" for the crystal. Thomas et al.'s [22] measurement of ordinary- and extraordinary-ray optical constants for the 11–28 eV region are also included.

Ordinary-ray index data in the 0.115–0.200 μm region are taken from Williams and Arakawa [23], supplemented by measurements of Laufer et al. [12]. Extraordinary-ray data for this region are obtained by combining ordinary-ray data with the anomalous dispersion data of Chandrasekharan and Damany [24]. Both ordinary- and extraordinary-ray data in the 1400–50,000 cm^{-1} range are calculated from the Sellmeier dispersion relationships (Eq. 1) of Dodge [27]. One value of ordinary-ray absorption coefficient is given by Laufer et al. [12].

Single [51] and multiphonon [41] lattice-vibration models are used to estimate the complex index of refraction for wavelengths of 7.41 μm and longer. Measurements of Bystrov et al. [47], and Fontanella et al. [49] are the best available low-frequency index data.

The accuracy of index measurements in the electronic region is relatively poor; estimated errors are approximately 10%. Data from Hanson et al.

[19] and Williams *et al.* [20] agree well in the overlap region (20–27 eV). Data from Stephan *et al.* [21] have consistently lower n and higher k compared with other sources [19, 20]. Data from Thomas *et al.* [22] have precision on the order of ±5%.

The real-index data from 0.115–0.200 μm have a quoted accuracy of ±0.002; the dispersion formula of Dodge [27] represents the data from 0.2–7.0 μm within ±0.00002. The accuracy of complex-index data at longer wavelength is unknown, but uncertainty in the values is probably in the least-significant digit reported in Table II (that is, n accurate to ±0.01 and k to about 5%). Low-frequency real-index measurements of Fontanella *et al.* [49] are given an accuracy of ±0.005. Bystrov *et al.* [47] states the accuracy of n to be ±0.005 and k to be within ±5%.

Figures 1 and 2 show a composite of the complex index of refraction based on the data of Table II. Figure 1 gives the ordinary-ray index and Fig. 2 shows the extraordinary-ray properties. Complex index-of-refraction data for the electronic region (wavelengths below 0.05 μm) derived from unpolarized measurements with an unknown mix of ordinary- and extraordinary-ray index are included in Fig. 1.

Tables III and IV give temperature dependence for the real part of the index of refraction. Measurements of dn/dT by Feldman *et al.* [28] typically have a standard deviation to a linear temperature-dependence fit of 0.1×10^{-6}/K.

REFERENCES

1. R. W. G. Wyckoff, "Crystal Structures," Interscience Publishers, New York, 251 (1965).
2. A. Duncanson and R. W. H. Stevenson, "Some Properties of Magnesium Fluoride Crystallized from the Melt," *Proc. Phys. Soc. (London)* 72, 1001 (1958).
3. W. A. Hargreaves, "Magnesium Fluoride Update and Summary of Optical Properties," *Laser Focus* 18, 66 (1982).
4. "Crystal Optics," Catalog OP 101, Harshaw/Filtrol, Solon, Ohio, 18 (1985).
5. "Kodak IRTRAN Infrared Optical Materials," Publication U-72, Eastman Kodak Company, Rochester, New York, (1971).
6. I. V. Men', R. K. Volynets, and V. P. Sorokaya, "The Stability of KO-1 Optical Ceramic," *Sov. J. Opt. Tech.* 41, 96 (1974).
7. A. L. Olsen and W. R. McBride, "Transmittance of Single-Crystal Magnesium Fluoride and IRTRAN-1 in the 0.2 to 15 μ Range," *J. Opt. Soc. Am.* 53, 1003 (1963).
8. L. F. Johnson and H. J. Guggenheim, "Phonon-Terminated Optical Masers," *Phys. Rev.* 149, 179 (1967).
9. P. F. Moulton, "Pulse-Pumped Operation of Divalent Transition-Metal Lasers," *IEEE J. Quantum Electron.* QE-18, 1185 (1982).
10. O. Siegmund, M. Gonzalez, H. Dowell, W. Fowler, and W. Morrison, "Fabrication of MgF_2 and LiF Windows for the Hubble Space Telescope Imaging Spectrograph," *Proc. SPIE* 932, 136 (1988).
11. W. Viehmann, A. G. Eubanks, G. F. Pieper, and J. H. Bredekamp, "Photomultiplier Window Materials under Electron Irradiation: Fluorescence and Phosphorescence," *Appl. Opt.* 14, 2104 (1975).

12. D. L. Steinmetz, W. G. Phillips, M. Wirick, and F. F. Forbes, "Polarizer for the Vacuum Ultraviolet," *Appl. Opt.* 6, 1001 (1967).
13. G. Hass and W. R. Hunter, "Reflection Polarizers for the Vacuum Ultraviolet Using Al + MgF_2 Mirrors and an MgF_2 Plate," *Appl. Opt.* 17, 76 (1978).
14. W. C. Johnson, Jr., "Magnesium Fluoride Polarizing Prism for the Vacuum Ultraviolet," *Rev. Sci. Instrum.* 35, 1375 (1964).
15. G. C. Morris and A. S. Abramson, "Single Rochon Prisms for Light Polarization Between 1400–70,000 Å," *Appl. Opt.* 8, 1249 (1969).
16. R. D. Pahl, "A MgF_2 Soleil Compensator for the Near Infrared," *Appl. Opt.* 7, 978 (1968).
17. W. R. Hunter, J. F. Osantowski, and G. Hass, "Reflectance of Aluminum Overcoated with MgF_2 and LiF in the Wavelength Region from 1600 Å to 300 Å at Various Angles of Incidence," *Appl. Opt.* 10, 540 (1971).
18. K. Yosa and D. J. McCartney, "Optical Properties of Multilayer Overcoated Aluminum Films in the UV (2800–2500 Å)," *Appl. Opt.* 16, 1216 (1978).
19. W. F. Hanson, E. T. Arakawa, and M. W. Williams, "Optical Properties of MgO and MgF_2 in the Extreme Ultraviolet Region," *J. Appl. Phys.* 43, 1661 (1972).
20. M. W. Williams, R. A. MacRae, and E. T. Arakawa, "Optical Properties of Magnesium Fluoride in the Vacuum Ultraviolet," *J. Appl. Phys.* 38, 1701 (1967).
21. G. Stephan, Y. Le Calvez, J. C. Lemonnier, and S. Robin, "Propriétés Optiques et Spectre Electronique du MgF_2 et du CaF_2 de 10 à 48 eV," *J. Phys. Chem. Solids* 30, 601 (1969).
22. J. Thomas, G. Stephan, J. C. Lemonnier, M. Nisar, and S. Robin, "Optical Anisotropy of MgF_2 in Its UV Absorption Region," *Phys. Stat. Solidi B* 56, 163 (1973).
23. M. W. Williams and E. T. Arakawa, "Optical Properties of Crystalline MgF_2 from 115 to 400 nm," *Appl. Opt.* 18, 1477 (1979).
24. V. Chandrasekharan and H. Damany, "Anomalous Dispersion of Birefringence of Sapphire and Magnesium Fluoride in the Vacuum Ultraviolet," *Appl. Opt.* 8, 671 (1969).
25. W. L. Wolfe, "Properties of Optical Materials," in "Handbook of Optics" (W. G. Driscoll, ed.), McGraw-Hill, New York, 7–95 (1978).
26. H. H. Li, "Refractive Index of Alkaline Earth Halides and Its Wavelength and Temperature Derivatives," *J. Phys. Chem. Ref. Data* 9, 161 (1980).
27. M. J. Dodge, "Refractive Properties of Magnesium Fluoride," *Appl. Opt.* 23, 1980 (1984).
28. A. Feldman, D. Horowitz, R. M. Waxler, and M. J. Dodge, "Optical Materials Characterization Final Technical Report, February 1, 1978–September 30, 1978," National Bureau of Standards Technical Note 993, 69 (February 1979).
29. F. D. Liechberger, A. K. Roy, L. W. Salter, and J. A. Blaw, "Thermal and Structural Constraints of Magnesium Fluoride and Rare Earth Fluorides for Optical Coating Applications," *Opt. Acta* 33, 500 (1986).
30. D. P. Belanger, A. R. King, and V. Jaccarino, "Temperature Dependence of the Optical Birefringence of MnF_2, MgF_2, and ZnF_2," *Phys. Rev. B* 29, 2636 (1984).
31. [illegible], "Photoelastic Properties of Magnesium Fluoride," in "Basic Optical Properties of Materials, Summaries of Papers," National Bureau of Standards Special Publication 574, 273 (May 1980).
32. I. I. Afanas'ev, L. R. Andrianova, I. Y. Mazurov, and V. M. Reiterov, "Photoelastic Properties and Residual Stresses in Magnesium Fluoride Crystals," *Sov. Phys. Solid State* 17, 2006 (1975).
33. D. Smith and P. Baumeister, "Refractive Index of Some Oxide and Fluoride Coating Materials," *Appl. Opt.* 18, 111 (1979).
34. O. R. Wood II, H. G. Craighead, J. E. Sweeney, and P. J. Maloney, "Vacuum Ultraviolet Loss in Magnesium Fluoride Films," *Appl. Opt.* 23, 3644 (1984).

35. P. J. Martin, W. G. Sainty, R. P. Netterfield, D. R. McKenzie, D. J. H. Cockayne, S. H. Sie, O. R. Wood, and H. G. Craighead, "Influence of Ion Assistance on the Optical Properties of MgF_2," *Appl. Opt.* 26, 1235 (1987).
36. A. H. Barrière and A. Lachter, "Optical Transitions in Disordered Thin Films of the Ionic Compounds MgF_2 and AlF_3 as a Function of Their Conditions of Preparation," *Appl. Opt.* 16, 2865 (1977).
37. J. M. Siqueiros, R. Machorro, and L. E. Regalado, "Determination of the Optical Constants of MgF_2 and ZnS from Spectrophotometric Measurements and the Classical Oscillator Method," *Appl. Opt.* 27, 2549 (1988).
38. M. J. Weber, ed., "CRC Handbook of Laser Science and Technology, Volume 3: Optical Materials, Part 1: Nonlinear Optical Properties/Radiation Damage," CRC Press, Boca Raton, Fla., 304 (1986).
39. W. Viehmann, A. G. Eubanks, G. F. Pieper, and J. H. Bredekamp, "Photomultiplier Window Materials under Electron Irradiation: Fluorescence and Phosphorescence," *Appl. Opt.* 14, 2104 (1975).
40. T. F. Deutsch, "Absorption Coefficient of Infrared Laser Window Materials," *J. Phys. Chem. Solids* 34, 2091 (1973).
41. M. E. Thomas, R. I. Joseph, and W. J. Tropf, "Infrared Transmission Properties of Sapphire, Spinel, Yttria, and ALON as a Function of Frequency and Temperature," *Appl. Opt.* 27, 239 (1988).
42. M. E. Thomas and R. I. Joseph, "A Comprehensive Model for the Intrinsic Transmission Properties of Optical Windows," *Proc. SPIE* 929, 87 (1988).
43. G. R. Hunt and C. H. Perry, "Far-Infrared Reflectance and Transmittance of Potassium Magnesium Fluoride and Magnesium Fluoride," *Phys. Rev.* 134, A688 (1964).
44. A. S. Barker, "Transverse and Longitudinal Optic Mode Study in MgF_2 and ZnF_2," *Phys. Rev.* 136, A1290 (1964).
45. S. P. S. Porto, P. A. Fleury, and T. C. Damen, "Raman Spectra of TiO_2, MgF_2, ZnF_2, FeF_2, and MnF_2," *Phys. Rev.* 154, 522 (1967).
46. J. Giordano and C. Benoit, "Infrared Spectra of Iron, Zinc and Magnesium Fluorides: I. Analysis of Results," *J. Phys. C: Solid State Phys.* 21, 2749 (1988).
47. V. P. Bystrov, Y. G. Goncharov, G. V. Kozlov, and A. F. Kuprijanenko, "Dielectric Properties of Optical Crystals at Submillimeter Wavelengths," *Sov. Phys. Tech. Phys.* 31, 1196 (1986).
48. M. Bass and G. Stambaugh, "Near Millimeter Wave Characterization of Dual Mode Materials," *Appl. Opt.* 28, 1879 (1989).
49. J. Fontanella, C. Andeen, and D. Schuele, "Low-Frequency Dielectric Constants of α-Quartz, Sapphire, MgF_2, and MgO," *J. Appl. Phys.* 45, 2852 (1974).
50. J. Link, M. C. Wintersgill, J. J. Fontanella, V. E. Bean, and C. G. Andeen, "Pressure Variation of the Low Frequency Dielectric Constants of Some Anisotropic Crystals," *J. Appl. Phys.* 52, 936 (1981).
51. M. E. Thomas, "A Computer Code for Modeling Optical Properties of Window Materials," *Proc. SPIE* 1112, 260 (1989).

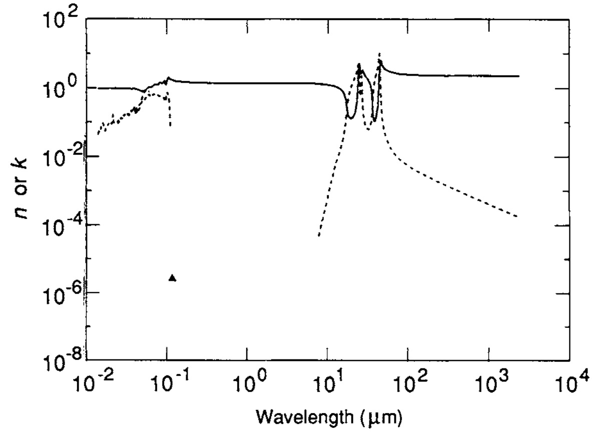

Fig. 1. Log–log plot of n_o (solid line) and k_o (dashed line) versus wavelength in micrometers for the ordinary ray of magnesium fluoride. Data below 0.05 μm (electronic region) are combined ordinary- and extraordinary-ray results.

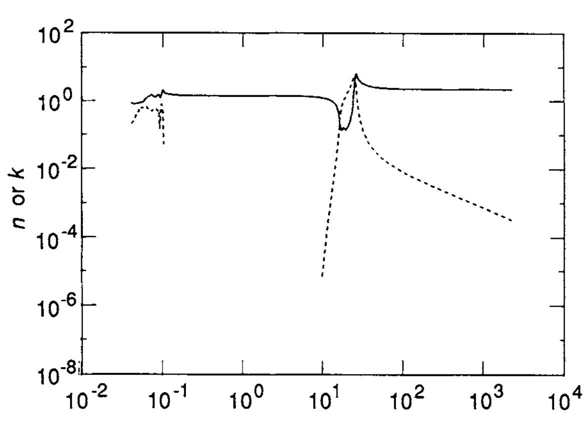

Fig. 2. Log–log plot of n_e (solid line) and k_e (dashed line) versus wavelength in micrometers for the extraordinary ray of magnesium fluoride.

TABLE I

Fundamental Infrared Lattice Vibration Parameters for MgF_2[a]

Mode	Transverse optical frequency (cm^{-1})	Strength	Normalized width	Longitudinal optical frequency (cm^{-1})	Refs.
		E ⊥ c axis (ordinary ray)			
1	247	2.22	0.014	303	[44]
2	410	0.19	0.033	415	[44]
3	450	1.14	0.058	617	[44]
	Total =	3.55			
1	248	2.23	0.0115	302	[51]
2	408.5	0.22	0.0165	414	[51]
3	447	1.10	0.025 }	621	[51]
4[b]	535	0.05	0.3 }		[51]
	Total =	3.60			
1	251			304	[46]
2	413			422	[46]
3	452			610	[46]
	Total =	3.38			
		E ∥ c axis (extraordinary ray)			
1	399	2.7	0.048 }	625	[44]
2[c]	556	0.01	0.08 }		
	Total =	2.71			
1	404	2.69		626	[46]

[a]The frequency (ν_j) is the location of the mode (transverse optical frequency). The strength ($\Delta\epsilon_j$) is the contribution of the mode to the dielectric constant. The normalized width (γ_j) is the mode width divided by the mode frequency. The complex dielectric constant (ϵ) is then modeled as a function of frequency (ν) by:

$$\epsilon(\nu) = \epsilon_\infty + \sum_j \frac{\Delta\epsilon_j \, \nu_j^2}{\nu_j^2 - \nu^2 + i\gamma_j\nu_j\nu},$$

where the ϵ_∞ term (= 1.886 for E ⊥ c and 1.918 for E ∥ c axis) represents the electronic contributions to the dielectric constant (plus one).

[b]Mode 4 (E ⊥ c) is probably caused by an impurity.

[c]Barker [44] identifies this as a weak forbidden mode.

TABLE II

Values of n and k Obtained from Various References for Magnesium Fluoride

eV	cm^{-1}	μm	n	k	n	k
83.0	669608	0.0149	0.906 [19]	0.046 [19]		
78.5	633311	0.0158	0.912	0.070		
76.5	620158	0.0161	0.905	0.064		
75.5	609144	0.0164	0.906	0.061		
74.5	599809	0.0167	0.902	0.063		
72.5	583834	0.0173	0.918	0.065		
[illegible]	571191	0.0175	0.902	0.059		
66.0	532322	0.0188	0.915	0.073		
65.0	524256	0.0191	0.917	0.076		
64.0	515181	0.0194	0.919	0.079		
63.0	506125	0.0197	0.921	0.085		
62.0	500060	0.0200	0.903	0.090		
61.0	491994	0.0203	0.924	0.095		
60.0	483929	0.0207	0.926	0.090		
59.0	475863	0.0210	0.926	0.090		
58.0	467798	0.0214	0.926	0.090		
57.0	459732	0.0218	0.925	0.092		
56.0	451667	0.0221	0.915	0.096		
55.0	443601	0.0225	0.936	0.105		
54.0	435535	0.0230	0.940	0.105		
53.0	427470	0.0234	0.935	0.098		
52.0	419405	0.0238	0.930	0.099		
51.0	411339	0.0243	0.903	0.100		
50.0	403274	0.0248	0.925	0.105		
49.0	395208	0.0253	0.922	0.107		
48.0	387143	0.0258	0.930	0.111		
47.5	383110	0.0261	0.930	0.113	0.957 [21]	0.092 [21]
47.0	379078	0.0264	0.929	0.115	0.956	0.096
46.5	375045	0.0267	0.919	0.118	0.955	0.099
46.0	371012	0.0270	0.919	0.125	0.954	0.103
45.5	366979	0.0272	0.906	0.122	0.953	0.107
45.0	362947	0.0276	0.930	0.120	0.949	0.110
44.5	358914	0.0279	0.918	0.128	0.946	0.114
44.0	354881	0.0282	0.930	0.131	0.947	0.119
43.5	350848	0.0285	0.918	0.134	0.943	0.123
43.0	346816	0.0288	0.918	0.137	0.934	0.130
42.5	342783	0.0292	0.938	0.143	0.924	0.140
42.0	338750	0.0295	0.918	0.145	0.921	0.129
41.5	334717	0.0299	0.948	0.150	0.944	0.129
41.0	330685	0.0302	0.919	0.154	0.947	0.131
40.5	326652	0.0306	0.943	0.159	0.880	0.159
40.0	322619	0.0310	0.919	0.163	0.869	0.168
39.5	318586	0.0314	0.948	0.157	0.896	0.130
39.0	314554	0.0318	0.925	0.177	0.896	0.159

(continued)

TABLE II (Continued)

Magnesium Fluoride

eV	cm^{-1}	μm	n	k	n	k
38.5	310521	0.0322	0.922	0.173	0.898	0.170
38.0	306488	0.0326	0.922	0.173	0.902	0.168
37.5	302456	0.0331	0.923	0.174	0.901	0.165
37.0	298423	0.0335	0.924	0.175	0.900	0.162
36.5	294390	0.0340	0.922	0.175	0.899	0.160
36.0	290357	0.0344	0.929	0.175	0.898	0.159
35.5	286325	0.0349	0.925	0.175	0.897	0.158
35.0	282292	0.0354	0.923	0.175	0.898	0.157
34.5	278259	0.0359	0.919	0.177	0.899	0.158
34.0	274226	0.0365	0.904	0.179	0.898	0.176
33.5	270194	0.0370	0.899	0.182	0.890	0.188
33.0	266161	0.0376	0.898	0.190	0.888	0.206
32.5	262128	0.0381	0.891	0.200	0.887	0.224
32.0	258095	0.0387	0.897	0.210	0.890	0.221
31.5	254063	0.0394	0.904	0.219	0.887	0.199
31.0	250030	0.0400	0.910	0.228	0.898	0.200
30.5	245997	0.0407	0.910	0.232	0.897	0.223
30.0	241964	0.0413	0.907	0.228	0.863	0.223
29.5	237932	0.0420	0.888	0.226	0.838	0.273
29.0	233899	0.0428	0.885	0.221	0.833	0.184
28.5	229866	0.0435	0.873	0.234	0.850	0.164
28.0	225833	0.0443	0.885	0.254	0.842	0.200
27.5	221801	0.0451	0.853	0.264	0.898	0.222
27.0	217768	0.0459	0.842	0.272	0.822	0.227
26.5	213735	0.0468	0.824	0.303	0.812	0.246
26.0	209702	0.0477	0.808	0.308	0.808	0.267
25.5	205670	0.0486	0.768	0.338	0.787	0.284
25.0	201637	0.0496	0.779	0.384	0.771	0.224
24.5	197604	0.0506	0.768	0.443	0.758	0.361
24.0	193571	0.0517	0.768	0.326	0.735	0.410
23.5	189539	0.0528	0.816	0.610	0.748	0.465
23.0	185506	0.0539	0.856	0.568	0.766	0.475
22.5	181473	0.0551	0.909	0.728	0.820	0.545
22.0	177441	0.0564	0.946	0.771	0.848	0.564
21.5	173408	0.0577	1.042	0.852	0.899	0.584
21.0	169375	0.0590	1.122	0.919	0.894	0.614
20.5	165342	0.0605	1.384	0.856	0.963	0.648
20.0	161310	0.0620	1.368	0.787	0.981	0.648
19.8	159697	0.0626			0.955	0.648
19.6	158084	0.0633			1.009	0.545
19.4	156470	0.0639			0.994	0.615
19.2	154857	0.0646			1.008	0.643
19.0	153244	0.0653			1.012	0.615
18.8	151631	0.0659			1.021	0.648

(continued)

TABLE VII (Continued)

Magnesium Fluoride

eV	cm⁻¹	μm	n	k	n	k
18.6	150018	0.0667			1.054	0.626
18.4	148406	0.0674			1.044	0.636
18.2	146792	0.0681			1.073	0.661
18.0	145179	0.0689	1.327 [20]	0.677 [20]	1.083	0.661
17.8	143566	0.0697	1.337	0.659	1.085	0.634
17.6	141952	0.0704	1.347	0.697	1.130	0.661
17.4	140339	0.0713	1.356	0.660	1.114	0.660
17.2	138726	0.0721	1.359	0.685	1.090	0.665
17.0	137113	0.0739	1.354	0.663	1.080	0.668
16.8	135500	0.0738	1.348	0.605	1.108	0.679
16.6	133887	0.0747	1.346	0.631	1.145	0.676
16.4	132274	0.0756	1.348	0.606	1.150	0.689
16.2	130661	0.0765	1.387	0.573	1.145	0.684
16.0	129048	0.0775	1.434	0.547	1.198	0.639
15.9	128241	0.0780	1.448	0.538	1.195	0.650
15.8	127435	0.0785	1.457	0.533	1.193	0.625
15.7	126628	0.0790	1.463	0.538	1.193	0.625
15.6	125822	0.0795	1.474	0.528	1.191	0.626
15.5	125015	0.0800	1.485	0.539	1.190	0.617
15.4	124209	0.0805	1.480	0.531	1.196	0.629
15.3	123402	0.0810	1.495	0.533	1.209	0.651
15.2	122596	0.0816	1.500	0.536	1.228	0.635
15.1	121789	0.0821	1.505	0.568	1.240	0.638
15.0	120983	0.0827	1.508	0.561	1.256	0.650
14.9	120176	0.0832	1.510	0.570	1.257	0.623
14.8	119369	0.0838	1.512	0.510	1.257	0.614
14.7	118563	0.0843	1.513	0.501	1.257	0.668
14.6	117756	0.0849	1.508	0.501	1.258	0.660
14.5	116949	0.0855	1.494	0.502	1.267	0.660
14.4	116143	0.0861	1.486	0.504	1.260	0.598
14.3	115336	0.0867	1.451	0.514	1.260	0.593
14.2	114530	0.0873	1.470	0.516	1.260	0.598
14.1	113723	0.0879	1.473	0.517	1.230	0.602
14.0	112917	0.0886	1.486	0.507	1.237	0.607
13.9	112110	0.0892	1.528	0.496	1.234	0.607
13.8	111304	0.0898	1.541	0.486	1.231	0.608
13.7	110497	0.0905	1.564	0.477	1.236	0.583
13.6	109691	0.0912	1.573	0.463	1.238	0.606
13.5	108884	0.0918	1.384	0.457	1.242	0.606
13.4	108077	0.0925	1.380	0.444	1.235	0.605
13.3	107271	0.0932	1.389	0.438	1.225	0.504
13.2	106464	0.0939	1.383	0.463	1.315	0.565
13.1	105658	0.0946	1.395	0.456	1.283	0.573
13.0	104851	0.0954	1.361	0.420	1.192	0.568

(continued)

TABLE II (Continued)

Magnesium Fluoride

eV	cm^{-1}	μm	n	k	n	k
12.9	104045	0.09611	1.566	0.395	1.192	0.363
12.8	103239	0.09686	1.579	0.357	1.240	0.330
12.7	102432	0.09762	1.574	0.332	1.297	0.326
12.6	101626	0.09840	1.506	0.328	1.272	0.338
12.5	100819	0.09919	1.409	0.364	1.238	0.395
12.4	100012	0.1000	1.330	0.408	1.232	0.636
12.3	99205	0.1008	1.269	0.451	1.212	0.676
12.2	98399	0.1016	1.231	0.651	1.184	0.717
12.1	97592	0.1025	1.207	0.542	1.177	0.756
12.0	96786	0.1033	1.351	0.732	1.176	0.790
11.9	95979	0.1042	1.403	0.953	1.231	0.828
11.8	95173	0.1051	1.759	1.375	1.343	0.834
11.7	94366	0.1060	1.872	1.024	1.477	0.831
11.6	93560	0.1069	2.301	0.807	1.573	0.823
11.5	92753	0.1078	2.256	0.643	1.617	0.736
11.4	91946	0.1088	2.261	0.524	1.615	0.793
11.3	91140	0.1097	2.239	0.332	1.609	0.640
11.2	90333	0.1107	2.123	0.220	1.627	0.478
11.1	89527	0.1117	2.200	0.110	1.590	0.341
11.0	88720	0.1127	1.958	0.059	1.519	0.192
10.9	87914	0.1137	1.906		1.480	0.026
10.8	87107	0.1148	1.863		1.480	
10.7	86301	0.1159	1.812		1.469	
10.6	85494	0.1170	1.773		1.463	
10.5	84688	0.1181	1.704		1.459	
10.4	83881	0.1192	1.694		1.456	
10.3	83074	0.1204	1.640		1.453	
10.2	82268	0.1216	1.650		1.469	
10.1	81461	0.1228	1.643		1.466	
10.0	80655	0.1240	1.601		1.443	

eV	cm^{-1}	μm	n_o	k_o	n_e	k_e
27.0	217766	0.04592	0.811 [22]	0.214 [22]	0.851 [22]	0.204 [22]
26.5	213735	0.04679	0.795	0.240	0.816	0.231
26.0	209702	0.04769	0.784	0.267	0.804	0.241
25.5	205670	0.04862	0.778	0.323	0.790	0.251
25.0	201637	0.04959	0.789	0.360	0.794	0.289
24.5	197605	0.05061	0.795	0.388	0.799	0.332
24.0	193573	0.05166	0.763	0.422	0.807	0.365
23.5	189540	0.05276	0.774	0.441	0.816	0.405
23.0	185508	0.05391	0.790	0.458	0.827	0.441
22.5	181476	0.05510	0.805	0.480	0.837	0.468
22.0	177443	0.05636	0.837	0.493	0.847	0.496

(continued)

TABLE II (Continued)

Magnesium Fluoride

eV	cm^{-1}	μm	n_o	k_o	n_e	k_e
21.5	173408	0.05767	0.386	0.585	0.866	0.586
21.0	169375	0.05904	0.390	0.500	0.881	0.614
20.5	165342	0.06048	1.405	0.507	0.894	0.612
20.0	161310	0.06199	1.010	0.610	0.906	0.607
19.5	157277	0.06358	1.006	0.541	0.949	0.607
19.0	153244	0.06525	1.400	0.580	0.963	0.525
18.5	149211	0.06702	1.406	0.572	1.117	0.632
18.0	145179	0.06888	1.480	0.604	1.151	0.692
17.5	141146	0.07085	1.186	0.597	1.364	0.525
17.0	137113	0.07293	1.185	0.632	1.317	0.575
16.5	133080	0.07514	1.186	0.286	1.353	0.564
16.0	129048	0.07749	1.186	0.807	1.415	0.556
15.5	125015	0.07999	1.180	0.581	1.513	0.496
15.0	120982	0.08266	1.354	0.556	1.467	0.506
14.5	116949	0.08551	1.363	0.580	1.389	0.590
14.0	112917	0.08856	1.367	0.525	1.272	0.520
13.5	108884	0.09184	1.343	0.514	1.348	0.550
13.0	104851	0.09537	1.346	0.407	1.409	0.506
12.8	103239	0.09686	1.361	0.386	1.353	0.463
12.6	101626	0.09840	1.180	0.406	1.419	0.486
12.4	100013	0.1000	1.323	0.349	1.479	0.324
12.2	98399	0.1016	1.463	0.308	1.346	0.151
12.0	96786	0.1033	1.690	0.724	1.223	0.465
11.8	95173	0.1051	1.933	0.620	1.343	0.723
11.6	93560	0.1069	1.949	0.515	1.696	0.777
11.4	91946	0.1088	1.914	0.380	1.911	0.615
11.2	90333	0.1107	1.701	0.247	1.986	0.401
11.0	88720	0.1127	1.938	0.069	1.931	0.054
10.9	87914	0.1137			1.892	
10.8	87107	0.1148			1.774	
10.781	86957	0.115	1.715 [23]		1.695[b]	
10.7	86291	0.1159			1.657 [22]	
10.331	83333	0.120	1.626		1.626[a]	
10.230	82508	0.1212		3.3×10^{-4} [12]		
9.913	80000	0.125	1.598		1.597[a]	
9.537	76923	0.130	1.553		1.567[a]	
8.856	71429	0.140	1.513		1.527[a]	
8.265	66667	0.150	1.494		1.498[a]	
7.749	62500	0.160	1.464		1.478[a]	
7.293	58824	0.170	1.451		1.480[a]	
6.965	56180	0.1780	1.42975 [12]		1.45963 [12]	
6.888	55556	0.180	1.346 [22]			
6.700	54054	0.1850	1.43424 [12]		1.44797	
6.526	52632	0.190	1.439 [22]			

(continued)

TABLE II (Continued)

Magnesium Fluoride

eV	cm^{-1}	μm	n_o	k_o	n_e	k_e
6.199	50000	0.200	1.42?? [27]		1.43657 [27]	
5.904	47619	0.210	1.41754		1.43383	
5.636	45455	0.220	1.41291		1.42858	
5.391	43478	0.230	1.40920		1.42264	
5.166	41667	0.240	1.40547		1.41890	
4.959	40000	0.250	1.40280		1.41352	
4.768	38462	0.260	1.40030		1.41505	
4.592	37037	0.270	1.39812		1.41077	
4.428	35714	0.280	1.39620		1.40877	
4.275	34483	0.290	1.39450		1.40700	
4.133	33333	0.300	1.39298		1.40544	
4.000	32258	0.310	1.39162		1.40402	
3.875	31250	0.320	1.39040		1.40275	
3.757	30303	0.330	1.38930		1.40160	
3.647	29412	0.340	1.38830		1.40056	
3.542	28571	0.350	1.38732		1.39961	
3.444	27778	0.360	1.38656		1.39875	
3.351	27027	0.370	1.38580		1.39796	
3.263	26316	0.380	1.38510		1.39723	
3.179	25641	0.390	1.38446		1.39656	
3.100	25000	0.400	1.38387		1.39594	
2.952	23810	0.420	1.38281		1.39485	
2.818	22727	0.440	1.38188		1.39389	
2.695	21739	0.460	1.38110		1.39306	
2.583	20833	0.480	1.38040		1.39233	
2.480	20000	0.500	1.37978		1.39168	
2.384	19231	0.520	1.37923		1.39111	
2.296	18519	0.540	1.37873		1.39059	
2.214	17857	0.560	1.37828		1.39013	
2.138	17241	0.580	1.37789		1.38971	
2.066	16667	0.600	1.37752		1.38933	
2.000	16129	0.620	1.37718		1.38897	
1.937	15625	0.640	1.37688		1.38865	
1.879	15152	0.660	1.37659		1.38835	
1.823	14706	0.680	1.37633		1.38808	
1.771	14286	0.700	1.37608		1.38782	
1.722	13889	0.720	1.37585		1.38758	
1.675	13514	0.740	1.37563		1.38735	
1.631	13158	0.760	1.37543		1.38714	
1.590	12821	0.780	1.37524		1.38693	
1.550	12500	0.800	1.37506		1.38674	
1.513	12195	0.820	1.37488		1.38655	
1.476	11905	0.840	1.37472		1.38639	
1.442	11628	0.860	1.37456		1.38622	

(continued)

TABLE II (Continued)

Magnesium Fluoride

eV	cm⁻¹	μm	n_o	k_o	n_e	k_e
1.409	11364	0.880	1.37440		1.38606	
1.378	11111	0.900	1.37420		1.38590	
1.348	10870	0.920	1.37411		1.38573	
1.319	10638	0.940	1.37398		1.38560	
1.292	10417	0.960	1.37384		1.38546	
1.265	10204	0.980	1.37371		1.38533	
1.240	10000	1.0000	1.37358		1.38519	
1.215	9800	1.0204	1.37344		1.38506	
1.190	9600	1.0417	1.37333		1.38492	
1.165	9400	1.0638	1.37319		1.38479	
1.141	9200	1.0870	1.37305		1.38464	
1.116	9000	1.1111	1.37290		1.38449	
1.091	8800	1.1364	1.37277		1.38434	
1.066	8600	1.1628	1.37263		1.38418	
1.041	8400	1.1905	1.37247		1.38402	
1.017	8200	1.2195	1.37231		1.38385	
0.9919	8000	1.2500	1.37215		1.38367	
0.9671	7800	1.2821	1.37197		1.38349	
0.9423	7600	1.3158	1.37179		1.38329	
0.9175	7400	1.3514	1.37160		1.38309	
0.8927	7200	1.3889	1.37140		1.38287	
0.8679	7000	1.4286	1.37118		1.38265	
0.8431	6800	1.4706	1.37096		1.38240	
0.8183	6600	1.5152	1.37071		1.38214	
0.7935	6400	1.5625	1.37046		1.38188	
0.7687	6200	1.6129	1.37017		1.38156	
0.7439	6000	1.6667	1.36985		1.38124	
0.7191	5800	1.7241	1.36953		1.38098	
0.6943	5600	1.7857	1.36917		1.38049	
0.6695	5400	1.8519	1.36873		1.38009	
0.6447	5200	1.9231	1.36833		1.37969	
0.6199	5000	2.0000	1.36784		1.37909	
0.6075	4900	2.0408	1.36757		1.37879	
0.5951	4800	2.0833	1.36730		1.37849	
0.5827	4700	2.1277	1.36698		1.37817	
0.5703	4600	2.1739	1.36663		1.37783	
0.5579	4500	2.2222	1.36633		1.37747	
0.5455	4400	2.2727	1.36597		1.37708	
0.5331	4300	2.3256	1.36559		1.37667	
0.5207	4200	2.3810	1.36518		1.37623	
0.5083	4100	2.4390	1.36478		1.37576	
0.4959	4000	2.5000	1.36434		1.37525	
0.4835	3900	2.5641	1.36373		1.37471	
0.4711	3800	2.6316	1.36329		1.37413	

(continued)

TABLE II (Continued)

Magnesium Fluoride

eV	cm^{-1}	μm	n_o	k_o	n_e	k_e
0.4587	3700	2.7027	1.36261		1.37348	
0.4463	3600	2.7778	1.36196		1.37279	
0.4339	3500	2.8571	1.36126		1.37204	
0.4215	3400	2.9412	1.36049		1.37122	
0.4091	3300	3.0303	1.35966		1.37035	
0.3968	3200	3.1250	1.35874		1.36934	
0.3844	3100	3.2258	1.35775		1.36827	
0.3720	3000	3.3333	1.35663		1.36707	
0.3596	2900	3.4483	1.35539		1.36575	
0.3472	2800	3.5714	1.35402		1.36429	
0.3348	2700	3.7037	1.35249		1.36265	
0.3224	2600	3.8462	1.35077		1.36080	
0.3100	2500	4.0000	1.34883		1.35873	
0.2976	2400	4.1667	1.34683		1.35637	
0.2852	2300	4.3478	1.34442		1.35366	
0.2728	2200	4.5455	1.34125		1.35060	
0.2604	2100	4.7619	1.33792		1.34709	
0.2480	2000	5.0000	1.33404	$4.2 \cdot 10^{-7}$ [51]	1.34308	
0.2418	1950	5.1282	1.33186	$6.0 \cdot 10^{-7}$	1.34034	
0.2356	1900	5.2632	1.32948	$8.5 \cdot 10^{-7}$	1.33799	
0.2294	1850	5.4054	1.32689	$1.2 \cdot 10^{-6}$	1.33521	
0.2232	1800	5.5556	1.32406	$1.7 \cdot 10^{-6}$	1.33217	
0.2170	1750	5.7143	1.32085	$2.5 \cdot 10^{-6}$	1.32889	
0.2108	1700	5.8824	1.31754	$3.6 \cdot 10^{-6}$	1.32548	
0.2046	1650	6.0606	1.31378	$5.1 \cdot 10^{-6}$	1.32116	
0.1984	1600	6.2500	1.30961	$7.4 \cdot 10^{-6}$	1.31666	
0.1922	1550	6.4516	1.30497	$1.1 \cdot 10^{-5}$	1.31134	
0.1860	1500	6.6667	1.29978	$1.4 \cdot 10^{-5}$	1.30611	
0.1798	1450	6.8966	1.29398	$2.4 \cdot 10^{-5}$	1.29946	
0.1736	1400	7.1429	1.28740	$3.7 \cdot 10^{-5}$	1.29280	
0.1674	1350	7.4074	1.281 [51]	$5.7 \cdot 10^{-5}$	1.288 [51]	
0.1612	1300	7.6923	1.275	$8.6 \cdot 10^{-5}$	1.279	
0.1550	1250	8.0000	1.264	$1.3 \cdot 10^{-4}$	1.269	
0.1488	1200	8.3333	1.252	$1.8 \cdot 10^{-4}$	1.257	
0.1426	1150	8.6957	1.240	$2.8 \cdot 10^{-4}$	1.243	
0.1364	1100	9.0909	1.224	$4.4 \cdot 10^{-4}$	1.227	
0.1302	1050	9.5238	1.206	$7.1 \cdot 10^{-4}$	1.208	
0.1240	1000	10.0000	1.18	$1.2 \cdot 10^{-3}$	1.18	
0.1215	980	10.204	1.17	$1.5 \cdot 10^{-3}$	1.17	
0.1190	960	10.417	1.16	$1.9 \cdot 10^{-3}$	1.16	
0.1165	940	10.638	1.15	$2.4 \cdot 10^{-3}$	1.15	
0.1141	920	10.870	1.14	$3.0 \cdot 10^{-3}$	1.13	
0.1116	900	11.111	1.12	$3.7 \cdot 10^{-3}$	1.12	
0.1091	880	11.364	1.11	$4.4 \cdot 10^{-3}$	1.10	

(continued)

TABLE II (Continued)

Magnesium Fluoride

eV	cm^{-1}	μm	n_o	k_o	n_e	k_e
0.1066	860	11.628	1.09	$5.7 \cdot 10^{-3}$	1.09	
0.1041	840	11.905	1.07	$6.9 \cdot 10^{-3}$	1.06	
0.1017	820	12.195	1.06	$8.4 \cdot 10^{-3}$	1.06	
0.0992	800	12.500	1.02	0.010	1.01	
0.0967	780	12.821	0.98	0.012	0.98	
0.0942	760	13.158	0.95	0.015	0.94	
0.0917	740	13.514	0.91	0.018	0.89	
0.0905	730	13.699	0.88	0.022	0.84	$7.2 \cdot 10^{-3}$ [31]
0.0868	700	14.286	0.79	0.029	0.78	0.012
0.0843	680	14.706	0.71	0.041	0.69	0.025
0.0818	660	15.152	0.61	0.063	0.58	0.049
0.0794	640	15.625	0.47	0.11	0.43	0.084
0.0769	620	16.129	0.28	0.34	0.22	0.26
0.0744	600	16.667	0.17	0.90	0.14	0.58
0.0719	580	17.241	0.14	0.72	0.14	0.78
0.0694	560	17.857	0.14	0.96	0.16	0.93
0.0670	540	18.519	0.14	1.4	0.15	1.1
0.0645	520	19.231	0.13	1.5	0.14	1.4
0.0620	500	20.000	0.17	1.9	0.15	1.7
0.0608	490	20.408	0.21	2.2	0.17	1.8
0.0595	480	20.833	0.27	2.5	0.19	2.0
0.0583	470	21.277	0.47	3.1	0.23	2.1
0.0570	460	21.739	0.86	4.0	0.27	2.3
0.0558	450	22.222	3.11	5.3	0.36	2.8
0.0546	440	22.727	4.97	1.6	0.46	2.2
0.0533	430	23.256	3.86	0.69	0.68	3.7
0.0521	420	23.810	2.99	0.58	1.08	4.4
0.0508	410	24.390	2.79	2.2	2.19	3.5
0.0496	400	25.000	3.30	0.39	3.09	3.3
0.0484	390	25.641	2.74	0.17	6.07	3.5
0.0471	380	26.316	2.48	0.12	5.15	1.1
0.0459	370	27.027	2.21	0.094	4.45	0.65
0.0446	360	27.778	2.02	0.079	3.98	0.49
0.0434	350	28.571	1.86	0.070	3.61	0.28
0.0422	340	29.412	1.68	0.068	3.41	0.21
0.0409	330	30.303	1.46	0.071	3.22	0.16
0.0397	320	31.250	1.20	0.083	3.05	0.15
0.0384	310	32.258	0.81	0.13	5.90	0.11
0.0372	300	33.333	0.18	0.64	2.48	0.100
0.0360	290	34.483	0.11	1.5	2.78	0.076
0.0347	280	35.714	0.11	2.0	2.69	0.063
0.0335	270	37.037	0.13	2.4	3.87	0.057
0.0322	260	38.462	0.12	4.5	2.91	0.050
0.0310	250	40.000	3.25	9.9	2.42	0.044

(continued)

TABLE II (Continued)

Magnesium Fluoride

eV	cm^{-1}	μm	n_o	k_o	n_e	k_e
0.0298	240	41.667	6.19	0.49	2.48	0.089
0.0285	230	43.478	4.43	0.14	2.44	0.054
0.0273	220	45.455	3.78	0.072	2.41	0.041
0.0260	210	47.619	3.40	0.045	2.38	0.027
0.0248	200	50.000	3.16	0.032	2.35	0.025
0.0236	190	52.632	2.99	0.025	2.33	0.022
0.0223	180	55.556	2.87	0.019	2.31	0.020
0.0211	170	58.824	2.78	0.015	2.29	0.018
0.0198	160	62.500	2.70	0.013	2.27	0.016
0.0186	150	66.667	2.64	0.011	2.25	0.015
0.0174	140	71.429	2.59	$9.3 \cdot 10^{-3}$	2.24	0.013
0.0161	130	76.923	2.54	$8.0 \cdot 10^{-3}$	2.22	0.012
0.0149	120	83.333	2.51	$7.0 \cdot 10^{-3}$	2.21	0.011
0.0136	110	90.909	2.48	$6.1 \cdot 10^{-3}$	2.20	$9.3 \cdot 10^{-3}$
0.0124	100	100.00	2.45	$5.2 \cdot 10^{-3}$	2.19	$8.3 \cdot 10^{-3}$
0.0112	90	111.11	2.43	$4.5 \cdot 10^{-3}$	2.18	$7.5 \cdot 10^{-3}$
0.0099	80	125.00	2.41	$3.9 \cdot 10^{-3}$	2.18	$6.5 \cdot 10^{-3}$
0.0087	70	142.86	2.39	$3.3 \cdot 10^{-3}$	2.17	$5.6 \cdot 10^{-3}$
0.0074	60	166.67	2.38	$2.8 \cdot 10^{-3}$	2.17	$4.7 \cdot 10^{-3}$
0.0062	50	200.00	2.37	$2.3 \cdot 10^{-3}$	2.16	$3.9 \cdot 10^{-3}$
0.0050	40	250.00	2.36	$1.8 \cdot 10^{-3}$	2.16	$3.1 \cdot 10^{-3}$
0.0037	30	333.33	2.35	$1.3 \cdot 10^{-3}$	2.15	$2.5 \cdot 10^{-3}$
0.0029	23.3	428.57	2.359 [47]	$2.4 \cdot 10^{-3}$ [47]	2.190 [47]	$2.8 \cdot 10^{-3}$ [47]
0.0025	20	500.0	2.35 [51]	$6.7 \cdot 10^{-4}$ [51]	2.15 [51]	$1.5 \cdot 10^{-3}$ [51]
0.0021	16.7	600.0	2.345 [47]	$1.4 \cdot 10^{-3}$ [47]	2.181 [47]	$1.7 \cdot 10^{-3}$ [47]
0.0019	15	666.67	2.34 [51]	$6.5 \cdot 10^{-4}$ [51]	2.15 [51]	$1.1 \cdot 10^{-3}$ [51]
0.0012	10	1000.0	2.335 [47]	$7.0 \cdot 10^{-4}$ [47]	2.173 [47]	$8.0 \cdot 10^{-4}$ [47]
			2.34 [51]	$4.3 \cdot 10^{-4}$ [51]	2.15 [51]	$7.0 \cdot 10^{-4}$ [51]
0.0006	5	2000.0	2.34	$2.2 \cdot 10^{-4}$	2.15	$3.8 \cdot 10^{-4}$
0.0000	≈0	—	2.34	0	2.15	0
			2.343 [49]		2.157 [49]	

[a]References are indicated in brackets.

[b]Ordinary data from Williams and Arakawa [23] and anomalous dispersion data from Chandrasekharan and Damany [24] are combined to estimate extraordinary-ray indices.

TABLE III

Values of dn_0/dT Obtained from Various References for Magnesium Fluoride

eV	cm^{-1}	μm	dn_o/dT (1/K)	Notes
2.708	21839	0.4579	$1.47 \cdot 10^{-6}$	20°C [28]
1.959	15803	0.6328	$1.12 \cdot 10^{-6}$	20°C [28]
1.078	8696	1.15	$0.88 \cdot 10^{-6}$	20°C [28]
0.366	2950	3.39	$1.1 \cdot 10^{-6}$	20°C [28]
0.0	≈0	—	$1.0 \cdot 10^{-4}$	Our data [51]

TABLE IV

Values of dn_e/dT Obtained from Various References for Magnesium Fluoride

eV	cm^{-1}	μm	dn_e/dT (1/K)	Notes
2.708	21839	0.4579	$0.86 \cdot 10^{-6}$	20°C [28]
1.959	15803	0.6328	$0.58 \cdot 10^{-6}$	20°C [28]
1.078	8696	1.15	$0.32 \cdot 10^{-6}$	20°C [28]
0.366	2950	3.39	$0.6 \cdot 10^{-6}$	20°C [28]