# 6g. Optical Properties of Metals

GEORG HASS

*U.S. Army Electronics Command, Night Vision Laboratory*

LAWRENCE HADLEY

*Colorado State University*

The optical properties of metals are usually characterized by two parameters, the index of refraction $n$ and the extinction coefficient $k$. The refractive index is defined as the ratio of the phase velocity of light in vacuum to the phase velocity of light in the material. The extinction coefficient is related to the exponential decay of the wave as it passes through the medium. Both of these parameters are contained in the equation for the propagation of a wave in an absorbing medium:

$$E = E_0 e^{-2\pi k x/\lambda_0} e^{-2\pi i(nx/\lambda_0 - \nu t)}$$

where $E_0$ is the amplitude of the wave measured at the point $x = 0$ in the medium, $E$ is the instantaneous value of the electric vector measured at a distance $x$ from the first point and at some time $t$, $\nu$ is the frequency of the source, and $\lambda_0$ is the wavelength in vacuum. The two parameters $n$ and $k$ (called the optical "constants," even though they vary strongly with frequency) can be combined to give a complex index of refraction $N = n - ik$. It should be noted that in much of the older literature the complex index of refraction is written as $N = n(1 - i\kappa)$. Consequently, the $k$ used here will equal the $n\kappa$ which is found tabulated in many places elsewhere. This $\kappa$ is called the absorption index.

In much of the current literature the real and imaginary parts of the complex dielectric constant are given instead of the index of refraction and the extinction coefficient. They are related through the following equations

$$\epsilon = \epsilon_1 - i\epsilon_2 = N^2 = n^2 - k^2 - 2ink$$

A second point on which some confusion has arisen in the literature is that of the absorption coefficient $\alpha$, which appears in the familiar equation $I = I_0 e^{-\alpha x}$. The absorption coefficient $\alpha$ is related to the extinction coefficient by $\alpha = 4\pi k/\lambda_0$. The use of the above absorption equation implies, however, that the intensities $I$ and $I_0$ are to be measured *within* the absorbing medium and that the total thickness of the medium is sufficiently great that there are no interference effects arising from multiple reflection.

When light is reflected from a metal surface, it experiences a phase shift which is a function of the angle of incidence and the state of polarization of the incident light. If $r_p$ and $r_s$ represent respectively the amplitude ratios of the reflected electric vector to the incident electric vector for light polarized parallel and perpendicular to the plane of incidence, then

$$\frac{r_p}{r_s} = \frac{|r_p|e^{i\beta_p}}{|r_s|e^{i\beta_s}} = e^{i\Delta} \tan \psi$$

It may be shown that the phase angle $\Delta$ and the azimuth angle $\psi$ are related to the refractive index and the extinction coefficient for a particular angle of incidence $\phi_1$ by the following equations

$$\frac{r_{1p}}{r_{1s}} = \frac{|r_{1p}|e^{i\beta_p}}{|r_{1s}|e^{i\beta_s}} = e^{i\Delta}\tan\psi$$

$$n^2 - k^2 = n_1^2 \sin^2\phi_1 \left\{1 + \frac{\tan^2\phi_1(\cos^2 2\psi - \sin^2 2\psi \sin^2\Delta)}{(1 + \sin 2\psi \cos\Delta)^2}\right\}$$

$$nk = \frac{n_1^2 \sin^2\phi_1 \tan^2\phi_1 \sin 2\psi \cos 2\psi \sin\Delta}{(1 + \sin 2\psi \cos\Delta)^2}$$

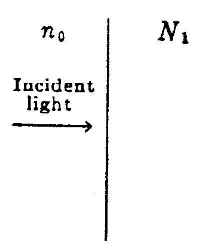
where $n_1$ is the refractive index of the incident medium. Since these angles are relatively easily measured quantities, these equations form the basis of several of the methods used to determine the optical constants of metals. Reference 1 also lists a number of other methods for these determinations.

Since reflection methods are used in determining the constants, they are strongly dependent on the characteristics of the metallic surface. These characteristics vary considerably with the chemical and mechanical treatment. Accordingly, there has always been a certain degree of controversy on the subject of the optical constants of metals. Since the oldest measurements were made, there has been considerable development in the preparation of metallic surfaces by evaporation in a vacuum. The properties of such surfaces are frequently quite different from those of surfaces of bulk metals prepared by polishing. By no means all the metallic constants have been determined on such freshly prepared surfaces.

It is also well known that the presence of an extremely thin surface film on a metal will significantly alter the values of the phase and azimuth angles, making ellipsometric measurements subject to some difficulties. The appropriate corrections to be made in the presence of such surface films are given in ref. 2.

The relationships existing among $n$ and $k$ and the reflectance, transmittance, and phase shift are given here for several cases of interest. Since the properties of an absorbing dielectric material can also be expressed by a complex index $N = n - ik$, the following equations have general application.

Case I. Reflection at the boundary between two homogeneous, isotropic massive media, the one a dielectric of refractive index $n_0$, which is assumed to be the medium of incidence, and the other an opaque absorbing medium whose complex refractive index will be denoted by $N_1 = n_1 - ik_1$:



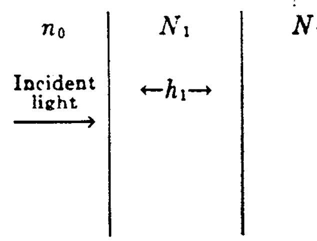

*a. Intensity reflectance* (normal incidence):

$$R = \frac{(n_0 - n_1)^2 + k_1^2}{(n_0 + n_1)^2 + k_1^2} \tag{6g-1}$$

*b. Phase change on reflection* (normal incidence):

$$\rho = \tan^{-1}\frac{2n_0k_1}{n_0^2 - n_1^2 - k_1^2} \tag{6g-2}$$

CASE II. Reflection, transmission, and absorption of light by a thin absorbing film $N_1$ of true thickness $h_1$ surrounded by homogeneous, isotropic, massive media, the incident medium being a dielectric of refractive index $n_0$ and the emergent medium being an absorbing medium whose complex refractive index is given by $N_2 = n_2 - ik_2$:




*a. Intensity reflectance* (normal incidence):

$$R = \frac{a_1 e^{\sigma} + a_2 e^{-\sigma} + a_3 \cos \nu + a_4 \sin \nu}{b_1 e^{\sigma} + b_2 e^{-\sigma} + b_3 \cos \nu + b_4 \sin \nu} \tag{6g-3}$$

where:

$$a_1 = [(n_0 - n_1)^2 + k_1^2][(n_1 + n_2)^2 + (k_1 + k_2)^2]$$
$$a_2 = [(n_0 + n_1)^2 + k_1^2][(n_1 - n_2)^2 + (k_1 - k_2)^2]$$
$$a_3 = 2\{[n_0^2 - (n_1^2 + k_1^2)][(n_1^2 + k_1^2) - (n_2^2 + k_2^2)] + 4n_0k_1(n_1k_2 - n_2k_1)\}$$
$$a_4 = 4\{[n_0^2 - (n_1^2 + k_1^2)](n_1k_2 - n_2k_1) - n_0k_1[(n_1^2 + k_1^2) - (n_2^2 + k_2^2)]\}$$
$$\sigma = \frac{4\pi k_1 h_1}{\lambda_0} \qquad \lambda_0 = \text{vacuum wavelength}$$
$$\nu = \frac{4\pi n_1 h_1}{\lambda_0}$$
$$b_1 = [(n_0 + n_1)^2 + k_1^2][(n_1 + n_2)^2 + (k_1 + k_2)^2]$$
$$b_2 = [(n_0 - n_1)^2 + k_1^2][(n_1 - n_2)^2 + (k_1 - k_2)^2]$$
$$b_3 = 2\{[n_0^2 - (n_1^2 + k_1^2)][(n_1^2 + k_1^2) - (n_2^2 + k_2^2)] - 4n_0k_1(n_1k_2 - n_2k_1)\}$$
$$b_4 = 4\{[n_0^2 - (n_1^2 + k_1^2)](n_1k_2 - n_2k_1) + n_0k_1[(n_1^2 + k_1^2) - (n_2^2 + k_2^2)]\}$$

*b. Phase change on reflection* (normal incidence):

$$\rho = \tan^{-1} \frac{c_1 e^{\sigma} + c_2 e^{-\sigma} + c_3 \cos \nu + c_4 \sin \nu}{d_1 e^{\sigma} + d_2 e^{-\sigma} + d_3 \cos \nu + d_4 \sin \nu} \tag{6g-4}$$

where

$$c_1 = 2n_0k_1[(n_1 + n_2)^2 + (k_1 + k_2)^2]$$
$$c_2 = -2n_0k_1[(n_1 - n_2)^2 + (k_1 - k_2)^2]$$
$$c_3 = 8n_0n_1[n_1k_2 - n_2k_1]$$
$$c_4 = -4n_0n_1[(n_1^2 + k_1^2) - (n_2^2 + k_2^2)]$$
$$d_1 = [n_0^2 - (n_1^2 + k_1^2)][(n_1 + n_2)^2 + (k_1 + k_2)^2]$$
$$d_2 = [n_0^2 - (n_1^2 + k_1^2)][(n_1 - n_2)^2 + (k_1 - k_2)^2]$$
$$d_3 = 2[n_0^2 + (n_1^2 + k_1^2)][(n_1^2 + k_1^2) - (n_2^2 + k_2^2)]$$
$$d_4 = 4[n_0^2 + (n_1^2 + k_1^2)](n_1k_2 - n_2k_1)$$

The symbols $\sigma$ and $\nu$ have the same definitions as in Eq. (6g-3).

*c. Intensity transmittance* (normal incidence): This denotes the percentage of incident intensity which is transmitted into the final medium.

$$T = \frac{16n_0n_2(n_1^2 + k_1^2)}{b_1 e^{\sigma} + b_2 e^{-\sigma} + b_3 \cos \nu + b_4 \sin \nu} \tag{6g-5}$$

where $b_1$, $b_2$, $b_3$, $b_4$, $\sigma$, and $\nu$ are defined as in Eq. (6g-3). Alternatively, one can write

$$T = (1 - R)\Psi \tag{6g-6}$$

where

$$\Psi = \frac{4n_2(n_1^2 + k_1^2)}{g_1e^{\sigma} + g_2e^{-\sigma} + g_3 \cos \nu + g_4 \sin \nu}$$

$$g_1 = \frac{b_1 - a_1}{4n_0} = n_1[(n_1 + n_2)^2 + (k_1 + k_2)^2]$$

$$g_2 = \frac{b_2 - a_2}{4n_0} = -n_2[(n_1 - n_2)^2 + (k_1 - k_2)^2]$$

$$g_3 = \frac{b_3 - a_3}{4n_0} = -4k_1(n_1k_2 - n_2k_1)$$

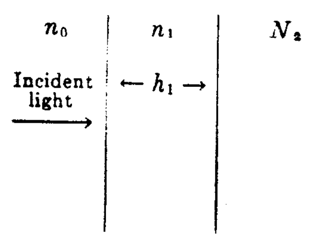
$$g_4 = \frac{b_4 - a_4}{4n_0} = 2k_1[(n_1^2 + k_1^2) - (n_2^2 + k_2^2)]$$

*d. Intensity absorptance* (normal incidence):

$$A = (1 - R - T) = (1 - R)(1 - \Psi) \qquad (6g\text{-}7)$$

This is the percentage of incident intensity which is absorbed by the film. In the simpler case where the emergent medium is a nonabsorbing material of refractive index $n_2$, the formulas for $R$, $T$, and $\Psi$ can be obtained from Eqs. (6g-3) and (6g-6) by setting $k_2 = 0$.

CASE III. The effect of a nonabsorbing surface film of refractive index $n_1$ and thickness $h_1$ on the reflectance of an opaque metal of complex index $N_2 = n_2 - ik_2$, where $n_0$ is the index (real) of the incident medium:




*a. Intensity reflectance* (normal incidence):

$$R = \frac{r_1^2 + r_2^2 - 2r_1r_2 \cos (\nu - \delta)}{1 + r_1^2r_2^2 - 2r_1r_2 \cos (\nu - \delta)} \qquad (6g\text{-}8)$$

where

$$r_1 = \frac{n_1 - n_0}{n_1 + n_0} \qquad r_2 = \left[\frac{(n_2 - n_1)^2 + k_2^2}{(n_2 + n_1)^2 + k_2^2}\right]^{\frac{1}{2}}$$

$$\nu = \frac{4\pi n_1h_1}{\lambda_0} \qquad \delta = \tan^{-1}\left(\frac{2n_1k_2}{n_1^2 - n_2^2 - k_2^2}\right)$$

$\delta$ is the absolute phase change at the dielectric-metal boundary.

A minimum value of reflectance occurs when $\nu - \delta = 2m\pi$, where $m$ is an integer:

$$R_{\min} = \frac{(r_1 - r_2)^2}{(1 - r_1r_2)^2} \qquad (6g\text{-}9)$$

A maximum value of reflectance occurs when $\nu - \delta = (2m - 1)\pi$:

$$R_{\max} = \frac{(r_1 + r_2)^2}{(1 + r_1r_2)^2} \qquad (6g\text{-}10)$$

CASE IV. The reflectance of a metal can be increased by the addition of a pair of dielectric layers to its surface (see ref. 3):

By using pairs of dielectric films with alternately low and high indices of refraction, mirror protection and reflectance enhancement over a rather broad spectral region can be achieved. To obtain the maximum reflectance increase with a low-index–high-index film pair, the metal surface must first be coated with low-index material until its reflectance decreases to a minimum at the wavelength at which highest reflectance is desired. Then the high-index material must be applied until the reflectance reaches a maximum. For further reflectance increase, more film pairs must be added in the same sequence. Under these conditions, the low-index film adjacent to the metal is effectively $\lambda/4$, and all other films are truly $\lambda/4$ thick. The optical thickness of the effectively $\lambda/4$-thick film on the metal surface can be determined from the following equation:

$$n_1 t_1 = \frac{\lambda}{4} \frac{\delta}{180°} \tag{6g-11}$$

where $\delta$ is the absolute phase change at the dielectric-metal boundary, as given by

$$\tan \delta = \frac{2n_1 k}{n_1^2 - n^2 - k^2} \tag{6g-12}$$

where $n_1$ is the refractive index of the low-index dielectric film, and $n$ and $k$ are the constants for the mirror material.

For normal incidence the maximum reflectance of a metal with optical constants $n$ and $k$ when coated with low-index $n_L$–high-index $n_H$ film pairs is given by the following expression:

$$R = \left| \frac{1 - Y^{2x}Z}{1 + Y^{2x}Z} \right|^2 \tag{6g-13}$$

where

$$Y = \frac{n_H}{n_L} \qquad Z = n_L \left| \frac{1 + r_3}{1 - r_3} \right|$$

$x$ is the number of film pairs, and

$$r_3 = \left( \frac{(n_L - n)^2 + k^2}{(n_L + n)^2 + k^2} \right)^{\frac{1}{2}} \tag{6g-14}$$

For opaque coatings, the reflectances $R_s$ and $R_p$ and their dependence on angle of incidence $i$ are given below. As before, the subscripts $s$ and $p$ refer to light polarized perpendicular and parallel to the plane of incidence. Here, the incident medium has refractive incidence of unity, and $n$ and $k$ are the values for the coating material. Normal incidence:

$$R_s = R_p = \frac{(n - 1)^2 + k^2}{(n + 1)^2 + k^2} \tag{6g-15}$$

Reflectances as a function of angle of incidence $i$:

$$R_s = \frac{a^2 + b^2 - 2a \cos i + \cos^2 i}{a^2 + b^2 + 2a \cos i + \cos^2 i} \tag{6g-16}$$

$$R_p = R_s \cdot \frac{a^2 + b^2 - 2a \sin i \tan i + \sin^2 i \tan^2 i}{a^2 + b^2 + 2a \sin i \tan i + \sin^2 i \tan^2 i} \tag{6g-17}$$

where

$$2a^2 = [(n^2 - k^2 - \sin^2 i)^2 + 4n^2k^2]^{\frac{1}{2}} + (n^2 - k^2 - \sin^2 i)$$
$$2b^2 = [(n^2 - k^2 - \sin^2 i)^2 + 4n^2k^2]^{\frac{1}{2}} - (n^2 - k^2 - \sin^2 i)$$

For unpolarized light with equal amplitudes of perpendicular and parallel components, the reflectance is

$$R = \tfrac{1}{2}(R_s + R_p) \tag{6g-18}$$

A great deal of work remains to be done in this area. The following tables and graph include both old and new data on the optical constants and reflectance of metals as a function of wavelength. In recent years many of these values have been extended into the vacuum ultraviolet region, and in some cases, further into the infrared region.

Many of the values of refractive index and extinction coefficient given in these tables have been calculated from graphical values of the real and imaginary parts of the dielectric coefficient. In order to facilitate these calculations a computer program was written. Because of this it was not possible to maintain a uniform standard of usable significant digits. Where the computer was used, the data were computed to four digits beyond the decimal place. If some question exists as to the reliability of a particular datum, the original reference should be consulted.

**References for Sec. 6g**

1. Heavens, O. S.: "Physics of Thin Films," G. Hass and R. Thun, eds., vol. 2, pp. 193–238, Academic Press, Inc., New York, 1964.
2. Burge, D. K., and H. E. Bennett: *J. Opt. Soc. Am.* **54,** 1428 (1964).
3. Hass, G., and A. P. Bradford: *J. Opt. Soc. Am.* **44,** 810 (1954).

TABLE 6g-1. OPTICAL CONSTANTS OF METALS

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Aluminum, evaporated.......... | 0.010 | 0.99 | 0.0041 | 0.00003 | 1 |
| | 0.011 | ....... | 0.0051 | | |
| | 0.012 | 0.99 | 0.0068 | | |
| | 0.013 | 0.99 | 0.0079 | | |
| | 0.014 | ....... | 0.0087 | | |
| | 0.015 | 0.98 | 0.0076 | | |
| | 0.016 | ....... | 0.0084 | | |
| | 0.017 | 0.99 | 0.0038 | | |
| | 0.018 | 0.98 | 0.0043 | | |
| | 0.019 | ....... | 0.0044 | | |
| | 0.020 | 0.97 | 0.0048 | | |
| | 0.021 | ....... | 0.0048 | | |
| | 0.022 | ....... | 0.0052 | | |
| | 0.023 | ....... | 0.0060 | | |
| | 0.024 | 0.96 | 0.0064 | | |
| | 0.025 | ....... | 0.0067 | | |
| | 0.026 | ....... | 0.0074 | | |
| | 0.027 | ....... | 0.0079 | | |
| | 0.028 | ....... | 0.0084 | | |
| | 0.029 | ....... | 0.0088 | | |
| | 0.030 | 0.93 | 0.0096 | | |
| | 0.0344 | 0.96 | 0.0095 | ........ | 2 |
| | 0.0376 | 0.943 | 0.0110 | | |
| | 0.0413 | 0.912 | 0.0125 | | |
| | 0.0443 | 0.880 | 0.0141 | | |
| | 0.0477 | 0.838 | 0.0159 | | |
| | 0.0516 | 0.785 | 0.0182 | | |
| | 0.0563 | 0.718 | 0.0213 | | |
| | 0.0620 | 0.635 | 0.0267 | | |
| | 0.0652 | 0.580 | 0.0307 | | |
| | 0.0689 | 0.520 | 0.0355 | | |
| | 0.0729 | 0.445 | 0.0424 | | |
| | 0.0775 | 0.345 | 0.0632 | | |
| | 0.0826 | 0.225 | 0.22 | | |
| | 0.0920 | 0.104 | 0.39 | | |
| | 0.1032 | 0.033 | 0.58 | | |
| | 0.0584 | 0.71 | 0.018 | ........ | 3 |
| | 0.735 | 0.455 | 0.043 | | |
| | 0.120 | 0.057 | 1.15 | 0.9019 | 4 |
| | 0.140 | 0.065 | 1.43 | 0.9122 | |
| | 0.160 | 0.080 | 1.73 | 0.9231 | |
| | 0.180 | 0.095 | 1.97 | 0.9290 | |
| | 0.200 | 0.110 | 2.20 | 0.9275 | |
| | 0.220 | 0.130 | 2.40 | 0.9261 | |
| | 0.240 | 0.160 | 2.53 | 0.9174 | |
| | 0.2200 | 0.14 | 2.35 | 0.918 | 5 |
| | 0.240 | 0.16 | 2.60 | 0.921 | |
| | 0.260 | 0.19 | 2.85 | 0.920 | |
| | 0.280 | 0.22 | 3.13 | 0.922 | |
| | 0.300 | 0.25 | 3.33 | 0.921 | |
| | 0.320 | 0.28 | 3.56 | 0.922 | |
| | 0.340 | 0.31 | 3.80 | 0.923 | |
| | 0.360 | 0.34 | 4.01 | 0.924 | |
| | 0.380 | 0.37 | 4.25 | 0.926 | |
| | 0.400 | 0.40 | 4.45 | 0.926 | |
| | 0.436 | 0.47 | 4.84 | 0.927 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Aluminum evaporated (*Cont.*) | 0.450 | 0.51 | 5.00 | 0.925 | |
| | 0.492 | 0.64 | 5.50 | 0.922 | |
| | 0.546 | 0.82 | 5.99 | 0.916 | |
| | 0.578 | 0.93 | 6.33 | 0.915 | |
| | 0.650 | 1.30 | 7.11 | 0.907 | |
| | 0.700 | 1.55 | 7.00 | 0.888 | 6, 7 |
| | 0.750 | 1.80 | 7.12 | 0.877 | |
| | 0.800 | 1.99 | 7.05 | 0.864 | |
| | 0.850 | 2.08 | 7.15 | 0.863 | |
| | 0.900 | 1.96 | 7.70 | 0.885 | |
| | 0.950 | 1.75 | 8.50 | 0.912 | |
| | 2.0 | 2.3 | 16.5 | 0.968 | 8 |
| | 4.0 | 6.1 | 30.4 | 0.975 | |
| | 6.0 | 10.8 | 42.6 | 0.978 | |
| | 8.0 | 17.9 | 55.3 | 0.979 | |
| | 10.0 | 26.0 | 67.3 | 0.980 | |
| | 12.0 | 33.1 | 78.0 | 0.982 | |
| Antimony, evaporated | 0.0310 | 1.0291 | 0.2429 | 0.0143 | 9 |
| | 0.0400 | 1.0055 | 0.3332 | 0.0269 | |
| | 0.0500 | 0.8194 | 0.1464 | 0.0162 | |
| | 0.0620 | 0.6976 | 0.1290 | 0.0373 | |
| | 0.0830 | 0.4989 | 0.4109 | 0.1739 | |
| | 0.1000 | 0.6013 | 0.8316 | 0.2612 | |
| | 0.1140 | 0.6167 | 1.0297 | 0.3286 | |
| | 0.1240 | 0.5141 | 1.0697 | 0.4016 | |
| | 0.1650 | 0.6694 | 1.3594 | 0.4223 | |
| | 0.1950 | 0.6246 | 1.2728 | 0.4134 | |
| | 0.2180 | 0.6805 | 1.4328 | 0.4419 | |
| | 0.2420 | 0.6000 | 1.2083 | 0.4030 | |
| | 0.2820 | 0.4602 | 1.5754 | 0.6010 | |
| Antimony, single crystal, optic axis | 0.4000 | 1.1297 | 2.8768 | 0.6473 | 10 |
| | 0.4500 | 1.4972 | 2.9054 | 0.5920 | |
| | 0.5000 | 1.6031 | 3.4308 | 0.6542 | |
| | 0.5500 | 2.0620 | 3.8797 | 0.6623 | |
| | 0.6000 | 2.6008 | 4.1910 | 0.6592 | |
| | 0.6500 | 2.7296 | 4.2131 | 0.6551 | |
| | 0.7000 | 2.7698 | 3.9714 | 0.6305 | |
| | 0.8000 | 2.9409 | 4.0803 | 0.6344 | |
| | 0.8500 | 3.0463 | 4.1689 | 0.6390 | |
| | 0.9000 | 3.2938 | 4.3415 | 0.6466 | |
| | 0.9500 | 3.5726 | 4.2266 | 0.6314 | |
| | 1.0000 | 3.8139 | 4.1165 | 0.6197 | |
| | 1.1000 | 3.9268 | 4.1255 | 0.6196 | |
| | 1.2000 | 4.0621 | 4.0989 | 0.6170 | |
| | 1.3000 | 4.4216 | 4.1049 | 0.6175 | |
| | 1.4000 | 4.6672 | 3.9853 | 0.6111 | |
| | 1.5000 | 4.8446 | 3.9838 | 0.6127 | |
| | 1.6000 | 4.9338 | 3.9928 | 0.6142 | |
| | 1.8000 | 5.1815 | 4.0432 | 0.6201 | |
| | 2.0000 | 5.4148 | 4.1737 | 0.6302 | |
| | 2.2000 | 5.8958 | 4.3082 | 0.6433 | |
| | 2.5000 | 6.3294 | 4.2263 | 0.6463 | |
| | 3.0000 | 7.0784 | 4.3936 | 0.6652 | |
| | 3.5000 | 7.8361 | 4.2432 | 0.6738 | |
| | 4.0000 | 7.9222 | 3.9194 | 0.6663 | |
| | 4.5000 | 7.3412 | 3.0649 | 0.6281 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Antimony, single crystal, optic axis (*Cont.*) | 5.0000 | 6.8470 | 2.0447 | 0.5835 | |
| | 5.5000 | 6.5086 | 4.0368 | 0.6028 | |
| | 6.0000 | 6.2512 | 3.3433 | 0.6078 | |
| | 6.5000 | 6.0593 | 3.5235 | 0.6106 | |
| | 7.0000 | 5.4416 | 3.9511 | 0.6188 | |
| | 7.5000 | 5.3852 | 4.3360 | 0.6384 | |
| | 8.0000 | 5.0797 | 5.0003 | 0.6721 | |
| | 8.5000 | 5.6760 | 5.7849 | 0.7152 | |
| | 9.0000 | 5.2135 | 6.5407 | 0.7438 | |
| | 9.5000 | 5.0092 | 7.1967 | 0.7721 | |
| | 10.0000 | 5.0755 | 7.4673 | 0.7809 | |
| Antimony, basal plane........... | 0.4000 | 0.9898 | 2.5258 | 0.6171 | |
| | 0.4500 | 1.1146 | 2.8710 | 0.6493 | |
| | 0.5000 | 1.3788 | 3.0824 | 0.6362 | |
| | 0.5500 | 1.6696 | 3.5338 | 0.6595 | |
| | 0.6000 | 1.9499 | 3.7950 | 0.6624 | |
| | 0.6500 | 2.0179 | 3.7910 | 0.6562 | |
| | 0.7000 | 2.1127 | 3.8812 | 0.6586 | |
| | 0.8000 | 2.5606 | 4.5888 | 0.6964 | |
| | 0.8500 | 2.7946 | 4.7233 | 0.6955 | |
| | 0.9000 | 2.8059 | 5.0964 | 0.7226 | |
| | 0.9500 | 3.1582 | 5.1453 | 0.7113 | |
| | 1.0000 | 3.3243 | 5.1138 | 0.7035 | |
| | 1.1000 | 3.5400 | 5.3800 | 0.7140 | |
| | 1.2000 | 3.8542 | 5.5005 | 0.7135 | |
| | 1.3000 | 4.3282 | 5.5797 | 0.7091 | |
| | 1.4000 | 4.5459 | 5.6094 | 0.7078 | |
| | 1.5000 | 4.6786 | 5.7175 | 0.7118 | |
| | 1.6000 | 5.1888 | 5.6854 | 0.7061 | |
| | 1.8000 | 5.6637 | 5.8972 | 0.7139 | |
| | 2.0000 | 6.0180 | 6.1981 | 0.7254 | |
| | 2.2000 | 6.5269 | 6.5728 | 0.7385 | |
| | 2.5000 | 7.3291 | 6.7539 | 0.7451 | |
| | 3.0000 | 8.8769 | 6.9281 | 0.7560 | |
| | 3.5000 | 10.2871 | 6.3186 | 0.7541 | |
| | 4.0000 | 11.1722 | 5.2362 | 0.7455 | |
| | 4.5000 | 11.2230 | 4.5888 | 0.7366 | |
| | 5.0000 | 11.0380 | 4.0542 | 0.7264 | |
| | 5.5000 | 10.5985 | 3.9911 | 0.7182 | |
| | 6.0000 | 10.4824 | 3.6442 | 0.7111 | |
| | 6.5000 | 10.2814 | 3.2875 | 0.7022 | |
| | 7.0000 | 10.2090 | 3.4675 | 0.7034 | |
| | 7.5000 | 9.8931 | 3.7248 | 0.7014 | |
| | 8.0000 | 9.8153 | 3.4843 | 0.6959 | |
| | 8.5000 | 9.4542 | 3.8448 | 0.6952 | |
| | 9.0000 | 9.0686 | 3.7602 | 0.6860 | |
| | 9.5000 | 8.7140 | 3.8903 | 0.6817 | |
| | 10.0000 | 8.1891 | 3.9321 | 0.6721 | |
| Antimony, evaporated........... | 1.0 | 3.4 | 4.1 | 0.624 | 11 |
| | 1.5 | 4.5 | 4.4 | 0.637 | |
| | 2.0 | 5.4 | 4.6 | 0.652 | |
| | 2.5 | 6.2 | 4.8 | 0.669 | |
| | 3.0 | 6.8 | 4.9 | 0.679 | |
| | 4.0 | 7.8 | 5.0 | 0.694 | |
| | 5.0 | 7.6 | 4.5 | 0.677 | |
| | 6.0 | 7.3 | 4.0 | 0.656 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Antimony, evaporated (*Cont.*) | 7.0 | 7.0 | 4.0 | 0.650 | |
| | 8.0 | 6.6 | 4.5 | 0.662 | |
| | 9.0 | 6.2 | 4.9 | 0.673 | |
| | 10.0 | 5.7 | 5.6 | 0.701 | |
| | 11.0 | 5.1 | 6.3 | 0.735 | |
| | 12.0 | 4.3 | 7.0 | 0.777 | |
| Antimony, bulk | 1.0000 | 2.8000 | 4.5000 | 0.6771 | 12 |
| | 2.0000 | 3.4000 | 4.4000 | 0.6488 | |
| | 3.0000 | 4.0000 | 4.3000 | 0.6321 | |
| | 4.0000 | 4.4000 | 4.1000 | 0.6171 | |
| | 5.0000 | 4.8000 | 4.0000 | 0.6132 | |
| | 6.0000 | 5.0000 | 4.0000 | 0.6154 | |
| | 7.0000 | 5.1000 | 3.9000 | 0.6108 | |
| | 8.0000 | 4.9000 | 3.9000 | 0.6082 | |
| | 9.0000 | 4.4000 | 3.8000 | 0.5963 | |
| | 10.0000 | 2.0000 | 3.9000 | 0.6696 | |
| | 11.0000 | 2.0000 | 5.0000 | 0.7647 | |
| | 12.0000 | 6.0000 | 9.0000 | 0.8154 | |
| Barium, evaporated | 0.1440 | 0.7400 | 0.1100 | 0.0262 | 13 |
| | 0.1550 | 0.6300 | 0.2000 | 0.0656 | |
| | 0.1650 | 0.5700 | 0.2900 | 0.1055 | |
| | 0.1770 | 0.5300 | 0.4300 | 0.1607 | |
| | 0.1900 | 0.5300 | 0.5300 | 0.1914 | |
| | 0.2070 | 0.5400 | 0.6300 | 0.2198 | |
| | 0.2250 | 0.5900 | 0.7300 | 0.2290 | |
| | 0.2480 | 0.6100 | 0.8700 | 0.2714 | |
| | 0.2750 | 0.6900 | 0.9300 | 0.2583 | |
| | 0.3100 | 0.7700 | 1.0900 | 0.2872 | |
| Barium, evaporated | 0.4046 | 0.82 | 1.07 | 0.264 | 14 |
| | 0.4358 | 0.78 | 1.10 | 0.287 | |
| | 0.4916 | 0.86 | 1.26 | 0.318 | |
| | 0.5461 | 0.89 | 1.51 | 0.392 | |
| | 0.5780 | 0.88 | 1.52 | 0.398 | |
| | 0.3130 | 0.76 | 7.84 | 0.288 | 15 |
| | 0.3650 | 0.72 | 7.10 | 0.347 | |
| | 0.4047 | 0.69 | 7.12 | 0.425 | |
| | 0.4358 | 0.72 | 2.12 | 0.454 | |
| | 0.4916 | 0.81 | 2.19 | 0.471 | |
| | 0.5461 | 0.90 | 2.19 | 0.520 | |
| | 0.5780 | 0.90 | 2.32 | 0.548 | |
| Beryllium, evaporated | 0.4046 | 2.48 | 2.20 | 0.415 | 14 |
| | 0.4358 | 2.56 | 2.23 | 0.420 | |
| | 0.4916 | 2.64 | 2.25 | 0.423 | |
| | 0.5461 | 2.66 | 2.36 | 0.439 | |
| | 0.5780 | 2.64 | 2.27 | 0.426 | |
| | 0.8 | 2.7 | 2.8 | 0.498 | 16 |
| | 0.9 | 2.7 | 2.9 | 0.511 | |
| | 1.2 | 2.4 | 3.5 | 0.597 | |
| | 1.5 | 2.4 | 4.7 | 0.715 | |
| | 2.0 | 2.5 | 5.8 | 0.782 | |
| | 2.5 | 2.75 | 7.25 | 0.835 | |
| | 3 | 3.45 | 9.0 | 0.863 | |
| | 3.5 | 3.9 | 10.8 | 0.889 | |
| | 4 | 5.0 | 12.2 | 0.892 | |
| | 5 | 6.85 | 14.3 | 0.897 | |
| | 6 | 8.0 | 15.4 | 0.899 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflec-tance calculated | Ref. |
|---|---|---|---|---|---|
| Beryllium, evaporated (*Cont.*) | 7 | 9.1 | 17.1 | 0.908 | |
| | 8 | 11.0 | 19.4 | 0.915 | |
| | 9 | 11.4 | 18.6 | 0.909 | |
| | 10 | 11.9 | 20.0 | 0.916 | |
| | 11 | 11.9 | 21.1 | 0.922 | |
| Bismuth, cleaved, single crystal | 0.350 | 0.82 | 2.57 | 0.669 | 17 |
| | 0.370 | 0.87 | 2.78 | 0.690 | |
| | 0.390 | 0.93 | 3.00 | 0.708 | |
| | 0.410 | 0.99 | 3.17 | 0.717 | |
| | 0.430 | 1.09 | 3.01 | 0.675 | |
| | 0.440 | 1.17 | 3.30 | 0.700 | |
| | 0.450 | 1.28 | 3.38 | 0.692 | |
| | 0.460 | 1.25 | 3.41 | 0.700 | |
| | 0.470 | 1.1 | 2.87 | 0.652 | |
| | 0.490 | 1.11 | 2.94 | 0.661 | |
| | 0.510 | 1.18 | 2.93 | 0.646 | |
| | 0.530 | 1.19 | 3.03 | 0.659 | |
| | 0.550 | 1.24 | 3.17 | 0.671 | |
| | 0.570 | 1.28 | 3.27 | 0.678 | |
| | 0.589 | 1.35 | 3.36 | 0.679 | |
| | 0.610 | 1.37 | 3.52 | 0.696 | |
| | 0.630 | 1.42 | 3.60 | 0.698 | |
| | 0.650 | 1.46 | 3.71 | 0.705 | |
| | 0.670 | 1.52 | 3.65 | 0.691 | |
| Bismuth, single crystal, optic axis | 0.4000 | 1.4477 | 2.2794 | 0.4824 | 10 |
| | 0.4500 | 1.6082 | 2.4872 | 0.5048 | |
| | 0.5000 | 1.7412 | 2.6705 | 0.5245 | |
| | 0.5500 | 2.1015 | 2.8313 | 0.5234 | |
| | 0.6000 | 2.0230 | 3.0647 | 0.5633 | |
| | 0.6500 | 2.0542 | 3.3346 | 0.5982 | |
| | 0.7000 | 2.2682 | 3.9679 | 0.6567 | |
| | 0.7500 | 2.6717 | 4.4540 | 0.6793 | |
| | 0.8000 | 2.8324 | 4.5191 | 0.6773 | |
| | 0.8500 | 3.2570 | 4.3598 | 0.6491 | |
| | 0.9000 | 3.4014 | 4.4687 | 0.6542 | |
| | 0.9500 | 3.7072 | 4.3294 | 0.6374 | |
| | 1.0000 | 4.0801 | 4.3872 | 0.6378 | |
| | 1.1000 | 4.1849 | 4.5402 | 0.6476 | |
| | 1.2000 | 4.6152 | 4.6368 | 0.6519 | |
| | 1.3000 | 5.0398 | 4.5934 | 0.6499 | |
| | 1.4000 | 5.4377 | 4.5791 | 0.6515 | |
| | 1.5000 | 5.8069 | 4.6066 | 0.6562 | |
| | 1.6000 | 6.1789 | 4.4021 | 0.6515 | |
| | 1.8000 | 6.6576 | 4.1381 | 0.6485 | |
| | 2.0000 | 7.0147 | 3.8348 | 0.6446 | |
| | 2.2000 | 8.0032 | 3.3987 | 0.6543 | |
| | 2.5000 | 7.6241 | 2.8331 | 0.6299 | |
| | 3.0000 | 7.6813 | 2.1220 | 0.6153 | |
| | 3.5000 | 7.5552 | 1.4427 | 0.5985 | |
| | 4.0000 | 7.3769 | 1.0574 | 0.5861 | |
| | 4.5000 | 7.3832 | 1.5847 | 0.5943 | |
| | 5.0000 | 7.4842 | 2.1245 | 0.6086 | |
| | 5.5000 | 7.6034 | 1.8741 | 0.6077 | |
| | 6.0000 | 7.5045 | 1.7656 | 0.6021 | |
| | 6.5000 | 7.6564 | 2.5338 | 0.6235 | |
| | 7.0000 | 7.5650 | 2.2868 | 0.6150 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflec-tance calculated | Ref. |
|---|---|---|---|---|---|
| Bismuth, single crystal optic axis. (*Cont.*) | 7.5000 | 7.4913 | 2.1492 | 0.6094 | |
| | 8.0000 | 7.5900 | 2.3254 | 0.6166 | |
| | 8.5000 | 7.6510 | 2.4572 | 0.6216 | |
| | 9.0000 | 7.7011 | 2.1231 | 0.6160 | |
| | 9.5000 | 7.6220 | 1.8696 | 0.6083 | |
| | 10.0000 | 7.4470 | 2.0141 | 0.6050 | |
| Bismuth, basal plane............ | 0.4000 | 1.2015 | 2.5384 | 0.5743 | |
| | 0.4500 | 1.4371 | 2.7139 | 0.5679 | |
| | 0.5000 | 1.5195 | 2.8300 | 0.5766 | |
| | 0.5500 | 1.7009 | 3.1453 | 0.6042 | |
| | 0.6000 | 1.7896 | 3.4645 | 0.6382 | |
| | 0.6500 | 1.7655 | 3.8232 | 0.6828 | |
| | 0.7000 | 2.1909 | 4.3589 | 0.6997 | |
| | 0.7500 | 2.1788 | 4.7273 | 0.7314 | |
| | 0.8000 | 2.6054 | 4.0088 | 0.7264 | |
| | 0.8500 | 3.0036 | 5.2270 | 0.7229 | |
| | 0.9000 | 3.2281 | 5.3592 | 0.7229 | |
| | 0.9500 | 3.7049 | 5.4522 | 0.7143 | |
| | 1.0000 | 3.9147 | 5.2750 | 0.6987 | |
| | 1.1000 | 4.2638 | 5.6991 | 0.7166 | |
| | 1.2000 | 4.8698 | 5.7805 | 0.7130 | |
| | 1.3000 | 5.3944 | 5.8394 | 0.7123 | |
| | 1.4000 | 5.9624 | 5.9624 | 0.7162 | |
| | 1.5000 | 6.4591 | 5.8754 | 0.7134 | |
| | 1.6000 | 7.0329 | 5.7586 | 0.7120 | |
| | 1.8000 | 7.8028 | 5.2994 | 0.7044 | |
| | 2.0000 | 8.2569 | 4.8142 | 0.6966 | |
| | 2.2000 | 8.5265 | 4.5388 | 0.6937 | |
| | 2.5000 | 8.7956 | 3.7633 | 0.6805 | |
| | 3.0000 | 8.7609 | 3.0419 | 0.6647 | |
| | 3.5000 | 8.7156 | 2.8742 | 0.6604 | |
| | 4.0000 | 8.5067 | 2.0161 | 0.6397 | |
| | 4.5000 | 8.8043 | 2.3909 | 0.6542 | |
| | 5.0000 | 8.7850 | 2.1855 | 0.6504 | |
| | 5.5000 | 8.7449 | 2.0183 | 0.6468 | |
| | 6.0000 | 8.9090 | 2.6210 | 0.6608 | |
| | 6.5000 | 8.7959 | 2.2511 | 0.6517 | |
| | 7.0000 | 8.8615 | 1.3880 | 0.6426 | |
| | 7.5000 | 8.8662 | 1.0997 | 0.6401 | |
| | 8.0000 | 8.8560 | 1.9309 | 0.6488 | |
| | 8.5000 | 8.8718 | 2.0514 | 0.6500 | |
| | 9.0000 | 8.6748 | 1.8848 | 0.6428 | |
| | 9.5000 | 8.6008 | 2.2965 | 0.6470 | |
| | 10.0000 | 8.6907 | 2.3934 | 0.6511 | |
| Bismuth, polycrystalline bulk.... | 1.0000 | 1.700 | 3.3000 | 0.6260 | 12 |
| | 2.0000 | 2.0000 | 3.2000 | 0.5842 | |
| | 3.0000 | 2.1000 | 3.3000 | 0.5902 | |
| | 4.0000 | 2.2000 | 3.4000 | 0.5963 | |
| | 5.0000 | 2.3000 | 3.4000 | 0.5902 | |
| | 6.0000 | 2.4000 | 3.5000 | 0.5968 | |
| | 7.0000 | 2.4000 | 3.6000 | 0.6085 | |
| | 8.0000 | 2.5000 | 3.7000 | 0.6145 | |
| | 9.0000 | 2.5000 | 3.9000 | 0.6358 | |
| | 10.0000 | 2.6000 | 4.0000 | 0.6409 | |
| | 11.0000 | 2.9000 | 4.1000 | 0.6377 | |
| | 12.0000 | 3.8000 | 4.3000 | 0.6340 | |
| | 13.0000 | 5.6000 | 4.4000 | 0.6440 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflec-tance calculated | Ref. |
|---|---|---|---|---|---|
| Bismuth, bulk | 1.00 | 4.5 | 5.0 | 0.674 | 18 |
| | 1.15 | 5.0 | 4.9 | 0.667 | |
| | 1.41 | 5.6 | 4.6 | 0.654 | |
| | 1.88 | 6.6 | 3.7 | 0.631 | |
| | 2.76 | 7.9 | 2.7 | 0.635 | |
| | 3.55 | 8.6 | 1.2 | 0.632 | |
| | 5.01 | 8.2 | 1.5 | 0.623 | |
| | 5.68 | 7.6 | 2.2 | 0.614 | |
| Cadmium, single crystal, optic axis | 0.2400 | 0.6084 | 1.7917 | 0.5802 | 19 |
| | 0.2600 | 0.3856 | 1.4521 | 0.6171 | |
| | 0.2800 | 0.3679 | 1.4406 | 0.6271 | |
| | 0.3000 | 0.3598 | 1.5425 | 0.6596 | |
| | 0.3200 | 0.3990 | 1.6791 | 0.6658 | |
| | 0.3400 | 0.4393 | 1.7757 | 0.6637 | |
| | 0.3600 | 0.5085 | 1.9075 | 0.6561 | |
| | 0.3800 | 0.6132 | 2.0140 | 0.6316 | |
| | 0.4000 | 0.7135 | 2.1585 | 0.6242 | |
| | 0.4200 | 0.7846 | 2.2750 | 0.6246 | |
| | 0.4400 | 0.9026 | 2.3653 | 0.6082 | |
| | 0.4600 | 0.9969 | 2.5127 | 0.6129 | |
| | 0.4800 | 1.1035 | 2.6959 | 0.6225 | |
| | 0.5000 | 1.1887 | 2.9023 | 0.6401 | |
| | 0.5200 | 1.2001 | 3.0332 | 0.6581 | |
| | 0.5400 | 1.3023 | 3.1521 | 0.6581 | |
| | 0.5600 | 1.4213 | 3.4088 | 0.6748 | |
| | 0.5800 | 1.5736 | 3.7049 | 0.6907 | |
| | 0.6000 | 1.9777 | 4.0350 | 0.6854 | |
| | 0.6100 | 2.0728 | 4.0910 | 0.6833 | |
| | 0.6500 | 2.3704 | 4.6743 | 0.7145 | |
| | 0.7000 | 1.9733 | 4.9663 | 0.7644 | |
| | 0.7500 | 2.0713 | 4.9245 | 0.7540 | |
| | 0.8000 | 2.3097 | 4.8492 | 0.7320 | |
| | 0.8500 | 2.2939 | 4.7605 | 0.7262 | |
| | 0.9000 | 1.9543 | 4.4440 | 0.7255 | |
| | 0.9500 | 2.0371 | 4.1725 | 0.6941 | |
| | 1.0000 | 2.5603 | 4.5503 | 0.6932 | |
| | 1.0500 | 3.0715 | 4.8202 | 0.6914 | |
| | 1.1000 | 3.2299 | 4.5466 | 0.6650 | |
| | 1.1500 | 3.2022 | 4.2736 | 0.6434 | |
| | 1.2000 | 3.4700 | 3.8731 | 0.6032 | |
| | 1.2500 | 2.7996 | 3.9291 | 0.6252 | |
| | 1.3000 | 2.8810 | 4.2190 | 0.6493 | |
| | 1.5000 | 2.1558 | 4.0009 | 0.6679 | |
| | 1.6000 | 1.8758 | 5.2885 | 0.7930 | |
| | 1.7000 | 1.5254 | 6.1852 | 0.8633 | |
| | 1.8000 | 1.7290 | 6.1424 | 0.8469 | |
| | 2.0000 | 1.7071 | 6.7952 | 0.8724 | |
| Cadmium, basal plane | 0.2400 | 0.5397 | 1.6677 | 0.5810 | |
| | 0.2600 | 0.2966 | 1.5678 | 0.7134 | |
| | 0.2800 | 0.2992 | 1.5873 | 0.7155 | |
| | 0.3000 | 0.2810 | 1.6550 | 0.7434 | |
| | 0.3200 | 0.3059 | 1.7982 | 0.7523 | |
| | 0.3400 | 0.4123 | 1.6492 | 0.6502 | |
| | 0.3600 | 0.4206 | 2.0801 | 0.7348 | |
| | 0.3800 | 0.4885 | 2.2313 | 0.7284 | |
| | 0.4000 | 0.5323 | 2.3671 | 0.7322 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Cadmium, basal plane (*Cont.*) | 0.4200 | 0.6001 | 2.5080 | 0.7288 | |
| | 0.4400 | 0.6647 | 2.6929 | 0.7347 | |
| | 0.4600 | 0.7664 | 2.9099 | 0.7354 | |
| | 0.4800 | 0.8792 | 3.1564 | 0.7394 | |
| | 0.5000 | 0.9053 | 3.3689 | 0.7583 | |
| | 0.5200 | 1.0188 | 3.6122 | 0.7620 | |
| | 0.5400 | 1.1062 | 3.8825 | 0.7732 | |
| | 0.5600 | 1.3257 | 4.1337 | 0.7643 | |
| | 0.5800 | 1.6193 | 4.5080 | 0.7616 | |
| | 0.6000 | 1.9007 | 4.8982 | 0.7654 | |
| | 0.6100 | 1.9076 | 5.1768 | 0.7836 | |
| | 0.6500 | 2.1409 | 5.3669 | 0.7785 | |
| | 0.7000 | 2.2464 | 5.0414 | 0.7501 | |
| | 0.7500 | 2.2127 | 4.9735 | 0.7475 | |
| | 0.8000 | 2.3403 | 4.9545 | 0.7378 | |
| | 0.8500 | 2.5598 | 4.7405 | 0.7087 | |
| | 0.9000 | 2.7066 | 4.8400 | 0.7087 | |
| | 0.9500 | 2.7465 | 4.9044 | 0.7116 | |
| | 1.0000 | 2.4292 | 4.4767 | 0.6944 | |
| | 1.0500 | 3.2890 | 4.7537 | 0.6791 | |
| | 1.1000 | 4.2983 | 4.0725 | 0.6150 | |
| | 1.1500 | 4.4419 | 4.4610 | 0.6412 | |
| | 1.2000 | 4.3324 | 4.1085 | 0.6176 | |
| | 1.2500 | 4.2414 | 3.9610 | 0.6069 | |
| | 1.3000 | 3.7442 | 4.1411 | 0.6223 | |
| | 1.5000 | 2.0119 | 4.5330 | 0.7283 | |
| | 1.6000 | 1.8016 | 5.1677 | 0.7915 | |
| | 1.7000 | 1.5862 | 5.3487 | 0.8208 | |
| | 1.8000 | 1.6502 | 5.8175 | 0.8385 | |
| | 2.0000 | 1.5222 | 6.6975 | 0.8811 | |
| Cadmium, evaporated | 0.0500 | 0.9800 | 0.2000 | 0.0102 | 20 |
| | 0.0600 | 0.9900 | 0.2200 | 0.0121 | |
| | 0.0700 | 1.0000 | 0.2500 | 0.0154 | |
| | 0.0800 | 1.0000 | 0.2800 | 0.0192 | |
| | 0.0900 | 1.0000 | 0.3000 | 0.0220 | |
| | 0.0950 | 1.0000 | 0.3100 | 0.0235 | |
| | 0.1000 | 1.0100 | 0.2900 | 0.0204 | |
| | 0.1050 | 1.0200 | 0.2600 | 0.0164 | |
| | 0.1100 | 1.0300 | 0.2200 | 0.0118 | |
| | 0.1150 | 1.0400 | 0.1900 | 0.0090 | |
| | 0.1200 | 1.0100 | 0.1300 | 0.0042 | |
| | 0.1220 | 0.9800 | 0.1200 | 0.0038 | |
| | 0.1240 | 0.9300 | 0.1700 | 0.0090 | |
| | 0.1260 | 0.8900 | 0.1600 | 0.0105 | |
| | 0.1280 | 0.8500 | 0.1900 | 0.0169 | |
| | 0.1300 | 0.8100 | 0.2900 | 0.0358 | |
| | 0.1320 | 0.7800 | 0.3600 | 0.0540 | |
| | 0.1340 | 0.7400 | 0.4300 | 0.0786 | |
| | 0.1360 | 0.7100 | 0.4800 | 0.0997 | |
| | 0.1380 | 0.6700 | 0.5100 | 0.1210 | |
| | 0.1400 | 0.6400 | 0.5300 | 0.1382 | |
| | 0.1500 | 0.5100 | 0.6200 | 0.2344 | |
| | 0.1600 | 0.4400 | 0.7200 | 0.3210 | |
| | 0.1700 | 0.4200 | 0.8100 | 0.3714 | |
| | 0.1800 | 0.4100 | 0.9100 | 0.4177 | |
| | 0.1900 | 0.4000 | 1.0000 | 0.4595 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Cadmium, evaporated (*Cont.*) | 0.2000 | 0.4000 | 1.1000 | 0.4953 | |
| | 0.2100 | 0.4000 | 1.1900 | 0.5261 | |
| | 0.2200 | 0.4000 | 1.2500 | 0.5458 | |
| | 0.2300 | 0.4000 | 1.3200 | 0.5678 | |
| | 0.2400 | 0.4000 | 1.4200 | 0.5976 | |
| | 0.2500 | 0.4000 | 1.5400 | 0.6306 | |
| | 0.2600 | 0.4100 | 1.6900 | 0.6615 | |
| | 0.2700 | 0.4100 | 1.8000 | 0.6863 | |
| | 0.2800 | 0.4100 | 2.0000 | 0.7261 | |
| Cadmium, bulk | 0.589 | 1.13 | 5.01 | 0.847 | 21 |
| Calcium, evaporated | 0.4046 | 0.34 | 1.56 | 0.678 | 24 |
| | 0.4358 | 0.29 | 1.64 | 0.734 | |
| | 0.4916 | 0.29 | 1.92 | 0.783 | |
| | 0.5461 | 0.27 | 2.16 | 0.828 | |
| | 0.5780 | 0.29 | 2.31 | 0.834 | |
| Cerium, evaporated | 0.4358 | 1.41 | 1.97 | 0.418 | 14 |
| | 0.5461 | 1.74 | 2.39 | 0.474 | |
| | 0.5780 | 1.91 | 2.58 | 0.495 | |
| Cesium, evaporated | 0.2536 | 0.916 | 0.143 | 0.007 | 22 |
| | 0.3126 | 0.827 | 0.174 | 0.018 | |
| | 0.3650 | 0.671 | 0.233 | 0.057 | |
| | 0.4047 | 0.540 | 0.320 | 0.127 | |
| | 0.4358 | 0.425 | 0.438 | 0.235 | |
| | 0.5461 | 0.278 | 0.950 | 0.561 | |
| | 0.5780 | 0.264 | 1.123 | 0.631 | |
| Chromium, evaporated | 0.133 | 0.83 | 0.35 | 0.044 | 23 |
| | 0.145 | 0.84 | 0.50 | 0.076 | |
| | 0.156 | 0.90 | 0.54 | 0.077 | |
| | 0.169 | 1.22 | 0.75 | 0.111 | |
| | 0.178 | 1.68 | 0.92 | 0.163 | |
| | 0.193 | 2.23 | 1.17 | 0.244 | |
| | 0.205 | 2.46 | 1.37 | 0.289 | |
| Chromium, bulk | 0.579 | 2.97 | 4.85 | 0.698 | 24 |
| Cobalt, evaporated | 0.1130 | 1.0748 | 0.8094 | 0.1332 | 25 |
| | 0.1240 | 1.0592 | 0.8497 | 0.1462 | |
| | 0.1380 | 1.0512 | 0.9513 | 0.1775 | |
| | 0.1550 | 1.0252 | 1.0729 | 0.2193 | |
| | 0.1770 | 1.0169 | 1.2783 | 0.2866 | |
| | 0.2070 | 1.1542 | 1.5595 | 0.3472 | |
| | 0.2480 | 1.2683 | 1.7346 | 0.3778 | |
| | 0.3100 | 1.3477 | 2.0776 | 0.4515 | |
| | 0.3870 | 1.5693 | 2.6763 | 0.5439 | |
| | 0.6200 | 2.1726 | 4.0274 | 0.6694 | |
| | 1.2400 | 3.8513 | 6.2316 | 0.7530 | |
| | 2.4800 | 4.8379 | 9.5082 | 0.8445 | |
| | 0.4400 | 1.9000 | 3.1800 | 0.5897 | 26 |
| | 0.5400 | 2.5000 | 3.7600 | 0.6210 | |
| | 0.6600 | 3.0000 | 4.1200 | 0.6361 | |
| | 0.8100 | 3.5400 | 4.5900 | 0.6603 | |
| | 1.0300 | 3.8500 | 5.2700 | 0.6998 | |
| | 1.3100 | 4.4000 | 5.7200 | 0.7156 | |
| | 1.6700 | 4.6100 | 5.8600 | 0.7198 | |
| | 2.1600 | 5.0000 | 6.0600 | 0.7250 | |
| Cobalt, polycrystalline | 2.5000 | 5.1000 | 7.8000 | 0.7919 | 27 |
| | 3.0000 | 4.8800 | 8.4600 | 0.8161 | |
| | 4.0000 | 4.7000 | 11.0000 | 0.8775 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Cobalt, polycrystalline (*Cont.*) | 4.5000 | 4.7800 | 12.6000 | 0.9005 | |
| | 5.0000 | 4.7000 | 14.7000 | 0.9244 | |
| | 5.5000 | 4.7600 | 15.2000 | 0.9356 | |
| | 6.0000 | 5.0000 | 17.5000 | 0.9416 | |
| | 6.5000 | 5.2000 | 19.3000 | 0.9494 | |
| | 7.0000 | 5.4000 | 20.9000 | 0.9548 | |
| | 8.0000 | 5.8000 | 24.0000 | 0.9627 | |
| | 9.0000 | 6.56 | 27.200 | 0.968 | |
| | 10.0000 | 7.1000 | 29.5000 | 0.9697 | |
| | 11.000 | 8.1000 | 32.6000 | 0.9717 | |
| | 12.0000 | 9.0000 | 34.7000 | 0.9724 | |
| | 14.0000 | 10.2000 | 38.0000 | 0.9740 | |
| | 15.0000 | 11.2000 | 40.5000 | 0.9750 | |
| | 17.0000 | 13.5000 | 45.0000 | 0.9758 | |
| | 19.0000 | 14.9000 | 49.0000 | 0.9775 | |
| | 20.0000 | 15.2000 | 51.7000 | 0.9793 | |
| Copper, bulk | 0.3650 | 1.0719 | 2.0710 | 0.5004 | 28 |
| | 0.4050 | 1.0769 | 2.2890 | 0.5491 | |
| | 0.4360 | 1.0707 | 2.4610 | 0.5860 | |
| | 0.5000 | 1.0308 | 2.7843 | 0.6528 | |
| | 0.5500 | 0.7911 | 2.7177 | 0.7013 | |
| | 0.5780 | 0.3250 | 2.8923 | 0.8716 | |
| | 0.6000 | 0.1491 | 3.2867 | 0.9508 | |
| | 0.6500 | 0.1074 | 3.9104 | 0.9740 | |
| | 0.7500 | 0.1034 | 4.8847 | 0.9835 | |
| | 1.0000 | 0.1471 | 6.9334 | 0.9881 | |
| Copper, single crystal | 0.4400 | 1.1070 | 2.5565 | 0.5965 | 29 |
| | 0.4600 | 1.0942 | 2.6320 | 0.6131 | |
| | 0.4800 | 1.0618 | 2.7124 | 0.6341 | |
| | 0.5000 | 1.0836 | 2.7684 | 0.6390 | |
| | 0.5200 | 1.0438 | 2.7784 | 0.6490 | |
| | 0.5400 | 0.9324 | 2.7348 | 0.6674 | |
| | 0.5600 | 0.6470 | 2.7200 | 0.7440 | |
| | 0.5800 | 0.2805 | 2.9764 | 0.8931 | |
| | 0.6000 | 0.1360 | 3.3464 | 0.9565 | |
| | 0.6200 | 0.1040 | 3.6525 | 0.9714 | |
| | 0.6400 | 0.0972 | 3.9114 | 0.9765 | |
| | 0.6600 | 0.0897 | 4.0692 | 0.9798 | |
| Copper, evaporated | 0.450 | 0.87 | 2.20 | 0.583 | 6, 7 |
| | 0.500 | 0.88 | 2.42 | 0.625 | |
| | 0.550 | 0.756 | 2.462 | 0.669 | 31 |
| | 0.600 | 0.186 | 2.980 | 0.928 | |
| | 0.650 | 0.142 | 3.570 | 0.960 | |
| | 0.700 | 0.150 | 4.049 | 0.966 | |
| | 0.750 | 0.157 | 4.463 | 0.970 | |
| | 0.800 | 0.170 | 4.840 | 0.973 | |
| | 0.850 | 0.182 | 5.222 | 0.975 | |
| | 0.900 | 0.190 | 5.569 | 0.977 | |
| | 0.950 | 0.197 | 5.900 | 0.978 | |
| | 1.000 | 0.197 | 6.272 | 0.981 | |
| | 5.0 | 2.92 | 27.45 | 0.985 | 32 |
| | 1.35 | 0.45 | 7.81 | 0.971 | 33 |
| | 1.69 | 0.58 | 9.96 | 0.977 | |
| | 2.28 | 0.82 | 13.0 | 0.981 | |
| | 3.00 | 1.22 | 17.1 | 0.984 | |
| | 3.4 | 1.53 | 20.3 | 0.985 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Copper, evaporated (*Cont.*) | 3.97 | 1.94 | 23.1 | 0.986 | |
| | 4.87 | 2.86 | 28.9 | 0.987 | |
| | 5.8 | 3.71 | 34.6 | 0.988 | |
| | 7.0 | 5.25 | 40.7 | 0.988 | |
| | 7.3 | 5.79 | 43.2 | 0.988 | |
| | 8.35 | 7.28 | 49.2 | 0.988 | |
| | 9.6 | 9.76 | 57.2 | 0.988 | |
| | 10.25 | 11.0 | 60.6 | 0.988 | |
| | 10.8 | 12.6 | 64.3 | 0.988 | |
| | 12.25 | 15.5 | 71.9 | 0.989 | |
| | 0.1025 | 1.05 | 0.70 | 0.098 | 84 |
| | 0.1113 | 0.95 | 0.73 | 0.115 | |
| | 0.1215 | 0.95 | 0.78 | 0.137 | |
| | 0.1306 | 0.90 | 0.83 | 0.148 | |
| | 0.1392 | 1.00 | 0.91 | 0.165 | |
| | 0.1500 | 1.02 | 1.02 | 0.192 | |
| | 0.1603 | 0.98 | 1.04 | 0.219 | |
| | 0.1700 | 0.94 | 1.12 | 0.254 | |
| | 0.1800 | 0.90 | 1.21 | 0.296 | |
| | 0.1900 | 0.88 | 1.36 | 0.335 | |
| | 0.2000 | 0.94 | 1.51 | 0.378 | |
| Gallium, liquid | 0.40 | 0.59 | 4.50 | 0.896 | 34 |
| | 0.50 | 0.89 | 5.60 | 0.898 | |
| | 0.60 | 1.25 | 6.60 | 0.897 | |
| | 0.70 | 1.65 | 7.60 | 0.898 | |
| | 0.80 | 2.09 | 8.50 | 0.898 | |
| | 0.87 | 2.40 | 9.20 | 0.900 | |
| Gallium, thin solid film | 0.4200 | 0.9555 | 1.7897 | 0.4561 | 35 |
| | 0.4400 | 1.0775 | 1.9675 | 0.4736 | |
| | 0.4600 | 1.1045 | 2.0688 | 0.4927 | |
| | 0.4800 | 1.1020 | 2.1643 | 0.5158 | |
| | 0.5000 | 0.9737 | 2.2645 | 0.5684 | |
| | 0.5200 | 0.8608 | 2.3582 | 0.6184 | |
| | 0.5400 | 1.0281 | 2.4366 | 0.5908 | |
| | 0.5600 | 1.3351 | 2.5578 | 0.5548 | |
| | 0.5800 | 1.5585 | 2.6436 | 0.5394 | |
| | 0.6000 | 1.6796 | 2.6346 | 0.5242 | |
| | 0.6200 | 1.7059 | 2.4678 | 0.4912 | |
| | 0.6400 | 1.5447 | 2.0943 | 0.4311 | |
| Germanium, evaporated | 0.0490 | 0.8100 | 0.0300 | 0.0113 | 36 |
| | 0.0550 | 0.7600 | 0.0400 | 0.0191 | |
| | 0.0580 | 0.7200 | 0.500 | 0.0273 | |
| | 0.0610 | 0.6800 | 0.0700 | 0.0380 | |
| | 0.0670 | 0.5700 | 0.1200 | 0.0804 | |
| | 0.0690 | 0.5300 | 0.1600 | 0.1042 | |
| | 0.0720 | 0.4800 | 0.1800 | 0.1362 | |
| | 0.0740 | 0.4500 | 0.2600 | 0.1705 | |
| | 0.0760 | 0.4000 | 0.3600 | 0.2343 | |
| | 0.0800 | 0.3800 | 0.4200 | 0.2695 | |
| | 0.0840 | 0.3400 | 0.4800 | 0.3287 | |
| | 0.0870 | 0.3200 | 0.5900 | 0.3877 | |
| | 0.0920 | 0.3100 | 0.6500 | 0.4202 | |
| | 0.1050 | 0.3500 | 0.9100 | 0.4718 | |
| | 0.1220 | 0.4200 | 1.0400 | 0.4577 | |
| | 0.1610 | 0.5300 | 1.4600 | 0.5260 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Germanium, single crystal | 0.0540 | 0.8400 | 0.0900 | 0.0099 | 37 |
| | 0.0560 | 0.8300 | 0.0900 | 0.0110 | |
| | 0.0590 | 0.8100 | 0.0900 | 0.0135 | |
| | 0.0620 | 0.7800 | 0.1100 | 0.0190 | |
| | 0.0650 | 0.7300 | 0.1300 | 0.0298 | |
| | 0.0690 | 0.6700 | 0.2000 | 0.0526 | |
| | 0.0730 | 0.6300 | 0.3500 | 0.0933 | |
| | 0.0770 | 0.6200 | 0.4400 | 0.1199 | |
| | 0.0830 | 0.6300 | 0.6300 | 0.1748 | |
| | 0.0880 | 0.6800 | 0.7600 | 0.1964 | |
| | 0.0950 | 0.7300 | 0.8800 | 0.2249 | |
| | 0.1030 | 0.7900 | 0.9600 | 0.2341 | |
| | 0.1133 | 0.8300 | 1.1200 | 0.2789 | |
| | 0.1240 | 0.8800 | 1.2900 | 0.3229 | |
| Germanium, bulk | 0.365 | 4.2 | 2.6 | 0.503 | 39 |
| | 0.405 | 4.25 | 2.2 | 0.475 | |
| | 0.430 | 4.1 | 2.2 | 0.468 | |
| | 0.465 | 4.15 | 2.27 | 0.476 | |
| | 0.49 | 4.5 | 2.3 | 0.494 | |
| | 0.52 | 4.8 | 2.25 | 0.504 | |
| | 0.545 | 5.15 | 2.15 | 0.515 | |
| | 0.58 | 5.5 | 1.8 | 0.416 | |
| | 0.60 | 5.7 | 1.25 | 0.509 | |
| | 0.63 | 5.45 | 0.85 | 0.485 | |
| | 0.655 | 5.3 | 0.70 | 0.472 | |
| | 0.68 | 5.0 | 0.55 | 0.449 | |
| | 0.250 | 1.7 | 1.35 | 0.245 | 40 |
| | 0.310 | 2.47 | 1.58 | 0.320 | |
| | 0.370 | 2.63 | 1.35 | 0.299 | |
| | 0.400 | 2.71 | 1.20 | 0.287 | |
| | 0.430 | 3.32 | 1.99 | 0.413 | |
| | 0.490 | 4.19 | 2.57 | 0.501 | |
| | 0.540 | 4.28 | 2.40 | 0.492 | |
| | 0.620 | 4.66 | 1.65 | 0.465 | |
| | 0.700 | 4.63 | 0.95 | 0.432 | |
| | 0.900 | 4.33 | 0.47 | 0.396 | |
| | 1.100 | 4.17 | 0.43 | 0.379 | |
| | 1.300 | 4.12 | 0.36 | 0.375 | |
| | 0.124 | 0.94 | 0.87 | 0.168 | 41 |
| | 0.138 | 0.92 | 1.10 | 0.219 | |
| | 0.155 | 0.94 | 1.37 | 0.219 | |
| | 0.177 | 1.00 | 1.74 | 0.287 | |
| | 0.190 | 1.07 | 2.00 | 0.321 | |
| | 0.207 | 1.27 | 2.38 | 0.354 | |
| | 0.255 | 1.54 | 2.47 | 0.417 | |
| | 0.247 | 1.63 | 2.88 | 0.419 | |
| | 0.258 | 1.74 | 3.15 | 0.448 | |
| | 0.269 | 2.06 | 3.61 | 0.501 | |
| | 0.281 | 3.18 | 4.26 | 0.526 | |
| | 0.295 | 3.94 | 3.45 | 0.508 | |
| | 0.310 | 3.94 | 2.88 | 0.544 | |
| | 0.354 | 4.00 | 2.42 | 0.598 | |
| | 0.413 | 4.15 | 1.88 | 0.647 | |
| | 0.442 | 4.12 | 1.87 | 0.513 | |
| | 0.477 | 4.27 | 2.00 | 0.484 | |
| | 0.516 | 4.71 | 2.00 | 0.466 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Germanium, bulk (*Cont.*) | 0.562 | 5.15 | 1.83 | 0.446 | |
| | 0.619 | 5.30 | 0.90 | 0.474 | |
| | 0.826 | 4.64 | 0.20 | 0.477 | |
| | 1.24 | 4.27 | 0.05 | 0.422 | |
| | 2.48 | 4.08 | 0.00 | 0.388 | |
| Germanium, evaporated | 1.33 | ....... | 0.131 | ...... | 42 |
| | 1.43 | ....... | 0.085 | | |
| | 1.54 | 4.50 | 0.061 | 0.405 | |
| | 1.67 | 4.45 | 0.040 | 0.401 | |
| | 1.82 | 4.40 | 0.036 | 0.396 | |
| | 2.00 | 4.35 | 0.03 | 0.392 | |
| | 2.22 | 4.29 | 0.02 | 0.387 | |
| | 2.50 | 4.26 | 0.02 | 0.384 | |
| | 0.4 | 2.3 | 2.8 | 0.509 | 43 |
| | 0.5 | 3.4 | 2.25 | 0.443 | |
| | 0.6 | 4.5 | 1.7 | 0.457 | |
| | 0.7 | 5.15 | 1.3 | 0.479 | |
| | 0.8 | 5.27 | 0.9 | 0.475 | |
| | 0.9 | 5.2 | 0.6 | 0.464 | |
| | 1.0 | 5.1 | 0.45 | 0.455 | |
| | 2.0 | 4.6 | | | |
| | 3.0 | 4.4 | | | |
| | 4.0 | 4.35 | | | |
| | 5.0 | 4.3 | | | |
| | 6.0 | 4.3 | | | |
| | 7.0 | 4.3 | | | |
| | 8.0 | 4.3 | | | |
| | 9.0 | 4.3 | | | |
| | 10.0 | 4.3 | | | |
| Gold, evaporated | 0.025 | 0.890 | 0.386 | 0.0433 | 38 |
| | 0.026 | 0.900 | 0.390 | 0.0431 | |
| | 0.027 | 0.906 | 0.392 | 0.0429 | |
| | 0.028 | 0.910 | 0.396 | 0.0433 | |
| | 0.029 | 0.910 | 0.400 | 0.0441 | |
| | 0.030 | 0.906 | 0.407 | 0.0459 | |
| | 0.031 | 0.900 | 0.416 | 0.0484 | |
| | 0.032 | 0.893 | 0.426 | 0.0512 | |
| | 0.033 | 0.882 | 0.440 | 0.0556 | |
| | 0.034 | 0.867 | 0.453 | 0.0604 | |
| | 0.035 | 0.855 | 0.470 | 0.0661 | |
| | 0.036 | 0.849 | 0.490 | 0.0719 | |
| | 0.037 | 0.846 | 0.512 | 0.0779 | |
| | 0.038 | 0.850 | 0.535 | 0.0832 | |
| | 0.039 | 0.865 | 0.555 | 0.0862 | |
| | 0.040 | 0.894 | 0.570 | 0.0859 | |
| | 0.041 | 0.925 | 0.572 | 0.0825 | |
| | 0.042 | 0.940 | 0.570 | 0.0803 | |
| | 0.043 | 0.942 | 0.562 | 0.0781 | |
| | 0.044 | 0.935 | 0.550 | 0.0758 | |
| | 0.045 | 0.910 | 0.542 | 0.0766 | |
| | 0.046 | 0.870 | 0.540 | 0.0814 | |
| | 0.047 | 0.855 | 0.548 | 0.0859 | |
| | 0.048 | 0.846 | 0.565 | 0.0920 | |
| | 0.049 | 0.846 | 0.600 | 0.1018 | |
| | 0.050 | 0.850 | 0.645 | 0.1142 | |
| | 0.051 | 0.860 | 0.695 | 0.1275 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Gold, evaporated (*Cont.*) | 0.052 | 0.872 | 0.740 | 0.1392 | |
| | 0.053 | 0.890 | 0.795 | 0.1532 | |
| | 0.054 | 0.915 | 0.825 | 0.1582 | |
| | 0.055 | 0.950 | 0.840 | 0.1571 | |
| | 0.056 | 0.985 | 0.848 | 0.1544 | |
| | 0.057 | 1.022 | 0.850 | 0.1503 | |
| | 0.058 | 1.055 | 0.842 | 0.1444 | |
| | 0.059 | 1.085 | 0.830 | 0.1382 | |
| | 0.060 | 1.113 | 0.813 | 0.1314 | |
| | 0.061 | 1.134 | 0.795 | 0.1253 | |
| | 0.062 | 1.146 | 0.770 | 0.1182 | |
| | 0.063 | 1.153 | 0.750 | 0.1127 | |
| | 0.064 | 1.157 | 0.730 | 0.1075 | |
| | 0.065 | 1.155 | 0.710 | 0.1026 | |
| | 0.066 | 1.140 | 0.700 | 0.1005 | |
| | 0.067 | 1.125 | 0.694 | 0.0995 | |
| | 0.068 | 1.107 | 0.687 | 0.0984 | |
| | 0.069 | 1.088 | 0.680 | 0.0975 | |
| | 0.070 | 1.075 | 0.678 | 0.0976 | |
| | 0.071 | 1.060 | 0.680 | 0.0990 | |
| | 0.072 | 1.050 | 0.685 | 0.1010 | |
| | 0.073 | 1.042 | 0.690 | 0.1029 | |
| | 0.074 | 1.038 | 0.697 | 0.1050 | |
| | 0.075 | 1.033 | 0.704 | 0.1073 | |
| | 0.076 | 1.030 | 0.713 | 0.1100 | |
| | 0.077 | 1.029 | 0.720 | 0.1120 | |
| | 0.078 | 1.028 | 0.730 | 0.1149 | |
| | 0.079 | 1.028 | 0.739 | 0.1174 | |
| | 0.080 | 1.029 | 0.745 | 0.1190 | |
| | 0.081 | 1.030 | 0.752 | 0.1200 | |
| | 0.082 | 1.033 | 0.759 | 0.1226 | |
| | 0.083 | 1.037 | 0.765 | 0.1239 | |
| | 0.084 | 1.041 | 0.770 | 0.1249 | |
| | 0.085 | 1.048 | 0.775 | 0.1257 | |
| | 0.086 | 1.053 | 0.780 | 0.1267 | |
| | 0.087 | 1.061 | 0.784 | 0.1272 | |
| | 0.088 | 1.070 | 0.789 | 0.1279 | |
| | 0.089 | 1.080 | 0.793 | 0.1282 | |
| | 0.090 | 1.090 | 0.798 | 0.1289 | |
| | 0.091 | 1.100 | 0.801 | 0.1290 | |
| | 0.092 | 1.110 | 0.806 | 0.1297 | |
| | 0.093 | 1.121 | 0.809 | 0.1298 | |
| | 0.094 | 1.133 | 0.812 | 0.1300 | |
| | 0.095 | 1.146 | 0.815 | 0.1301 | |
| | 0.096 | 1.159 | 0.819 | 0.1305 | |
| | 0.097 | 1.170 | 0.823 | 0.1311 | |
| | 0.098 | 1.180 | 0.826 | 0.1315 | |
| | 0.099 | 1.190 | 0.831 | 0.1324 | |
| | 0.100 | 1.200 | 0.836 | 0.1334 | |
| | 0.105 | 1.215 | 0.862 | 0.1397 | |
| | 0.110 | 1.218 | 0.896 | 0.1486 | |
| | 0.115 | 1.232 | 0.930 | 0.1571 | |
| | 0.120 | 1.258 | 0.963 | 0.1649 | |
| | 0.125 | 1.282 | 0.992 | 0.1718 | |
| | 0.130 | 1.307 | 1.020 | 0.1783 | |
| | 0.135 | 1.330 | 1.048 | 0.1849 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Gold, evaporated (*Cont.*) | 0.140 | 1.357 | 1.070 | 0.1899 | |
| | 0.145 | 1.386 | 1.089 | 0.1941 | |
| | 0.150 | 1.419 | 1.102 | 0.1967 | |
| | 0.155 | 1.450 | 1.108 | 0.1978 | |
| | 0.160 | 1.483 | 1.106 | 0.1971 | |
| | 0.165 | 1.512 | 1.093 | 0.1941 | |
| | 0.170 | 1.519 | 1.070 | 0.1888 | |
| | 0.175 | 1.500 | 1.070 | 0.1886 | |
| | 0.180 | 1.470 | 1.085 | 0.1921 | |
| | 0.185 | 1.442 | 1.107 | 0.1976 | |
| | 0.190 | 1.427 | 1.135 | 0.2049 | |
| | 0.195 | 1.424 | 1.170 | 0.2138 | |
| | 0.200 | 1.427 | 1.215 | 0.2251 | |
| | 0.450 | 1.40 | 1.88 | 0.397 | 6, 7 |
| | 0.500 | 0.84 | 1.84 | 0.504 | |
| | 0.550 | 0.331 | 2.324 | 0.815 | 31 |
| | 0.600 | 0.200 | 2.897 | 0.919 | |
| | 0.650 | 0.142 | 3.374 | 0.955 | |
| | 0.700 | 0.131 | 3.842 | 0.967 | |
| | 0.750 | 0.140 | 4.266 | 0.971 | |
| | 0.800 | 0.149 | 4.654 | 0.974 | |
| | 0.850 | 0.157 | 4.993 | 0.976 | |
| | 0.900 | 0.166 | 5.335 | 0.978 | |
| | 0.950 | 0.174 | 5.691 | 0.979 | |
| | 1.000 | 0.179 | 6.044 | 0.981 | |
| Gold, crystalline | 0.4400 | 1.5778 | 1.9077 | 0.3863 | 29 |
| | 0.4600 | 1.4843 | 1.8257 | 0.3754 | |
| | 0.4800 | 1.2543 | 1.7301 | 0.3787 | |
| | 0.5000 | 0.8031 | 1.8180 | 0.5100 | |
| | 0.5200 | 0.5264 | 2.1277 | 0.6929 | |
| | 0.5400 | 0.3772 | 2.4520 | 0.8092 | |
| | 0.5600 | 0.3054 | 2.7501 | 0.8682 | |
| | 0.5800 | 0.2524 | 3.0106 | 0.9050 | |
| | 0.6000 | 0.2113 | 3.2411 | 0.9294 | |
| | 0.6200 | 0.1906 | 3.4621 | 0.9431 | |
| | 0.6400 | 0.1667 | 3.6902 | 0.9555 | |
| | 1.0000 | 0.2200 | 6.7100 | 0.9811 | 44 |
| | 1.5000 | 0.3600 | 10.4000 | 0.9869 | |
| | 2.0000 | 0.5500 | 13.9000 | 0.9888 | |
| | 2.5000 | 0.8200 | 17.3000 | 0.9892 | |
| | 3.0000 | 1.1700 | 21.0000 | 0.9895 | |
| | 4.0000 | 2.0400 | 27.9000 | 0.9896 | |
| | 5.0000 | 3.2700 | 35.2000 | 0.9896 | |
| | 6.0000 | 4.7000 | 35.2000 | 0.9896 | |
| | 8.0000 | 7.8200 | 54.60000 | 0.9898 | |
| | 10.0000 | 11.5000 | 67.5000 | 0.9902 | |
| | 12.0000 | 15.4000 | 80.5000 | 0.9909 | |
| | 1.0000 | 0.3100 | 5.5800 | 0.9623 | 45 |
| | 2.0000 | 0.5400 | 11.2000 | 0.9831 | |
| | 3.0000 | 0.9300 | 16.7000 | 0.9868 | |
| | 4.0000 | 1.4900 | 22.2000 | 0.9881 | |
| | 5.0000 | 2.1900 | 27.7000 | 0.9887 | |
| | 6.0000 | 3.0100 | 33.0000 | 0.9891 | |
| | 7.0000 | 3.9700 | 38.3000 | 0.9894 | |
| | 8.0000 | 5.0500 | 43.5000 | 0.9895 | |
| | 9.0000 | 6.2100 | 48.6000 | 0.9897 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflec-tance calculated | Ref. |
|---|---|---|---|---|---|
| Gold, crystalline (*Cont.*) | 10.0000 | 7.4100 | 53.4000 | 0.9899 | |
| | 11.0000 | 8.7100 | 58.2000 | 0.9900 | |
| | 2.5000 | 0.6900 | 14.4000 | 0.9869 | 87 |
| | 3.0000 | 1.2500 | 17.6000 | 0.9841 | |
| | 4.0000 | 1.8800 | 23.2000 | 0.9862 | |
| | 4.5000 | 2.2800 | 25.3000 | 0.9860 | |
| | 5.0000 | 2.7100 | 28.5000 | 0.9869 | |
| | 6.0000 | 4.7100 | 34.5000 | 0.9846 | |
| | 6.5000 | 5.4800 | 37.4000 | 0.9848 | |
| | 7.0000 | 6.6200 | 39.4000 | 0.9836 | |
| | 8.0000 | 7.9000 | 44.0000 | 0.9843 | |
| | 8.5000 | 9.7200 | 45.6000 | 0.9823 | |
| | 9.0000 | 10.0000 | 47.9000 | 0.9834 | |
| | 9.5000 | 10.9000 | 50.6000 | 0.9839 | |
| Indium, evaporated | 0.4200 | 0.6505 | 1.8448 | 0.5753 | 35 |
| | 0.4400 | 0.8128 | 1.8085 | 0.5041 | |
| | 0.4600 | 0.8676 | 1.8902 | 0.5085 | |
| | 0.4800 | 0.8103 | 1.9252 | 0.5359 | |
| | 0.5000 | 1.0190 | 2.0805 | 0.5150 | |
| | 0.5200 | 1.0536 | 2.2068 | 0.5362 | |
| | 0.5400 | 1.0778 | 2.3242 | 0.5564 | |
| | 0.5600 | 1.1743 | 2.4185 | 0.5559 | |
| | 0.5800 | 1.2039 | 2.4919 | 0.5648 | |
| | 0.6000 | 1.2915 | 2.5900 | 0.5680 | |
| | 0.6200 | 1.4285 | 2.7406 | 0.5738 | |
| | 0.6400 | 1.4502 | 2.8307 | 0.5861 | |
| | 0.7100 | 1.3800 | 6.2400 | 0.8762 | 46 |
| | 1.0500 | 1.8300 | 7.9400 | 0.8970 | |
| | 1.5600 | 2.3100 | 11.3000 | 0.9334 | |
| | 2.2000 | 3.5300 | 15.8000 | 0.9477 | |
| | 2.6800 | 4.4300 | 18.2000 | 0.9509 | |
| | 3.1400 | 5.5000 | 21.2000 | 0.9553 | |
| | 4.0000 | 7.6000 | 26.1000 | 0.9597 | |
| | 5.9500 | 13.4000 | 35.6000 | 0.9637 | |
| | 8.0000 | 19.2000 | 42.2000 | 0.9649 | |
| | 10.0000 | 23.8000 | 51.7000 | 0.9710 | |
| Iridium, evaporated | 0.0500 | 0.65 | 0.88 | 0.255 | 47 |
| | 0.0550 | 0.76 | 0.99 | 0.255 | |
| | 0.0600 | 0.88 | 1.08 | 0.251 | |
| | 0.0650 | 1.02 | 1.08 | 0.221 | |
| | 0.0700 | 1.13 | 0.97 | 0.175 | |
| | 0.0750 | 1.15 | 0.90 | 0.153 | |
| | 0.0800 | 1.14 | 0.90 | 0.154 | |
| | 0.0850 | 1.10 | 0.93 | 0.166 | |
| | 0.0900 | 1.09 | 0.98 | 0.182 | |
| | 0.0950 | 1.11 | 1.06 | 0.204 | |
| | 0.1000 | 1.14 | 1.13 | 0.220 | |
| | 0.1100 | 1.27 | 1.23 | 0.238 | |
| | 0.1200 | 1.36 | 1.21 | 0.227 | |
| | 0.1300 | 1.38 | 1.16 | 0.213 | |
| | 0.1400 | 1.35 | 1.14 | 0.205 | |
| | 0.1500 | 1.28 | 1.18 | 0.222 | |
| | 0.1600 | 1.17 | 1.29 | 0.275 | |
| | 0.17 | 1.07 | 1.45 | 0.340 | |
| | 0.18 | 1.01 | 1.64 | 0.400 | |
| | 0.19 | 0.95 | 1.81 | 0.460 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Iridium, evaporated (*Cont.*) | 0.20 | 0.89 | 1.93 | 0.510 | |
| | 0.21 | 0.82 | 1.98 | 0.555 | |
| | 0.22 | 0.74 | 2.01 | 0.585 | |
| Iron, single crystal | 0.3670 | 1.9500 | 3.5300 | 0.6314 | 50 |
| | 0.3730 | 2.0200 | 3.5700 | 0.6305 | |
| | 0.3800 | 2.1100 | 3.5600 | 0.6223 | |
| | 0.3930 | 2.2000 | 3.6800 | 0.6300 | |
| | 0.4060 | 2.3200 | 3.7100 | 0.6256 | |
| | 0.4190 | 2.4600 | 3.7600 | 0.6231 | |
| | 0.4320 | 2.5800 | 3.8000 | 0.6214 | |
| | 0.4450 | 2.6900 | 3.8500 | 0.6216 | |
| | 0.4580 | 2.8300 | 3.8400 | 0.6152 | |
| | 0.4710 | 2.9200 | 3.8800 | 0.6161 | |
| | 0.4840 | 3.0400 | 3.8600 | 0.6105 | |
| | 0.4970 | 3.1200 | 3.8700 | 0.6094 | |
| | 0.5100 | 3.1900 | 3.8600 | 0.6068 | |
| | 0.5230 | 3.2500 | 3.8500 | 0.6047 | |
| | 0.5460 | 3.3500 | 3.8400 | 0.6020 | |
| | 0.5490 | 3.3600 | 3.8400 | 0.6018 | |
| | 0.5620 | 3.4200 | 3.8500 | 0.6018 | |
| | 0.5750 | 3.4400 | 3.8700 | 0.6033 | |
| | 0.5880 | 3.4600 | 3.8800 | 0.6040 | |
| | 0.6010 | 3.4900 | 3.8900 | 0.6044 | |
| | 0.6140 | 3.5000 | 3.8800 | 0.6034 | |
| | 0.6270 | 3.5300 | 3.9300 | 0.6074 | |
| | 0.6400 | 3.4900 | 3.9700 | 0.6114 | |
| | 0.6530 | 3.5600 | 4.0400 | 0.6163 | |
| | 0.6660 | 3.5700 | 4.0200 | 0.6145 | |
| | 0.6790 | 3.5800 | 4.1000 | 0.6210 | |
| | 0.6920 | 3.5800 | 4.1700 | 0.6267 | |
| Iron, evaporated | 0.4400 | 2.9400 | 3.3400 | 0.5592 | 26 |
| | 0.5400 | 3.1100 | 3.6200 | 0.5853 | |
| | 0.6600 | 3.3100 | 3.7500 | 0.5943 | |
| | 0.8100 | 3.6900 | 3.9400 | 0.6066 | |
| | 1.0300 | 3.8100 | 4.4400 | 0.6443 | |
| | 1.3100 | 4.1200 | 5.3100 | 0.6971 | |
| | 1.6700 | 4.0600 | 5.9400 | 0.7333 | |
| | 2.1600 | 3.8100 | 6.3800 | 0.7613 | |
| Iron, bulk | 0.4800 | 2.9057 | 3.8201 | 0.6106 | 51 |
| | 0.5000 | 3.0222 | 3.8449 | 0.6096 | |
| | 0.5200 | 3.0931 | 3.8246 | 0.6057 | |
| | 0.5400 | 3.2151 | 3.8485 | 0.6062 | |
| | 0.5600 | 3.2972 | 3.8563 | 0.6044 | |
| | 0.5800 | 3.3629 | 3.8509 | 0.6028 | |
| | 0.6000 | 3.3975 | 3.8410 | 0.6014 | |
| | 0.6200 | 3.4396 | 3.8537 | 0.6019 | |
| | 0.6400 | 3.4558 | 3.8500 | 0.6014 | |
| | 0.6600 | 3.4801 | 3.8563 | 0.6016 | |
| | 0.589 | 2.36 | 3.20 | 0.561 | 21 |
| Lanthanum, evaporated | 0.4046 | 1.34 | 2.33 | 0.508 | 14 |
| | 0.4358 | 1.35 | 2.49 | 0.539 | |
| | 0.5461 | 1.79 | 3.43 | 0.634 | |
| | 0.5780 | 1.74 | 3.47 | 0.644 | |
| Lead, bulk | 0.589 | 2.01 | 3.48 | 0.620 | 21 |
| Lead, evaporated | 0.7000 | 1.6800 | 3.6700 | 0.6746 | 52 |
| | 0.8000 | 1.5100 | 4.2400 | 0.7512 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Lead, evaporated (*Cont.*) | 0.9000 | 1.4400 | 4.8500 | 0.8046 | |
| | 1.0000 | 1.4100 | 5.4000 | 0.8387 | |
| | 1.1000 | 1.4200 | 5.9700 | 0.8631 | |
| | 1.2000 | 1.4600 | 6.3500 | 0.8741 | |
| | 1.3000 | 1.5100 | 7.1200 | 0.8940 | |
| | 1.4000 | 1.5900 | 7.6700 | 0.9030 | |
| | 1.5000 | 1.6700 | 8.2400 | 0.9110 | |
| | 1.7000 | 1.9000 | 9.3700 | 0.9210 | |
| | 2.0000 | 2.2800 | 11.1000 | 0.9319 | |
| | 2.5000 | 3.2000 | 13.7000 | 0.9377 | |
| | 3.0000 | 4.2700 | 16.4000 | 0.9424 | |
| | 3.5000 | 5.3900 | 18.6000 | 0.9443 | |
| | 4.0000 | 6.5800 | 20.8000 | 0.9463 | |
| | 5.0000 | 9.0400 | 24.8000 | 0.9495 | |
| | 6.0000 | 11.7000 | 28.1000 | 0.9508 | |
| | 7.0000 | 14.1000 | 30.9000 | 0.9523 | |
| | 8.0000 | 16.4000 | 33.6000 | 0.9542 | |
| | 9.0000 | 18.7000 | 35.8000 | 0.9552 | |
| | 10.0000 | 21.0000 | 37.4000 | 0.9554 | |
| | 11.0000 | 24.6000 | 40.5000 | 0.9571 | |
| | 12.0000 | 24.6000 | 40.5000 | 0.9571 | |
| Magnesium, evaporated | 0.1200 | 0.2500 | 0.4000 | 0.4194 | 53 |
| | 0.1400 | 0.1500 | 0.9500 | 0.7303 | |
| | 0.1600 | 0.2000 | 1.2000 | 0.7222 | |
| | 0.1800 | 0.2500 | 1.3000 | 0.6925 | |
| | 0.2000 | 0.2000 | 1.4000 | 0.7647 | |
| | 0.2200 | 0.1500 | 1.5000 | 0.8321 | |
| | 0.2400 | 0.1000 | 1.6000 | 0.8939 | |
| | 0.4046 | 0.52 | 2.05 | 0.681 | 14 |
| | 0.4358 | 0.52 | 2.65 | 0.777 | |
| | 0.4916 | 0.53 | 2.92 | 0.805 | |
| | 0.5461 | 0.57 | 3.47 | 0.843 | |
| | 0.5780 | 0.48 | 3.71 | 0.880 | |
| Magnesium, bulk | 0.589 | 0.37 | 4.42 | 0.931 | 21 |
| Manganese, evaporated | 0.4358 | 2.08 | 2.62 | 0.491 | 14 |
| | 0.5461 | 2.46 | 3.07 | 0.540 | |
| | 0.5780 | 2.59 | 3.04 | 0.532 | |
| Manganese, bulk | 0.4600 | 1.97 | 3.43 | 0.617 | 54 |
| | 0.5000 | 1.92 | 3.42 | 0.620 | |
| | 0.5408 | 2.10 | 3.53 | 0.619 | |
| | 0.5890 | 2.26 | 3.71 | 0.629 | |
| | 0.6410 | 2.61 | 3.97 | 0.637 | |
| | 0.6800 | 2.85 | 4.05 | 0.635 | |
| Mercury, liquid | 0.40 | 0.73 | 3.01 | 0.758 | 34 |
| | 0.50 | 1.04 | 3.70 | 0.767 | |
| | 0.60 | 1.39 | 4.32 | 0.772 | |
| | 0.70 | 1.76 | 4.83 | 0.773 | |
| | 0.80 | 2.14 | 5.33 | 0.776 | |
| | 0.87 | 2.40 | 5.63 | 0.778 | |
| | 0.3022 | 0.55 | 2.25 | 0.705 | 55 |
| | 0.3130 | 0.44 | 2.53 | 0.792 | |
| | 0.3650 | 0.64 | 2.97 | 0.778 | |
| | 0.4047 | 0.79 | 3.40 | 0.786 | |
| | 0.4358 | 0.88 | 3.47 | 0.774 | |
| Molybdenum, bulk | 0.0550 | 0.4900 | 0.6300 | 0.2511 | 56 |
| | 0.0580 | 0.5200 | 0.9600 | 0.3564 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction *n* | Extinction coefficient *k* | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Molybdenum, bulk (*Cont.*) | 0.0730 | 1.1500 | 1.3500 | 0.2863 | |
| | 0.0740 | 1.0300 | 1.2200 | 0.2655 | |
| | 0.0830 | 1.1700 | 1.2000 | 0.2389 | |
| | 0.0870 | 1.1700 | 1.2000 | 0.2389 | |
| | 0.0880 | 1.3200 | 1.3300 | 0.2617 | |
| | 0.0890 | 1.3300 | 1.3500 | 0.2663 | |
| | 0.0910 | 1.3800 | 1.3800 | 0.2707 | |
| | 0.0970 | 1.5500 | 1.3100 | 0.2456 | |
| | 0.1030 | 1.6700 | 1.2000 | 0.2204 | |
| | 0.1070 | 1.6400 | 1.0800 | 0.1937 | |
| | 0.1100 | 1.3300 | 1.0500 | 0.1855 | |
| | 0.1200 | 0.8300 | 1.4200 | 0.3812 | |
| | 0.1210 | 0.8100 | 1.4200 | 0.3878 | |
| | 0.1260 | 1.0000 | 1.9000 | 0.4744 | |
| | 0.1290 | 0.9200 | 1.9200 | 0.5009 | |
| | 0.1340 | 0.9500 | 2.0200 | 0.5179 | |
| | 0.1400 | 1.0300 | 2.4200 | 0.5871 | |
| | 0.1450 | 0.9700 | 2.4500 | 0.6074 | |
| | 0.1600 | 1.1000 | 2.7700 | 0.6358 | |
| | 0.1750 | 1.6700 | 3.0200 | 0.5889 | |
| | 0.2480 | 1.2300 | 2.7300 | 0.6040 | |
| | 0.2540 | 1.3000 | 2.7300 | 0.5919 | |
| | 0.2650 | 1.4000 | 2.9300 | 0.6096 | |
| | 0.2800 | 1.6300 | 3.0000 | 0.5904 | |
| | 0.3120 | 2.0200 | 3.0100 | 0.5556 | |
| | 0.3660 | 2.4300 | 2.9700 | 0.5278 | |
| | 0.4050 | 2.5000 | 3.0000 | 0.5294 | |
| | 0.4360 | 2.4800 | 3.0100 | 0.5314 | |
| | 0.4920 | 2.7500 | 3.4500 | 0.5764 | |
| | 0.5460 | 3.0000 | 3.4200 | 0.5667 | |
| | 0.5780 | 3.1800 | 3.4100 | 0.5629 | |
| | 0.4720 | 2.8600 | 3.0000 | 0.5213 | 48 |
| | 0.5010 | 3.1700 | 3.0000 | 0.5195 | |
| | 0.5610 | 3.4300 | 3.0000 | 0.5207 | |
| | 0.6220 | 3.5600 | 3.0100 | 0.5230 | |
| | 0.8000 | 3.6900 | 3.0200 | 0.5257 | |
| | 1.0000 | 3.8300 | 3.5500 | 0.5736 | |
| | 1.2000 | 4.0000 | 4.0400 | 0.6128 | |
| | 1.4000 | 4.3100 | 4.5200 | 0.6455 | |
| | 1.6000 | 4.6000 | 5.0000 | 0.6735 | |
| | 1.8000 | 4.8300 | 5.4900 | 0.6987 | |
| | 2.0000 | 5.0700 | 5.8600 | 0.7151 | |
| | 0.436 | 2.95 | 3.283 | 0.553 | 57 |
| | 0.546 | 3.59 | 3.403 | 0.560 | |
| | 0.578 | 3.65 | 3.274 | 0.549 | |
| Neodymium, evaporated | 0.3950 | 0.89 | 1.20 | 0.290 | 58 |
| | 0.4060 | 0.84 | 1.22 | 0.311 | |
| | 0.4170 | 0.79 | 1.28 | 0.347 | |
| | 0.4280 | 0.67 | 1.36 | 0.422 | |
| | 0.4420 | 0.56 | 1.42 | 0.497 | |
| | 0.4550 | 0.46 | 1.47 | 0.571 | |
| | 0.4690 | 0.40 | 1.46 | 0.609 | |
| | 0.4840 | 0.37 | 1.42 | 0.620 | |
| | 0.5000 | 0.38 | 1.41 | 0.610 | |
| | 0.5170 | 0.43 | 1.44 | 0.582 | |
| | 0.5360 | 0.43 | 1.44 | 0.582 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction n | Extinction coefficient k | Reflec-tance calculated | Ref. |
|---|---|---|---|---|---|
| Neodymium, evaporated (*Cont.*) | 0.5560 | 0.42 | 1.42 | 0.583 | |
| | 0.5770 | 0.40 | 1.38 | 0.586 | |
| | 0.6000 | 0.37 | 1.37 | 0.606 | |
| | 0.6250 | 0.35 | 1.36 | 0.619 | |
| | 0.6520 | 0.34 | 1.35 | 0.624 | |
| | 0.6820 | 0.32 | 1.32 | 0.633 | |
| | 0.7140 | 0.28 | 1.30 | 0.664 | |
| | 0.7500 | 0.27 | 1.30 | 0.673 | |
| | 0.7900 | 0.28 | 1.32 | 0.669 | |
| | 0.8340 | 0.28 | 1.42 | 0.694 | |
| | 0.8830 | 0.30 | 1.50 | 0.695 | |
| Nickel, evaporated | 0.4400 | 1.5600 | 2.6800 | 0.5457 | 26 |
| | 0.5400 | 1.8500 | 3.2700 | 0.6067 | |
| | 0.6600 | 2.0600 | 3.8900 | 0.6636 | |
| | 0.8100 | 2.3700 | 4.2100 | 0.6740 | |
| | 1.0300 | 2.8700 | 4.8700 | 0.7033 | |
| | 1.3100 | 3.3600 | 5.6500 | 0.7361 | |
| | 1.6700 | 3.6200 | 6.1600 | 0.7558 | |
| | 2.1600 | 4.2500 | 6.2500 | 0.7448 | |
| Nickel, bulk | 0.4800 | 1.7763 | 3.2765 | 0.6147 | 51 |
| | 0.5000 | 1.8282 | 3.3886 | 0.6246 | |
| | 0.5200 | 1.8796 | 3.5061 | 0.6348 | |
| | 0.5400 | 1.9245 | 3.6268 | 0.6454 | |
| | 0.5600 | 1.9670 | 3.7469 | 0.6556 | |
| | 0.5800 | 1.9830 | 3.9208 | 0.6732 | |
| | 0.6000 | 2.0663 | 3.9950 | 0.6741 | |
| | 0.6200 | 2.1278 | 4.0887 | 0.6788 | |
| | 0.6400 | 2.1890 | 4.2074 | 0.6858 | |
| | 0.6600 | 2.2498 | 4.3338 | 0.6933 | |
| | 0.420 | 1.41 | 2.53 | 0.538 | 59 |
| | 0.589 | 1.79 | 3.33 | 0.621 | 21 |
| | 0.750 | 2.19 | 4.36 | 0.700 | 60 |
| | 1.000 | 2.63 | 5.26 | 0.742 | |
| | 2.25 | 3.95 | 9.20 | 0.855 | |
| Nickel, evaporated | 2.0 | 3.74 | 8.80 | 0.850 | 32 |
| | 1.12 | 2.63 | 4.28 | 0.666 | 33 |
| | 1.58 | 2.89 | 5.08 | 0.718 | |
| | 2.18 | 3.18 | 6.13 | 0.769 | |
| | 2.72 | 3.44 | 7.15 | 0.806 | |
| | 3.4 | 3.72 | 8.49 | 0.842 | |
| | 4.4 | 4.35 | 10.59 | 0.876 | |
| | 5.4 | 4.92 | 12.4 | 0.896 | |
| | 6.75 | 5.86 | 15.2 | 0.916 | |
| | 8.7 | 7.31 | 19.2 | 0.933 | |
| | 10.5 | 8.86 | 22.5 | 0.941 | |
| | 12.5 | 10.2 | 26.2 | 0.950 | |
| Niobium, bulk | 0.4720 | 2.2600 | 2.2600 | 0.4255 | 48 |
| | 0.5010 | 2.3900 | 2.2800 | 0.4272 | |
| | 0.5610 | 2.5700 | 2.3400 | 0.4358 | |
| | 0.6220 | 2.5200 | 2.5200 | 0.4621 | |
| | 0.8000 | 2.2300 | 3.0400 | 0.5466 | |
| | 1.0000 | 2.0300 | 4.0000 | 0.6775 | |
| | 1.2000 | 2.0000 | 5.0400 | 0.7675 | |
| | 1.4000 | 2.1800 | 6.1800 | 0.8195 | |
| | 1.6000 | 2.4200 | 7.1300 | 0.8452 | |
| | 1.8000 | 2.7800 | 8.3600 | 0.8679 | |
| | 2.0000 | 3.1300 | 9.1300 | 0.8753 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflec-tance calculated | Ref. |
|---|---|---|---|---|---|
| Niobium, crystalline, bulk | 1.0000 | 1.5200 | 4.2900 | 0.7544 | 61 |
| | 1.5000 | 1.5600 | 7.1200 | 0.8910 | |
| | 2.0000 | 1.8500 | 8.7000 | 0.9117 | |
| | 2.5000 | 2.5000 | 11.0000 | 0.9250 | |
| | 3.0000 | 2.9000 | 12.2000 | 0.9293 | |
| | 3.5000 | 3.8000 | 15.6000 | 0.9429 | |
| | 4.0000 | 4.2000 | 17.4000 | 0.9491 | |
| | 4.5000 | 4.7000 | 19.0000 | 0.9522 | |
| | 5.0000 | 5.5000 | 21.6000 | 0.9568 | |
| | 5.5000 | 6.4000 | 23.0000 | 0.9561 | |
| | 6.0000 | 7.2000 | 25.0000 | 0.9584 | |
| | 6.5000 | 7.8000 | 25.9000 | 0.9583 | |
| | 7.0000 | 9.0000 | 27.7000 | 0.9585 | |
| | 7.5000 | 9.9000 | 29.4000 | 0.9597 | |
| | 8.0000 | 10.6000 | 31.0000 | 0.9613 | |
| | 8.5000 | 11.4000 | 33.2000 | 0.9637 | |
| | 9.0000 | 12.5000 | 34.9000 | 0.9643 | |
| | 9.5000 | 14.0000 | 36.4000 | 0.9639 | |
| | 10.0000 | 15.6000 | 38.7000 | 0.9648 | |
| | 12.0000 | 19.1000 | 42.0000 | 0.9648 | |
| | 14.0000 | 24.8000 | 45.4000 | 0.9636 | |
| | 15.0000 | 26.1000 | 48.8000 | 0.9665 | |
| Niobium, bulk | 0.579 | 1.80 | 2.11 | 0.414 | 24 |
| Palladium, evaporated | 0.3021 | 1.5 | 2.0 | 0.415 | 62 |
| | 0.3404 | 1.5 | 2.1 | 0.437 | |
| | 0.4358 | 1.8 | 2.4 | 0.471 | |
| | 0.5085 | 1.9 | 2.7 | 0.516 | |
| | 0.5461 | 2.3 | 2.7 | 0.494 | |
| Platinum, evaporated | 0.0580 | 0.9700 | 1.0300 | 0.2149 | 63 |
| | 0.0730 | 1.0800 | 0.7900 | 0.1274 | |
| | 0.1220 | 1.2800 | 1.1600 | 0.2176 | |
| Platinum, bulk | 0.589 | 2.06 | 4.26 | 0.701 | 21 |
| Platinum, electrolytic | 0.257 | 1.17 | 1.93 | 0.445 | 64 |
| | 0.441 | 1.94 | 3.16 | 0.584 | |
| | 0.589 | 2.63 | 3.54 | 0.591 | |
| | 0.668 | 2.91 | 3.66 | 0.594 | |
| Platinum, sputtered | 1.00 | 3.42 | 6.3 | 0.770 | 49 |
| | 1.97 | 5.92 | 9.8 | 0.830 | |
| | 3.29 | 7.50 | 12.2 | 0.860 | |
| | 4.65 | 10.9 | 15.5 | 0.890 | |
| Plutonium, bulk | 0.5461 | 2.0700 | 3.6100 | 0.6313 | 65 |
| Potassium, evaporated | 0.1270 | 0.9600 | 0 | 0.0004 | 66 |
| | 0.1390 | 0.9700 | 0 | 0.0002 | |
| | 0.1420 | 0.9800 | 0 | 0.0001 | |
| | 0.1480 | 0.9800 | 0 | 0.0001 | |
| | 0.1560 | 0.9600 | 0 | 0.0004 | |
| | 0.1590 | 0.9600 | 0 | 0.0004 | |
| | 0.1720 | 0.9300 | 0 | 0.0013 | |
| | 0.1780 | 0.9200 | 0 | 0.0017 | |
| | 0.1830 | 0.9100 | 0 | 0.0022 | |
| | 0.1880 | 0.8900 | 0 | 0.0034 | |
| | 0.1980 | 0.8800 | 0 | 0.0041 | |
| | 0.2080 | 0.8400 | 0 | 0.0076 | |
| | 0.2180 | 0.8200 | 0 | 0.0098 | |
| | 0.2280 | 0.7900 | 0 | 0.0138 | |
| | 0.2520 | 0.7200 | 0 | 0.0265 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Potassium, evaporated (*Cont.*) | 0.3120 | 0.3900 | 0 | 0.1926 | |
| | 0.2536 | 0.744 | 0.049 | 0.022 | 67 |
| | 0.3126 | 0.410 | 0.080 | 0.178 | |
| | 0.3650 | 0.150 | 0.443 | 0.605 | |
| | 0.4047 | 0.105 | 0.710 | 0.757 | |
| | 0.4358 | 0.121 | 0.978 | 0.781 | |
| | 0.5461 | 0.091 | 1.42 | 0.886 | |
| | 0.5780 | 0.094 | 1.57 | 0.897 | |
| | 0.3126 | 0.51 | 0.07 | 0.107 | 68 |
| | 0.3341 | 0.30 | 0.21 | 0.308 | |
| | 0.3650 | 0.21 | 0.42 | 0.488 | |
| | 0.4047 | 0.12 | 0.56 | 0.694 | |
| | 0.4358 | 0.08 | 0.68 | 0.804 | |
| | 0.4916 | 0.07 | 1.22 | 0.894 | |
| | 0.5461 | 0.05 | 1.41 | 0.935 | |
| | 0.5780 | 0.05 | 1.60 | 0.938 | |
| Potassium, bulk behind glass | 0.472 | 0.070 | 1.00 | 0.869 | 69 |
| | 0.589 | 0.068 | 1.50 | 0.920 | |
| | 0.665 | 0.066 | 1.77 | 0.938 | |
| | 0.546 | 0.06 | 1.29 | 0.914 | 70 |
| Potassium, bulk behind KBr | 2.5000 | 0.3500 | 7.5500 | 0.9762 | 71 |
| | 3.2000 | 0.6500 | 9.6500 | 0.9729 | |
| | 4.5000 | 1.3800 | 14.3000 | 0.9737 | |
| | 5.5000 | 1.6600 | 17.1000 | 0.9778 | |
| | 7.2000 | 2.8900 | 21.6000 | 0.9768 | |
| | 10.1500 | 4.77 | 28.2000 | 0.9770 | |
| Rhenium, bulk | 0.436 | 2.62 | 2.97 | 0.510 | 72 |
| | 0.589 | 3.18 | 3.55 | 0.576 | |
| | 0.4720 | 3.0000 | 3.0200 | 0.5223 | 48 |
| | 0.5010 | 3.3000 | 3.0300 | 0.5230 | |
| | 0.5610 | 3.4600 | 3.0800 | 0.5289 | |
| | 0.6220 | 3.4100 | 3.1300 | 0.5336 | |
| | 0.8000 | 3.3800 | 4.1700 | 0.6303 | |
| | 1.0000 | 3.3300 | 5.3700 | 0.7201 | |
| | 1.2000 | 3.5600 | 6.6000 | 0.7787 | |
| | 1.4000 | 4.1700 | 7.7900 | 0.8092 | |
| | 1.6000 | 4.7800 | 8.7300 | 0.8256 | |
| | 1.8000 | 5.6300 | 9.5200 | 0.8327 | |
| | 2.0000 | 6.0000 | 10.0200 | 0.8394 | |
| Rhodium, bulk | 0.4000 | 0.8400 | 3.9100 | 0.8201 | 73 |
| | 0.5000 | 1.0900 | 4.1700 | 0.7996 | |
| | 0.6000 | 1.4300 | 4.6200 | 0.7901 | |
| | 0.7000 | 1.6800 | 5.6700 | 0.8291 | |
| | 0.8000 | 2.0300 | 6.3600 | 0.8364 | |
| | 0.9000 | 2.2700 | 6.5000 | 0.8285 | |
| | 1.0000 | 2.3300 | 6.8000 | 0.8374 | |
| | 1.5000 | 3.1000 | 8.5200 | 0.8613 | |
| | 2.0000 | 3.2800 | 9.8700 | 0.8866 | |
| | 2.5000 | 4.4500 | 12.2000 | 0.9003 | |
| | 3.0000 | 5.0800 | 14.3000 | 0.9158 | |
| | 3.5000 | 5.6500 | 16.9900 | 0.9321 | |
| | 4.0000 | 5.9900 | 17.4600 | 0.9323 | |
| | 4.5000 | 6.6900 | 19.0900 | 0.9368 | |
| | 5.0000 | 6.7900 | 19.8800 | 0.9404 | |
| | 5.5000 | 7.6300 | 23.7100 | 0.9521 | |
| | 6.0000 | 8.0000 | 24.5400 | 0.9532 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Rhodium, bulk (*Cont.*) | 6.5000 | 8.9100 | 25.5000 | 0.9541 | |
| | 7.0000 | 8.9100 | 28.9100 | 0.9618 | |
| | 7.5000 | 9.5900 | 31.4200 | 0.9651 | |
| | 8.0000 | 9.1200 | 33.3100 | 0.9699 | |
| | 8.5000 | 10.6900 | 35.6200 | 0.9696 | |
| | 9.0000 | 10.9700 | 37.5400 | 0.9717 | |
| | 9.5000 | 11.3200 | 38.8900 | 0.9728 | |
| | 10.0000 | 12.0700 | 41.7600 | 0.9748 | |
| | 10.5000 | 12.8800 | 43.9500 | 0.9757 | |
| | 11.0000 | 13.8300 | 56.2100 | 0.9765 | |
| | 0.579 | 1.54 | 5.67 | 0.782 | 24 |
| Rhodium, evaporated | 0.546 | 1.62 | 4.63 | 0.771 | 74 |
| Rubidium, vacuum deposited | 0.2536 | 1.031 | 0.056 | 0.001 | 22 |
| | 0.3022 | 0.833 | 0.071 | 0.010 | |
| | 0.3126 | 0.814 | 0.078 | 0.012 | |
| | 0.3341 | 0.745 | 0.090 | 0.024 | |
| | 0.3650 | 0.496 | 0.135 | 0.121 | |
| | 0.4047 | 0.275 | 0.373 | 0.377 | |
| | 0.4358 | 0.181 | 0.636 | 0.598 | |
| | 0.5461 | 0.157 | 1.05 | 0.742 | |
| | 0.5780 | 0.164 | 1.19 | 0.763 | |
| Selenium, single crystal, ⊥ to $C$ axis | 0.2810 | 1.9000 | 1.7263 | 0.3328 | 75 |
| | 0.2940 | 2.1800 | 1.8715 | 0.3595 | |
| | 0.3100 | 2.4965 | 1.8145 | 0.3565 | |
| | 0.3260 | 2.7947 | 1.6764 | 0.3504 | |
| | 0.3440 | 3.0381 | 1.4318 | 0.3380 | |
| | 0.3640 | 3.1990 | 1.2222 | 0.3309 | |
| | 0.3860 | 3.3009 | 0.9467 | 0.3192 | |
| | 0.4100 | 3.2483 | 0.7219 | 0.3003 | |
| | 0.4400 | 3.1415 | 0.5825 | 0.2816 | |
| | 0.4750 | 3.0063 | 0.5455 | 0.2644 | |
| | 0.5150 | 2.9317 | 0.6123 | 0.2594 | |
| | 0.5600 | 3.0460 | 0.7337 | 0.2794 | |
| | 0.6100 | 3.2439 | 0.7229 | 0.2999 | |
| | 0.6200 | 3.3708 | 0.6497 | 0.3095 | |
| | 0.6500 | 3.4611 | 0.3149 | 0.3078 | |
| | 0.6900 | 3.3106 | 0.1420 | 0.2881 | |
| Selenium, ‖ to $C$ axis | 0.3440 | 3.3908 | 3.0509 | 0.5255 | |
| | 0.3640 | 3.6899 | 2.7304 | 0.4988 | |
| | 0.3860 | 3.8083 | 2.7282 | 0.5016 | |
| | 0.3960 | 4.2412 | 2.4875 | 0.4960 | |
| | 0.4100 | 4.4447 | 2.3207 | 0.4925 | |
| | 0.4400 | 4.5964 | 1.7340 | 0.4644 | |
| | 0.4750 | 4.3729 | 1.3572 | 0.4304 | |
| | 0.5150 | 4.2640 | 1.2090 | 0.4153 | |
| | 0.5600 | 4.4567 | 1.1926 | 0.4286 | |
| | 0.6200 | 4.7644 | 0.7210 | 0.4353 | |
| | 0.6350 | 4.7660 | 0.5245 | 0.4313 | |
| | 0.6900 | 4.4723 | 0.0347 | 0.4026 | |
| Selenium, evaporated amorphous | 0.2400 | 1.881 | 1.131 | 0.215 | 76 |
| | 0.2600 | 2.069 | 1.257 | 0.248 | |
| | 0.2800 | 2.280 | 1.285 | 0.265 | |
| | 0.3000 | 2.453 | 1.240 | 0.271 | |
| | 0.3200 | 2.570 | 1.157 | 0.270 | |
| | 0.3400 | 2.661 | 1.060 | 0.267 | |
| | 0.3625 | 2.734 | 0.965 | 0.265 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Selenium, evaporated amorphous (*Cont.*) | 0.3875 | 2.792 | 0.877 | 0.263 | |
| | 0.4000 | 2.820 | 0.838 | 0.262 | |
| | 0.4250 | 2.871 | 0.756 | 0.262 | |
| | 0.4500 | 2.917 | 0.679 | 0.262 | |
| | 0.4750 | 2.963 | 0.600 | 0.262 | |
| | 0.5000 | 3.003 | 0.515 | 0.263 | |
| | 0.5250 | 3.041 | 0.410 | 0.263 | |
| | 0.5500 | 3.051 | 0.282 | 0.260 | |
| | 0.5750 | 3.005 | 0.147 | 0.252 | |
| | 0.6000 | 2.922 | 0.061 | 0.240 | |
| | 0.6297 | 2.810 | 0.000 | | |
| | 0.6766 | 2.710 | 0.000 | | |
| | 0.7429 | 2.633 | 0.000 | | |
| | 0.8349 | 2.580 | 0.000 | | |
| | 0.9643 | 2.539 | 0.000 | | |
| | 1.1470 | 2.494 | 0.000 | | |
| | 1.4350 | 2.464 | 0.000 | | |
| | 1.6490 | 2.454 | 0.000 | | |
| | 1.9410 | 2.445 | 0.000 | | |
| | 2.3630 | 2.435 | 0.00 | | |
| Silicon, single crystal............ | 0.0650 | 0.5000 | 0.1300 | 0.1177 | 77 |
| | 0.0690 | 0.4500 | 0.1700 | 0.1555 | |
| | 0.0730 | 0.3700 | 0.3600 | 0.2624 | |
| | 0.0770 | 0.3700 | 0.3700 | 0.2651 | |
| | 0.0820 | 0.4100 | 0.5400 | 0.2806 | |
| | 0.0880 | 0.4300 | 0.5900 | 0.2812 | |
| | 0.0950 | 0.4100 | 0.6600 | 0.3233 | |
| | 0.1030 | 0.3600 | 0.7700 | 0.4104 | |
| | 0.1130 | 0.4600 | 1.0400 | 0.4274 | |
| | 0.1240 | 0.4800 | 1.1800 | 0.4641 | |
| | 0.1240 | 0.5200 | 1.2600 | 0.4664 | 78 |
| | 0.1300 | 0.5700 | 1.3300 | 0.4615 | |
| | 0.1380 | 0.5800 | 1.5000 | 0.5112 | |
| | 0.1460 | 0.6500 | 1.6400 | 0.5196 | |
| | 0.1550 | 0.6700 | 1.7700 | 0.5474 | |
| | 0.1650 | 0.6800 | 1.9500 | 0.5894 | |
| | 0.1770 | 0.7500 | 2.2500 | 0.6308 | |
| | 0.1990 | 0.8000 | 2.5300 | 0.6681 | |
| | 0.2060 | 1.1400 | 2.8300 | 0.6378 | |
| | 0.2140 | 1.2700 | 3.0000 | 0.6411 | |
| | 0.2210 | 1.5000 | 3.1700 | 0.6319 | |
| | 9.2290 | 1.6600 | 3.1500 | 0.6094 | |
| | 0.2380 | 1.7500 | 3.2500 | 0.6138 | |
| | 0.2480 | 1.7000 | 3.3800 | 0.6366 | |
| | 0.2580 | 1.6700 | 3.6700 | 0.6757 | |
| | 0.2690 | 2.0900 | 4.3800 | 0.7098 | |
| | 0.2810 | 3.3300 | 5.1300 | 0.7044 | |
| | 0.2940 | 4.8300 | 3.9500 | 0.6104 | |
| | 0.3100 | 4.9000 | 3.5500 | 0.5866 | |
| | 0.3260 | 5.1000 | 3.0000 | 0.5585 | |
| | 0.3440 | 5.2000 | 3.0900 | 0.5666 | |
| | 0.3640 | 7.0000 | 2.1600 | 0.5922 | |
| | 0.3860 | 6.0000 | 0.4200 | 0.5120 | |
| | 0.4100 | 5.1100 | 0.1700 | 0.4529 | |
| | 0.4400 | 4.6700 | 0.1300 | 0.4193 | |
| | 0.4750 | 4.3300 | 0.1100 | 0.3906 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Silicon, single crystal (*Cont.*) | 0.5150 | 4.1600 | 0.1000 | 0.3753 | |
| | 0.5600 | 4.0000 | 0.1000 | 0.3603 | |
| | 0.6200 | 3.9200 | 0.0500 | 0.3523 | |
| Silicon, evaporated | 0.5000 | 4.3000 | 0.7400 | 0.3994 | 79 |
| | 0.5500 | 4.4000 | 0.6300 | 0.4045 | |
| | 0.6000 | 4.3500 | 0.5900 | 0.3994 | |
| | 0.6500 | 4.2300 | 0.5700 | 0.3887 | |
| | 0.7000 | 4.1900 | 0.4000 | 0.3815 | |
| | 0.7500 | 4.1700 | 0.3700 | 0.3791 | |
| | 0.8000 | 4.0600 | 0.2100 | 0.3668 | |
| Silicon, bulk (low purity) | 0.589 | 4.18 | 0.376 | 0.380 | 60 |
| | 1.25 | 3.67 | 0.294 | 0.330 | |
| | 2.25 | 3.53 | 0.282 | 0.315 | |
| Silver, bulk | 0.1030 | 1.6500 | 0.4100 | 0.0821 | 80 |
| | 0.1100 | 1.5900 | 0.3200 | 0.0661 | |
| | 0.1240 | 1.4000 | 0.2700 | 0.0399 | |
| | 0.1300 | 1.3000 | 0.2900 | 0.0324 | |
| | 0.1340 | 1.2500 | 0.3200 | 0.0319 | |
| | 0.1370 | 1.2300 | 0.3700 | 0.0371 | |
| | 0.1430 | 1.1500 | 0.4200 | 0.0414 | |
| | 0.1550 | 1.0700 | 0.5800 | 0.0739 | |
| | 0.1620 | 1.0600 | 0.6900 | 0.1016 | |
| | 0.1710 | 1.0700 | 0.7800 | 0.1253 | |
| | 0.1790 | 1.0900 | 0.8700 | 0.1493 | |
| | 0.1960 | 1.1500 | 1.0100 | 0.1848 | |
| | 0.2160 | 1.2300 | 1.1000 | 0.2043 | |
| | 0.2360 | 1.2800 | 1.1800 | 0.2232 | |
| | 0.2620 | 1.3900 | 1.2800 | 0.2436 | |
| | 0.2810 | 1.5800 | 1.2400 | 0.2287 | |
| | 0.2920 | 1.7100 | 1.0800 | 0.1963 | |
| | 0.3010 | 1.8100 | 0.8500 | 0.1600 | |
| | 0.3070 | 1.7400 | 0.5400 | 0.1076 | |
| | 0.3140 | 1.3500 | 0.2300 | 0.0315 | |
| | 0.3180 | 1.1500 | 0.1900 | 0.0216 | |
| | 0.3200 | 1.0700 | 0.1800 | 0.0086 | |
| | 0.3210 | 0.9800 | 0.1600 | 0.0066 | |
| | 0.3230 | 0.8900 | 0.1600 | 0.0105 | |
| | 0.3260 | 0.6800 | 0.1700 | 0.0460 | |
| | 0.3290 | 0.4900 | 0.2100 | 0.1344 | |
| | 0.3320 | 0.2300 | 0.4000 | 0.4501 | |
| | 0.3350 | 0.1700 | 0.5900 | 0.6040 | |
| | 0.3440 | 0.1400 | 0.9400 | 0.7435 | |
| | 0.3620 | 0.1000 | 1.3400 | 0.8669 | |
| | 0.3760 | 0.0900 | 1.5700 | 0.9015 | |
| Silver, evaporated | 0.1025 | 1.19 | 0.57 | 0.078 | 84 |
| | 0.1113 | 1.09 | 0.56 | 0.067 | |
| | 0.1215 | 1.10 | 0.57 | 0.063 | |
| | 0.1306 | 1.14 | 0.57 | 0.063 | |
| | 0.1392 | 1.04 | 0.54 | 0.074 | |
| | 0.1500 | 0.96 | 0.66 | 0.100 | |
| | 0.1603 | 0.94 | 0.86 | 0.149 | |
| | 0.1700 | 0.95 | 0.91 | 0.195 | |
| | 0.1800 | 0.99 | 1.07 | 0.226 | |
| | 0.1900 | 1.02 | 1.11 | 0.250 | |
| | 0.2000 | 1.13 | 1.23 | 0.263 | |
| | 0.2200 | 1.3200 | 1.2900 | 0.2507 | 81 |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Silver, evaporated (*Cont.*) | 0.2300 | 1.3800 | 1.3100 | 0.2521 | |
| | 0.2400 | 1.3700 | 1.3300 | 0.2580 | |
| | 0.2500 | 1.3900 | 1.3400 | 0.2594 | |
| | 0.2550 | 1.3900 | 1.3400 | 0.2594 | |
| | 0.2600 | 1.4500 | 1.3500 | 0.2588 | |
| | 0.2650 | 1.4700 | 1.3400 | 0.2554 | |
| | 0.2700 | 1.5100 | 1.3300 | 0.2515 | |
| | 0.2750 | 1.5100 | 1.3100 | 0.2465 | |
| | 0.2800 | 1.5700 | 1.2700 | 0.2358 | |
| | 0.2850 | 1.6100 | 1.2400 | 0.2287 | |
| | 0.2900 | 1.6000 | 1.1700 | 0.2127 | |
| | 0.2950 | 1.6400 | 1.0800 | 0.1937 | |
| | 0.3000 | 1.6700 | 0.9600 | 0.1702 | |
| | 0.3020 | 1.6500 | 0.8200 | 0.1423 | |
| | 0.3040 | 1.6400 | 0.7500 | 0.1291 | |
| | 0.3060 | 1.6200 | 0.6800 | 0.1156 | |
| | 0.3080 | 1.5800 | 0.6100 | 0.1008 | |
| | 0.3100 | 1.5400 | 0.5400 | 0.0865 | |
| | 0.3120 | 1.4700 | 0.4800 | 0.0713 | |
| | 0.3140 | 1.4000 | 0.4300 | 0.0580 | |
| | 0.3160 | 1.3000 | 0.3800 | 0.0431 | |
| | 0.3180 | 1.1900 | 0.3400 | 0.0309 | |
| | 0.3200 | 1.0700 | 0.3200 | 0.0244 | |
| | 0.3220 | 0.9200 | 0.3000 | 0.0255 | |
| | 0.3240 | 0.7900 | 0.3000 | 0.0407 | |
| | 0.3260 | 0.6400 | 0.3500 | 0.0896 | |
| | 0.3280 | 0.4800 | 0.4400 | 0.1946 | |
| | 0.3300 | 0.3000 | 0.5500 | 0.3977 | |
| | 0.3320 | 0.2300 | 0.6800 | 0.5342 | |
| | 0.3340 | 0.2000 | 0.7900 | 0.6124 | |
| | 0.3360 | 0.1900 | 0.9200 | 0.6641 | |
| | 0.3380 | 0.1800 | 1.0500 | 0.7114 | |
| | 0.3400 | 0.1600 | 1.1400 | 0.7581 | |
| | 0.3450 | 0.1400 | 1.2700 | 0.8077 | |
| | 0.3500 | 0.1200 | 1.3500 | 0.8440 | |
| | 0.3550 | 0.1000 | 1.4200 | 0.8760 | |
| | 0.3600 | 0.0900 | 1.5200 | 0.8971 | |
| | 0.3650 | 0.0700 | 1.6000 | 0.9244 | |
| | 0.3700 | 0.0600 | 1.7000 | 0.9402 | |
| Silver, bulk | 0.226 | 1.41 | 1.11 | 0.199 | 82 |
| | 0.293 | 1.57 | 0.97 | 0.168 | |
| | 0.316 | 1.13 | 0.43 | 0.043 | |
| | 0.332 | 0.41 | 0.65 | 0.320 | |
| | 0.395 | 0.16 | 1.91 | 0.872 | |
| | 0.500 | 0.17 | 2.94 | 0.932 | |
| | 0.589 | 0.18 | 3.64 | 0.951 | |
| Silver, evaporated | 0.3021 | 1.2 | 0.8 | 0.124 | 83 |
| | 0.3261 | 0.5 | 0.5 | 0.200 | |
| | 0.3404 | 0.22 | 1.0 | 0.646 | |
| | 0.40 | 0.075 | 1.93 | 0.939 | 6, 7 |
| | 0.45 | 0.055 | 2.42 | 0.968 | |
| | 0.50 | 0.050 | 2.87 | 0.979 | |
| | 0.55 | 0.055 | 3.32 | 0.982 | |
| | 0.60 | 0.060 | 3.75 | 0.984 | |
| | 0.65 | 0.070 | 4.20 | 0.985 | |
| | 0.70 | 0.075 | 4.62 | 0.987 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflec-tance calculated | Ref. |
|---|---|---|---|---|---|
| Silver, evaporated (*Cont.*)........ | 0.75 | 0.080 | 5.05 | 0.988 | |
| | 0.80 | 0.090 | 5.45 | 0.988 | |
| | 0.85 | 0.100 | 5.85 | 0.989 | |
| | 0.90 | 0.105 | 6.22 | 0.989 | |
| | 0.95 | 0.110 | 6.56 | 0.989 | |
| Silver, crystalline.............. | 0.4400 | 0.0462 | 2.5985 | 0.9765 | 29 |
| | 0.4600 | 0.0410 | 2.8039 | 0.9817 | |
| | 0.4800 | 0.0415 | 3.0136 | 0.9837 | |
| | 0.5000 | 0.0468 | 3.2019 | 0.9835 | |
| | 0.5200 | 0.0427 | 3.3988 | 0.9865 | |
| | 0.5400 | 0.0448 | 3.5696 | 0.9870 | |
| | 0.5600 | 0.0453 | 3.7499 | 0.9880 | |
| | 0.5800 | 0.0496 | 3.9335 | 0.9880 | |
| | 0.6000 | 0.0489 | 4.0881 | 0.9890 | |
| | 0.6200 | 0.0552 | 4.2595 | 0.9885 | |
| | 0.6400 | 0.0542 | 4.4320 | 0.9896 | |
| Silver, chemically deposited...... | 0.750 | 0.17 | 5.16 | 0.976 | 60 |
| | 1.00 | 0.24 | 6.96 | 0.981 | |
| | 1.50 | 0.45 | 10.7 | 0.985 | |
| | 2.25 | 0.77 | 15.4 | 0.987 | |
| | 2.89 | 1.39 | 19.0 | 0.985 | 49 |
| | 4.37 | 4.34 | 32.6 | 0.985 | |
| Silver, evaporated.............. | 1.2500 | 0.3700 | 7.700 | 0.9785 | 30 |
| | 1.5000 | 0.4500 | 9.000 | 0.9783 | |
| | 2.0000 | 0.6500 | 12.2000 | 0.9828 | |
| | 3.000 | 1.3000 | 18.2000 | 0.9845 | |
| | 4.000 | 2.3000 | 24.3000 | 0.9847 | |
| | 5.000 | 3.5000 | 30.4000 | 0.9852 | |
| | 6.000 | 5.0000 | 36.0000 | 0.9850 | |
| | 7.000 | 6.9000 | 41.0000 | 0.9842 | |
| | 8.000 | 8.9000 | 46.000 | 0.9839 | |
| | 9.0000 | 11.0000 | 50.0000 | 0.9834 | |
| | 10.0000 | 13.0000 | 54.0000 | 0.9830 | |
| | 1.000 | 0.2500 | 6.8100 | 0.9791 | 45 |
| | 2.000 | 0.6800 | 13.6000 | 0.9855 | |
| | 3.0000 | 1.3800 | 20.3000 | 0.9868 | |
| | 4.0000 | 2.3400 | 26.9000 | 0.9873 | |
| | 5.0000 | 3.5200 | 33.2000 | 0.9875 | |
| | 6.0000 | 4.8700 | 39.4000 | 0.9877 | |
| | 7.0000 | 6.3100 | 45.300 | 0.9880 | |
| | 8.0000 | 7.8600 | 50.9000 | 0.9882 | |
| | 9.0000 | 9.3600 | 56.0000 | 0.9885 | |
| | 10.0000 | 10.8000 | 60.7000 | 0.9887 | |
| | 11.0000 | 12.0000 | 64.8000 | 0.9890 | |
| | 12.0000 | 12.8000 | 67.8000 | 0.9893 | |
| | 1.0 | 0.129 | 6.83 | 0.989 | 31 |
| | 2.0 | 0.48 | 14.4 | 0.991 | 8 |
| | 4.0 | 1.89 | 28.7 | 0.991 | |
| | 6.0 | 4.15 | 42.6 | 0.991 | |
| | 8.0 | 7.14 | 56.1 | 0.991 | |
| | 10.00 | 10.69 | 69.0 | 0.991 | |
| | 12.00 | 14.50 | 81.4 | 0.992 | |
| Sodium, vacuum deposited....... | 0.2536 | 0.026 | 0.621 | 0.928 | 7 |
| | 0.2652 | 0.028 | 0.735 | 0.930 | |
| | 0.3126 | 0.040 | 1.02 | 0.925 | |
| | 0.3650 | 0.042 | 1.44 | 0.947 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflec-tance calculated | Ref. |
|---|---|---|---|---|---|
| Sodium, vacuum deposited (*Cont.*) | 0.4047 | 0.048 | 1.56 | 0.946 | |
| | 0.4358 | 0.048 | 1.80 | 0.956 | |
| | 0.5461 | 0.029 | 2.32 | 0.982 | |
| | 0.5780 | 0.027 | 2.59 | 0.986 | |
| Sodium, bulk behind NaCl....... | 2.2500 | 0.4100 | 11.6000 | 0.9880 | 71 |
| | 2.5000 | 0.5000 | 12.5000 | 0.9874 | |
| | 3.0000 | 0.6100 | 14.7000 | 0.9888 | |
| | 3.5000 | 0.8100 | 17.2000 | 0.9892 | |
| | 4.0000 | 1.0200 | 19.4000 | 0.9893 | |
| | 4.7500 | 1.7100 | 22.3000 | 0.9864 | |
| | 7.2000 | 3.6600 | 32.9000 | 0.9867 | |
| | 10.1500 | 6.4300 | 44.5000 | 0.9874 | |
| Strontium, evaporated........... | 0.4046 | 0.55 | 1.28 | 0.456 | 14 |
| | 0.4358 | 0.57 | 1.50 | 0.516 | |
| | 0.4916 | 0.58 | 1.61 | 0.544 | |
| | 0.5461 | 0.63 | 1.99 | 0.619 | |
| | 0.5780 | 0.61 | 2.13 | 0.658 | |
| Tantalum, bulk................. | 0.4720 | 2.5200 | 2.9600 | 0.5234 | 48 |
| | 0.5010 | 2.5500 | 2.9600 | 0.5226 | |
| | 0.5610 | 2.4700 | 2.8100 | 0.5044 | |
| | 0.6220 | 2.1300 | 2.8900 | 0.5306 | |
| | 0.8000 | 1.3400 | 3.6400 | 0.7138 | |
| | 1.0000 | 1.3000 | 4.4200 | 0.7905 | |
| | 1.2000 | 1.4100 | 5.1000 | 0.8227 | |
| | 1.4000 | 1.6900 | 5.7800 | 0.8337 | |
| | 1.6000 | 2.0000 | 6.3900 | 0.8395 | |
| | 1.8000 | 2.5000 | 6.9400 | 0.8345 | |
| | 2.0000 | 2.9800 | 7.5400 | 0.8360 | |
| Tin (gray), single crystal......... | 1.0000 | 4.7000 | 1.6000 | 0.4636 | 85 |
| | 3.0000 | 4.6000 | 1.3000 | 0.4433 | |
| | 4.0000 | 4.6000 | 1.1000 | 0.4351 | |
| | 5.0000 | 4.5000 | 0.9000 | 0.4205 | |
| | 6.0000 | 4.4000 | 1.0000 | 0.4164 | |
| | 7.0000 | 4.4000 | 0.9000 | 0.4127 | |
| | 8.0000 | 4.3000 | 0.8000 | 0.4013 | |
| | 9.0000 | 4.2000 | 0.8000 | 0.3931 | |
| | 9.5000 | 4.2000 | 0.8000 | 0.3931 | |
| | 10.0000 | 4.1000 | 0.8000 | 0.3846 | |
| | 10.5000 | 4.0000 | 0.9000 | 0.3801 | |
| | 11.0000 | 4.0000 | 1.0000 | 0.3846 | |
| | 11.500 | 3.900 | 1.000 | 0.3762 | |
| | 12.000 | 3.800 | 1.000 | 0.3677 | |
| | 12.500 | 3.7000 | 0.900 | 0.3537 | |
| | 13.000 | 3.6000 | 0.900 | 0.3446 | |
| | 13.500 | 3.6000 | 0.900 | 0.3446 | |
| | 14.000 | 3.6000 | 0.800 | 0.3394 | |
| | 14.500 | 3.5000 | 0.900 | 0.3352 | |
| | 15.000 | 3.3000 | 0.800 | 0.3100 | |
| | 15.500 | 3.2000 | 0.800 | 0.2998 | |
| | 16.000 | 3.2000 | 0.800 | 0.2998 | |
| | 16.500 | 3.2000 | 0.900 | 0.3062 | |
| | 17.000 | 3.000 | 0.900 | 0.2861 | |
| | 17.500 | 2.900 | 1.000 | 0.2844 | |
| | 18.000 | 2.800 | 1.100 | 0.2843 | |
| | 18.500 | 2.700 | 1.3000 | 0.2978 | |
| | 19.000 | 2.500 | 1.500 | 0.3103 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Tin (gray), single crystal (*Cont.*) | 19.500 | 2.400 | 1.6000 | 0.3201 | |
| | 20.000 | 2.100 | 2.0000 | 0.3828 | |
| Titanium, evaporated | 0.436 | 2.04 | 2.85 | 0.530 | 86 |
| | 0.546 | 2.53 | 3.33 | 0.570 | |
| | 0.578 | 2.64 | 3.42 | 0.577 | |
| | 0.650 | 3.03 | 3.65 | 0.590 | |
| Titanium, bulk | 2.000 | 4.3800 | 4.8400 | 0.6655 | 87 |
| | 2.500 | 4.5700 | 5.3900 | 0.6957 | |
| | 3.000 | 4.5700 | 5.8300 | 0.7188 | |
| | 3.500 | 4.5600 | 6.5800 | 0.7542 | |
| | 4.000 | 4.6600 | 7.2700 | 0.7804 | |
| | 4.500 | 4.6600 | 8.0700 | 0.8082 | |
| | 5.000 | 4.8700 | 9.1800 | 0.8359 | |
| | 5.500 | 5.0700 | 10.3000 | 0.8581 | |
| | 6.000 | 5.3800 | 11.3000 | 0.8722 | |
| | 6.500 | 5.6300 | 12.2000 | 0.8832 | |
| | 7.000 | 5.9900 | 13.2000 | 0.8926 | |
| | 7.500 | 6.3100 | 13.9000 | 0.8977 | |
| | 8.000 | 6.5600 | 14.8000 | 0.9050 | |
| | 8.500 | 6.9600 | 16.1000 | 0.9137 | |
| | 9.000 | 7.5600 | 16.6000 | 0.9133 | |
| | 9.5000 | 8.5600 | 17.1000 | 0.9108 | |
| | 10.0000 | 9.0100 | 17.8000 | 0.9136 | |
| Thallium, evaporated | 0.0800 | 1.3500 | 0.1000 | 0.0239 | 20 |
| | 0.0900 | 1.1200 | 0.1900 | 0.0111 | |
| | 0.0950 | 1.1200 | 0.2400 | 0.0158 | |
| | 0.1000 | 1.2000 | 0.2800 | 0.0241 | |
| | 0.1020 | 1.1300 | 0.1900 | 0.0116 | |
| | 0.1040 | 0.9400 | 0.1500 | 0.0069 | |
| | 0.1060 | 0.8600 | 0.1900 | 0.0159 | |
| | 0.1080 | 0.8100 | 0.2500 | 0.0295 | |
| | 0.1100 | 0.7700 | 0.3300 | 0.0499 | |
| | 0.1150 | 0.6700 | 0.4600 | 0.1008 | |
| | 0.1200 | 0.5900 | 0.5500 | 0.1663 | |
| | 0.1300 | 0.500 | 0.7700 | 0.2965 | |
| | 0.1400 | 0.4800 | 0.9600 | 0.3830 | |
| | 0.1500 | 0.5400 | 1.1200 | 0.4043 | |
| | 0.1600 | 0.6100 | 1.2800 | 0.4232 | |
| | 0.1700 | 0.6700 | 1.3900 | 0.4323 | |
| | 0.1800 | 0.7300 | 1.4900 | 0.4399 | |
| | 0.1900 | 0.7800 | 1.5900 | 0.4523 | |
| | 0.2000 | 0.8400 | 1.7000 | 0.4646 | |
| | 0.2100 | 0.8800 | 1.8000 | 0.4804 | |
| | 0.2200 | 0.9100 | 1.9000 | 0.4985 | |
| | 0.2300 | 0.9700 | 2.0000 | 0.5077 | |
| | 0.2400 | 1.0300 | 2.1100 | 0.5194 | |
| | 0.2500 | 1.1100 | 2.2800 | 0.5399 | |
| | 0.2600 | 1.1900 | 2.4000 | 0.5491 | |
| | 0.2700 | 1.2600 | 2.5400 | 0.5640 | |
| | 0.2800 | 1.3500 | 2.7000 | 0.5785 | |
| | 0.4200 | 0.8099 | 2.0312 | 0.5623 | 35 |
| | 0.4400 | 0.9407 | 2.1154 | 0.5434 | |
| | 0.4600 | 1.0414 | 2.1942 | 0.5362 | |
| | 0.4800 | 1.1057 | 2.2655 | 0.5377 | |
| | 0.5000 | 1.1336 | 2.3377 | 0.5473 | |
| | 0.5200 | 1.1588 | 2.3860 | 0.5523 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Thallium, evaporated (*Cont.*) | 0.5400 | 1.1540 | 2.4437 | 0.5650 | |
| | 0.5600 | 1.1622 | 2.5081 | 0.5761 | |
| | 0.5800 | 1.1135 | 2.5729 | 0.5983 | |
| | 0.6000 | 1.0681 | 2.6497 | 0.6218 | |
| | 0.6200 | 1.0405 | 2.7005 | 0.6367 | |
| | 0.6400 | 0.9717 | 2.8043 | 0.6693 | |
| Tungsten, bulk | 0.4720 | 2.9900 | 2.2600 | 0.4312 | 48 |
| | 0.5010 | 3.0400 | 2.3400 | 0.4421 | |
| | 0.5610 | 3.2800 | 2.5200 | 0.4682 | |
| | 0.6220 | 3.4100 | 2.6300 | 0.4826 | |
| | 0.8000 | 3.5400 | 2.7600 | 0.4984 | |
| | 1.0000 | 3.0400 | 3.5200 | 0.5765 | |
| | 1.2000 | 3.0400 | 4.2800 | 0.6490 | |
| | 1.4000 | 2.9400 | 4.5700 | 0.6770 | |
| | 1.6000 | 2.4700 | 5.1300 | 0.7424 | |
| | 1.8000 | 2.1300 | 6.4900 | 0.8359 | |
| | 2.0000 | 2.0000 | 7.0200 | 0.8627 | |
| | 0.579 | 2.76 | 2.71 | 0.486 | 24 |
| | 0.589 | 3.46 | 3.25 | 0.545 | 88 |
| Vanadium, bulk | 2.000 | 2.0800 | 6.4300 | 0.8363 | 87 |
| | 2.500 | 2.1800 | 7.3700 | 0.8647 | |
| | 3.000 | 2.4400 | 8.8100 | 0.8909 | |
| | 3.500 | 2.9500 | 10.6000 | 0.9078 | |
| | 4.000 | 3.2400 | 11.5000 | 0.9137 | |
| | 4.500 | 3.7500 | 12.8000 | 0.9195 | |
| | 5.000 | 4.1500 | 14.3000 | 0.9281 | |
| | 5.500 | 4.7200 | 14.6000 | 0.9316 | |
| | 6.000 | 5.2000 | 16.8000 | 0.9351 | |
| | 7.000 | 6.1800 | 18.5000 | 0.9372 | |
| | 7.500 | 6.7400 | 19.8000 | 0.9403 | |
| | 8.000 | 7.0000 | 20.2000 | 0.9407 | |
| | 9.000 | 8.1000 | 22.8000 | 0.9462 | |
| Zinc | 0.2573 | 0.554 | 0.612 | 0.206 | 64 |
| | 0.2749 | 0.456 | 1.167 | 0.476 | |
| | 0.2981 | 0.469 | 1.598 | 0.602 | |
| | 0.3255 | 0.599 | 2.229 | 0.682 | |
| | 0.3611 | 0.720 | 2.610 | 0.705 | |
| | 0.3982 | 0.846 | 2.917 | 0.716 | |
| | 0.4413 | 0.934 | 3.178 | 0.730 | |
| | 0.4678 | 1.049 | 3.485 | 0.743 | |
| | 0.508 | 1.406 | 4.101 | 0.751 | |
| | 0.5893 | 1.932 | 4.661 | 0.745 | |
| | 0.668 | 2.618 | 4.083 | 0.731 | |
| Zinc, single crystal, optic axis | 0.2650 | 0.2354 | 1.6357 | 0.7759 | 19 |
| | 0.3050 | 0.2510 | 1.8528 | 0.7991 | |
| | 0.3450 | 0.2737 | 2.1737 | 0.8275 | |
| | 0.3850 | 0.3069 | 2.5088 | 0.8466 | |
| | 0.4250 | 0.3589 | 2.8140 | 0.8530 | |
| | 0.4650 | 0.4430 | 3.1379 | 0.8515 | |
| | 0.5050 | 0.6395 | 3.4013 | 0.8206 | |
| | 0.5450 | 0.7737 | 3.9129 | 0.8250 | |
| | 0.5850 | 1.0017 | 3.8683 | 0.7888 | |
| | 0.5920 | 1.2525 | 3.9961 | 0.7619 | |
| | 0.6000 | 1.4856 | 4.0555 | 0.7374 | |
| | 0.6250 | 1.8562 | 3.9706 | 0.6896 | |
| | 0.6400 | 3.0132 | 3.9974 | 0.6243 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflectance calculated | Ref. |
|---|---|---|---|---|---|
| Zinc, single crystal, optic axis (*Cont.*) | 0.6800 | 3.4234 | 4.3232 | 0.6421 | |
| | 0.7200 | 3.5908 | 4.4614 | 0.6495 | |
| | 0.7500 | 3.7577 | 4.6239 | 0.6585 | |
| | 0.8000 | 3.8086 | 4.6212 | 0.6575 | |
| | 0.8500 | 3.2523 | 4.2447 | 0.6396 | |
| | 0.9000 | 2.9459 | 3.5761 | 0.5845 | |
| | 0.9500 | 3.2039 | 3.0042 | 0.5200 | |
| | 1.0000 | 2.8821 | 3.4766 | 0.5755 | |
| | 1.0500 | 1.9808 | 4.2004 | 0.7013 | |
| | 1.1000 | 1.7768 | 4.5307 | 0.7483 | |
| | 1.1500 | 1.5853 | 4.9013 | 0.7935 | |
| | 1.2000 | 1.5407 | 5.3192 | 0.8227 | |
| | 1.2500 | 1.5762 | 5.8843 | 0.8472 | |
| | 1.3000 | 1.4824 | 6.2296 | 0.8681 | |
| | 1.4000 | 1.5571 | 6.7753 | 0.8812 | |
| | 1.5000 | 1.7921 | 6.9973 | 0.8737 | |
| | 1.6500 | 1.9241 | 7.5619 | 0.8829 | |
| Zinc, basal plane | 0.2650 | 0.2806 | 1.7997 | 0.7699 | |
| | 0.3050 | 0.3013 | 2.0077 | 0.7894 | |
| | 0.3450 | 0.3147 | 2.3041 | 0.8212 | |
| | 0.3850 | 0.3911 | 2.7463 | 0.8250 | |
| | 0.4250 | 0.4774 | 3.0476 | 0.8335 | |
| | 0.4650 | 0.5470 | 3.4277 | 0.8453 | |
| | 0.5050 | 0.7568 | 3.7627 | 0.8264 | |
| | 0.5450 | 0.9725 | 4.2879 | 0.8254 | |
| | 0.5850 | 1.3329 | 4.4751 | 0.7907 | |
| | 0.5920 | 1.7048 | 4.7923 | 0.7748 | |
| | 0.6000 | 2.0802 | 4.7231 | 0.7383 | |
| | 0.6250 | 3.2515 | 4.2980 | 0.6441 | |
| | 0.6400 | 3.4512 | 4.1942 | 0.6309 | |
| | 0.6800 | 3.7549 | 4.3042 | 0.6417 | |
| | 0.7200 | 3.9369 | 4.6356 | 0.6566 | |
| | 0.7500 | 4.0269 | 4.8027 | 0.6668 | |
| | 0.8000 | 4.1241 | 4.7768 | 0.6638 | |
| | 0.8500 | 3.5064 | 4.1994 | 0.6303 | |
| | 0.9000 | 3.1807 | 3.4709 | 0.5691 | |
| | 0.9500 | 3.3991 | 2.7684 | 0.4967 | |
| | 1.0000 | 2.8717 | 3.2873 | 0.5547 | |
| | 1.0500 | 1.9701 | 4.0176 | 0.6843 | |
| | 1.1000 | 1.6897 | 4.4062 | 0.7464 | |
| | 1.1500 | 1.3095 | 4.9025 | 0.8216 | |
| | 1.2000 | 1.2889 | 5.4001 | 0.8501 | |
| | 1.2500 | 1.3835 | 5.8910 | 0.8630 | |
| | 1.3000 | 1.3165 | 6.2212 | 0.8805 | |
| | 1.4000 | 1.3628 | 6.6886 | 0.8917 | |
| | 1.5000 | 1.4744 | 6.9688 | 0.8922 | |
| | 1.6500 | 1.4469 | 7.4158 | 0.9051 | |
| Zirconium, polycrystalline | 2.5000 | 3.8000 | 6.0500 | 0.7451 | 61 |
| | 3.0000 | 3.9500 | 6.4600 | 0.7615 | |
| | 3.5000 | 3.4500 | 7.5500 | 0.8203 | |
| | 4.0000 | 3.5700 | 8.7100 | 0.8524 | |
| | 4.5000 | 3.7500 | 9.8000 | 0.8735 | |
| | 5.0000 | 3.9900 | 11.5000 | 0.8984 | |
| | 5.5000 | 4.3500 | 12.8000 | 0.9096 | |
| | 6.0000 | 4.5200 | 14.0000 | 0.9202 | |
| | 6.5000 | 5.0000 | 15.3000 | 0.9260 | |

TABLE 6g-1. OPTICAL CONSTANTS OF METALS (*Continued*)

| Metal | Wave-length, μm | Index of refraction $n$ | Extinction coefficient $k$ | Reflec-tance calculated | Ref. |
|---|---|---|---|---|---|
| Zirconium, polycrystalline (*Cont.*). | 7.0000 | 5.5000 | 16.6000 | 0.9308 | |
| | 8.0000 | 6.4000 | 18.3000 | 0.9343 | |
| | 9.0000 | 7.3000 | 21.0000 | 0.9427 | |
| | 10.0000 | 8.2000 | 23.0000 | 0.9465 | |
| | 11.0000 | 9.0500 | 25.0000 | 0.9501 | |
| | 12.0000 | 10.0000 | 26.40000 | 0.9511 | |
| | 15.0000 | 12.4000 | 32.50000 | 0.9599 | |
| | 16.0000 | 12.6000 | 34.60000 | 0.9635 | |
| | 17.0000 | 13.3000 | 36.60000 | 0.9655 | |

**References for Table 6g-1**


1. Philipp, H. R., and H. Ehrenreich: *J. App. Phys.* **35,** 1416 (1964).
2. Ditchburn, R. W., and G. H. C. Freeman: *Proc. Roy. Soc.* (*London*), ser. A, **294,** 20 (1966).
3. Madden, R. R., L. R. Canfield, and G. Hass: *J. Opt. Soc. Am.* **53,** 620 (1963).
4. Daudae, A., M. Priol, and S. Robin: *Compt. Rend.* **263,** 1178 (1966).
5. Hass, G., and J. E. Waylonis: *J. Opt. Soc. Am.* **50,** 1133 (TB15)(1960).
6. Schulz, L. G., and F. R. Tangherlini: *J. Opt. Soc. Am.* **44,** 362 (1954).
7. Schulz, L. G.: *J. Opt. Soc. Am.* **44,** 357 (1954).
8. Beattie, J. R.: *Physica* **23,** 898 (1957).
9. Lemonnier, J., Y. LeCalvez, G. Stepahan, and S. Robin: *Compt. Rend.* **264,** 1599 (1967).
10. Lenham, A. P., D. M. Treherne, and P. J. Metcalfe: *J. Opt. Soc. Am.* **55,** 1072 (1965).
11. Shkliarevskii, Avdeenko, and Padalka: *Opt. Specktroskopiya* **6,** 528 (1959).
12. Potapov, E. V.: *Soviet Phys.—JETP* **20,** 307 (1965).
13. Fisher, E. I., I. Fugita, and G. L. Weissler: *J. Opt. Soc. Am.* **56,** 1560 (1966).
14. O'Bryan, H. M.: *J. Opt. Soc. Am.* **26,** 122 (1936).
15. Maurer, R. J.: *Phys. Rev.* **57,** 653 (1940).
16. Shkliarevskii, I. N., and R. G. Yarovaya: *Opt. Spectr. U.S.S.R.* **11,** 355 (1961).
17. Dix, F. E., and L. H. Rowse: *J. Opt. Soc. Am.* **14,** 306 (1927).
18. Hodgson, J. N.: *Proc. Phys. Soc.* (*London*), ser B, **67,** 260 (1954).
19. Lenham, A. P., and D. M. Treherne: *Proc. Phys. Soc.* **83,** 1059 (1964).
20. Jelinek, T. M., R. N. Hamm, E. T. Arakawa, and R. H. Huebner: *J. Opt. Soc. Am.* **36,** 185 (1966).
21. Drude, P.: *Ann. Physik* **39,** 481 (1890).
22. Ives, H. E., and N. B. Briggs: *J. Opt. Soc. Am.* **27,** 395 (1937).
23. Robin, S.: *Compt. Rend.* **236,** 674 (1953).
24. Wartenberg, H. V.: *Verhandl. Deut. Physik. Deut. Ges.* **12,** 105 (1910).
25. Yu, A. Y. C., T. M. Donovan, and W. E. Spicer: *Phys. Rev.* **167,** 670 (1968).
26. Clemens, K. H., and J. Jaumann:*Z. Physik* **173,** 135 (1963).
27. Kirillova, M. M., and B. A. Charikov: *Opt. Spectr. U.S.S.R.* **17,** 134 (1965).
28. Roberts, S.: *Phys. Rev.* **118,** 1509 (1960).
29. Otter, M.: *Z. Physik* **161,** 163 (1961).
30. Dold, B., and R. Mecke: *Optik* **22,** 435 (1965).
31. Weiss, K.: *Z. Naturforsch.* **3a,** 143 (1948).
32. Beattie, J. R., and G. K. T. Conn: *Phil. Mag.* **46,** 989 (1955).
33. Shkliarevskii, I. N., and V. G. Padalka: *Opt. Specktroskopiya* **6,** 78 (1959).
34. Schulz, L. G.: *J. Opt. Soc. Am.* **47,** 64 (1957).
35. Bor, J., and C. Bartholomew: *Proc. Phys. Soc.* (*London*) **90,** 1153 (1966).
36. Marton, L., and J. Toots: *Phys. Rev.* **160,** 602 (1967).
37. Sasaki, T.: *J. Phys. Soc. Japan* **18,** 701 (1963).
38. Canfield, L. R., G. Hass, and W. R. Hunter: *J. Phys.* **25,** 124 (1964).
39. Archer, R. J.: *Phys. Rev.* **110,** 354 (1958).
40. Avery, D. G., and P. L. Clegg: *Proc. Phys. Soc.* (*London*), ser. B, **66,** 512 (1953).
41. Philipp, H. R., and E. A. Taft: *Phys. Rev.* **113,** 1002 (1959).
42. Huldt, L., and T. Staflin: *Opt. Acta* **6,** 27 (1959).

43. Brattain, W. H., and H. B. Briggs: *Phys. Rev.* **75**, 1705 (1949).
44. Motulevich, G. P., and A. A. Shubin: *Soviet Phys.—JETP* **20**, 560 (1965).
45. Padalka, V. G., and I. N. Shklyarevskii: *Opt. Spectr. U.S.S.R.* **11**, 285 (1961).
46. Motulevich, G. P., and A. A. Shubin: *Soviet Phys.—JETP* **17**, 33 (1963).
47. Hass, G., G. F. Jacobus, and W. R. Hunter: *J. Opt. Soc. Am.* **57**, 758 (1967).
48. Barnes, B. T.: *J. Opt. Soc. Am.* **56**, 1546 (1966).
49. Forsterling, K., and V. Freedericksz: *Ann. Physik* **40**, 201 (1913).
50. Yolken, H. T., and J. Kruger: *J. Opt. Soc. Am.* **55**, 842 (1965).
51. Menzel, E., and J. Gebhart: *Z. Physik* **168**, 392 (1962).
52. Golovashkin, A. I.: *Soviet Phys. JETP* **21**, 548 (1965).
53. Priol, M., A. Daudé, and S. Robin: *Compt. Rend.* **264b** 935 (1967).
54. Nathanson, J. B.: *J. Opt. Soc. Am.* **20**, 594 (1930).
55. O'Brien, Brian: *Phys. Rev.* **27**, 93 (1926).
56. Juenker, D. W., L. J. LeBlanc, and C. R. Martin: *J. Opt. Soc. Am.* **58**, 164 (1968).
57. Summers, R. D.: *J. Opt. Soc. Am.* **24**, 262 (1934).
58. Kern, E.: *Z. Physik* **148**, 38 (1957).
59. Tool, A. Q.: *Phys. Rev.* **31**, 1 (1910).
60. Ingersoll, L. R.: *Astrophys. J.* **32**, 282 (1910).
61. Kirillova, M. M., and B. A. Charikov: *Phys. Metals Metallog.* (GB) **16**, 41 (1964).
62. Malé, D., and J. Trompette: *J. Phys. Radium* **18**, 128 (1957).
63. Jacobus, G. F., R. P. Madden, and L. R. Canfield: *J. Opt. Soc. Am.* **53**, 1084 (1963).
64. Meier, W.: *Ann. Physik* **31**, 1017 (1910).
65. Larson, D. T., and D. L. Cash: *J. Nucl. Mater.* **24**, 2232 (1967).
66. Sutherland, J. C., and L. T. Arakawa: *J. Opt. Soc. Am.* **58**, 1080 (1968).
67. Ives, H. E., and H. B. Briggs: *J. Opt. Soc. Am.* **26**, 238 (1936); **27**, 182 (1937).
68. Bolle, H. J.: *Z. Physik* **143**, 538 (1956).
69. Duncan, R. W.: *Phys. Rev.* **1**, 306 (1913).
70. Morgan, R.: *Phys. Rev.* **20**, 203 (1922).
71. Althoff, R., and J. H. Hertz: *Infrared Phys.* **7**, 11 (1967).
72. Lange, H.: *Z. Physik* **94**, 650 (1935).
73. Bolotin, G. A., and T. P. Chukina: *Opt. Spectr. U.S.S.R.* **23**, 333 (1967).
74. Hass, Schroeder, and Turner: *J. Opt. Soc. Am.* **46**, 31 (1956).
75. Tutihasi, S., and I. Chen: *Phys. Rev.* **158**, 623 (1967).
76. Koehler, Odencrantz, and White: *J. Opt. Soc. Am.* **49**, 109 (1959).
77. Sasaki, T., and K. Ishiguro: *Phys. Rev.* **127**, 1091 (1962).
78. Philipp, H. R., and E. A. Taft: *Phys. Rev.* **120**, 37 (1960).
79. Pulker, H., and E. Ritter: *Optik* **21**, 21 (1964).
80. Taft, E. A., and H. R. Phillip: *Phys. Rev.* **121**, 1100 (1961).
81. Huebner, R. H., E. T. Arakawa, R. A. MacRae, and R. N. Hamm: *J. Opt. Soc. Am.* **54**, 1434 (1964).
82. Minor, R. S.: *Ann. Physik* **10**, 581 (1903).
83. Philip, R., and J. Trompette: *Compt. Rend.* **241**, 627 (1955).
84. Canfield, L. R., and G. Hass: *J. Opt. Soc. Am.* **55**, 61 (1965).
85. Lindquist, R. E., and A. A. Ewald: *Phys. Rev.* **135**, A191 (1964).
86. Hass, G., and A. P. Bradford: *J. Opt. Soc. Am.* **47**, 125 (1957).
87. Bolotin, G. A., et al.: *Fiz. Metal. Metalloved.* **13**, 823 (1962).
88. Littleton, J. T.: *Phys. Rev.* **35**, 306 (1912).

TABLE 6g-2. PERCENT NORMAL-INCIDENCE REFLECTANCE OF FRESHLY EVAPORATED MIRROR COATINGS OF ALUMINUM, SILVER, GOLD, COPPER, RHODIUM, AND PLATINUM, FROM THE ULTRAVIOLET TO THE INFRARED*†

| λ, μm | Al | Ag | Au | Cu | Rh | Pt |
|---|---|---|---|---|---|---|
| 0.220 | 91.5 | 28.0 | 27.5 | 40.4 | 57.8 | 40.5 |
| 0.240 | 91.9 | 29.5 | 31.6 | 39.0 | 63.2 | 46.9 |
| 0.260 | 92.2 | 29.2 | 35.6 | 35.5 | 67.7 | 51.5 |
| 0.280 | 92.3 | 25.2 | 37.8 | 33.0 | 70.7 | 54.9 |
| 0.300 | 92.3 | 17.6 | 37.7 | 33.6 | 73.4 | 57.6 |
| 0.315 | 92.4 | 5.5 | 37.3 | 35.5 | 75.0 | 59.4 |
| 0.320 | 92.4 | 8.9 | 37.1 | 36.3 | 75.5 | 60.0 |
| 0.340 | 92.5 | 72.9 | 36.1 | 38.5 | 76.9 | 62.0 |
| 0.360 | 92.5 | 88.2 | 36.3 | 41.5 | 78.0 | 63.4 |
| 0.380 | 92.5 | 92.8 | 37.8 | 44.5 | 78.1 | 64.9 |
| 0.400 | 92.4 | 95.6 | 38.7 | 47.5 | 77.4 | 66.3 |
| 0.450 | 92.2 | 97.1 | 38.7 | 55.2 | 76.0 | 69.1 |
| 0.500 | 91.8 | 97.9 | 47.7 | 60.0 | 76.6 | 71.4 |
| 0.550 | 91.5 | 98.3 | 81.7 | 66.9 | 78.2 | 73.4 |
| 0.600 | 91.1 | 98.6 | 91.9 | 93.3 | 79.7 | 75.2 |
| 0.650 | 90.5 | 98.8 | 95.5 | 96.6 | 81.1 | 76.4 |
| 0.700 | 89.7 | 98.9 | 97.0 | 97.5 | 82.0 | 77.2 |
| 0.750 | 88.6 | 99.1 | 97.4 | 97.9 | 82.6 | 77.9 |
| 0.800 | 86.7 | 99.2 | 98.0 | 98.1 | 83.1 | 78.5 |
| 0.850 | 86.7 | 99.2 | 98.2 | 98.3 | 83.4 | 79.5 |
| 0.900 | 89.1 | 99.3 | 98.4 | 98.4 | 83.6 | 80.5 |
| 0.950 | 92.4 | 99.3 | 98.5 | 98.4 | 83.9 | 80.6 |
| 1.0 | 94.0 | 99.4 | 98.6 | 98.5 | 84.2 | 80.7 |
| 1.5 | 97.4 | 99.4 | 99.0 | 98.5 | 87.7 | 81.8 |
| 2.0 | 97.8 | 99.4 | 99.1 | 98.6 | 91.4 | 81.8 |
| 3.0 | 98.0 | 99.4 | 99.3 | 98.6 | 95.0 | 90.6 |
| 4.0 | 98.2 | 99.4 | 99.4 | 98.7 | 95.8 | 93.7 |
| 5.0 | 98.4 | 99.5 | 99.4 | 98.7 | 96.4 | 94.9 |
| 6.0 | 98.5 | 99.5 | 99.4 | 98.7 | 96.8 | 95.6 |
| 7.0 | 98.6 | 99.5 | 99.4 | 98.7 | 97.0 | 95.9 |
| 8.0 | 98.7 | 99.5 | 99.4 | 98.8 | 97.2 | 96.0 |
| 9.0 | 98.7 | 99.5 | 99.4 | 98.8 | 97.4 | 96.1 |
| 10.0 | 98.7 | 99.5 | 99.4 | 98.9 | 97.6 | 96.2 |
| 15.0 | 98.9 | 99.6 | 99.4 | 99.0 | 98.1 | 96.5 |
| 20.0 | 99.0 | 99.6 | 99.4 | | | |
| 30.0 | 99.2 | 99.6 | 99.4 | | | |

* The reflectance of a good evaporated mirror coating is always higher than that of a polished or electroplated surface of the same material.

† G. Hass, in R. Kingslake, ed., "Applied Optics and Optical Engineering," vol. III, pp. 309–330, Academic Press, Inc., New York, 1965.

TABLE 6g-3. PERCENT REFLECTANCE OF VARIOUS POLISHED METALS AT CLOSE TO NORMAL INCIDENCE

| Wave-length λ, μm | Au (1) | Be (2) | Cu (3) | Mo (8) | Ni | Pd (7) | Rh (8) | Ag | Ta (8) |
|---|---|---|---|---|---|---|---|---|---|
| 0.25 | .... | 56 | 25.9 | .... | 47.5 (2) | .... | .... | 25 (6) | |
| 0.30 | .... | 50 | 25.3 | .... | 41.5 (2) | .... | .... | 13 (6) | |
| 0.35 | .... | .... | 27.5 | .... | 45.0 (2) | .... | .... | 68 (6) | |
| 0.40 | 36.0 | 48 | 30.0 | 44.0 | 53.3 (2) | .... | .... | 87.5 (6) | |
| 0.50 | 41.5 | 46 | 43.7 | 45.5 | 59.7 (1) | .... | 76 | 95.2 (6) | 38.0 |
| 0.60 | 87.0 | .... | 71.8 | 47.6 | 64.5 (1) | .... | .... | ....... | 45.0 |
| 0.70 | 93.0 | .... | 83.1 | 49.8 | 67.6 (1) | .... | 79 | 96.1 (3) | 56.0 |
| 0.80 | .... | 50 | 88.6 | 52.3 | ....... | .... | 81 | 96.2 (3) | 64.5 |
| 1.0 | .... | 54.5 | 90.1 | 58.2 | 74.1 (4) | 74.8 | 84 | 96.4 (3) | 78.5 |
| 2.0 | .... | .... | 95.5 | 81.6 | 84.4 (4) | .... | 91 | 97.3 (3) | 90.5 |
| 4.0 | .... | .... | 97.3 | 90.5 | ....... | 88.1 | 92.5 | 97.7 (3) | 93.0 |
| 6.0 | .... | .... | 98.0 | 93.0 | ....... | .... | 93.5 | 98.0 (3) | 93.2 |
| 8.0 | .... | .... | 98.3 | 93.7 | 96.0 (5) | 94.7 | 94 | 98.7 (3) | 93.8 |
| 10.0 | .... | .... | 98.4 | 94.5 | ....... | 96.5 | 95 | 98.9 (3) | 94.5 |
| 12.0 | .... | .... | 98.4 | 95.2 | ....... | 96.5 | .... | 98.9 (3) | 95.0 |

| Wave-length λ, μm | Al (7) | Sb (8) | Cd (7) | Cr (8) | Fe (8) | Ir (7) | Co (7) | Mg (8) | W (9) |
|---|---|---|---|---|---|---|---|---|---|
| 0.6 | .... | 53 | .... | 55.5 | 57.5 | .... | .... | .... | 53.1 |
| 1.0 | 73.3 | 55 | 71.0 | 57.0 | 65.0 | 79.4 | 67.5 | 74.0 | 57.6 |
| 2.0 | 82.0 | 60 | .... | 63.0 | 78.0 | .... | .... | 77.0 | 90.0 |
| 3.0 | 88.3 | 65 | 93 | 70.0 | 84.5 | 91.4 | 76.7 | 80.5 | 94.3 |
| 4.0 | 91.4 | 68 | .... | 76.0 | 89.5 | 93.3 | 80.7 | 83.5 | 94.8 |
| 5.0 | 93.7 | ... | 95.9 | 81.0 | 91.5 | 94.0 | 86.0 | 86.0 | 95.3 |
| 6.0 | .... | 70 | .... | 85.0 | 93.0 | 94.5 | .... | 88.0 | 95.8 |
| 7.0 | 95.0 | ... | .... | .... | 94.0 | 94.7 | 93.0 | 91.0 | |
| 8.0 | 96.9 | ... | 97.2 | 89.0 | 94.0 | 94.8 | 95.8 | 93.0 | |
| 9.0 | .... | 72 | 98.0 | 92.0 | 94.0 | 95.5 | 96.4 | 93.0 | |
| 10.0 | 97.0 | ... | 98.0 | 93.0 | .... | 95.8 | 96.8 | | |
| 12.0 | 97.3 | ... | 98.2 | .... | .... | 96.1 | 96.6 | | |

Numbers in parentheses refer to the references which follow.

**References for Table 6g-3**


1. Tool, A. Q.: *Phys. Rev.* **31,** 1 (1910).
2. Coblentz, W. W., and R. Stair: *Natl. Bur. Standards J. Research* **2,** 343 (1929).
3. Hagen, E., and H. Rubens: *Ann. Physik* **8,** 16 (1902), and **11,** 873 (1903).
4. Ingersoll, L. R.: *Astrophys. J.* **32,** 282 (1910).
5. Hagen, E., and H. Rubens: *Berliner Sitzber.* 491 (1909).
6. Minor, R. S.: *Ann. Physik* **10,** 581 (1903).
7. Coblentz, W. W.: *Natl. Bur. Standards Bull.* **2,** 457 (1906).
8. Coblentz, W. W.: *Natl. Bur. Standards Bull.* **7,** 198 (1911).
9. Coblentz, W. W., and W. B. Emerson: *Natl. Bur. Standards Bull.* **14,** 306 (1918–1919).

TABLE 6g-4. CALCULATED REFLECTANCE AND TRANSMITTANCE OF AL FILMS ON TRANSPARENT SUBSTRATES OF $n = 1.5$ FOR VARIOUS WAVELENGTHS AS A FUNCTION OF FILM THICKNESS

(Calculated values agree with directly measured ones for film thicknesses $t > 80$ Å; back surface antireflected)*

| Film thickness, angstroms | Wavelength, nm | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 220 | | 300 | | 400 | | 546 | | 650 | |
| | R % | T % | R % | T % | R % | T % | R % | T % | R % | T % |
| 40 | 14 | 82 | 19 | 74 | 25 | 65 | 33 | 51 | 38 | 42 |
| 80 | 33 | 60 | 43 | 47 | 52 | 36 | 60 | 24 | 63 | 18 |
| 120 | 52 | 40 | 62 | 27 | 70 | 19 | 74 | 12 | 75 | 9 |
| 160 | 67 | 25 | 74 | 16 | 79 | 11 | 81 | 7 | 82 | 5 |
| 200 | 76.3 | 15.2 | 81.5 | 9.1 | 84.9 | 5.9 | 85.6 | 3.5 | 85.4 | 2.6 |
| 240 | 82.4 | 9.1 | 86.0 | 5.1 | 88.1 | 3.3 | 88.1 | 2.0 | 87.5 | 1.4 |
| 280 | 86.2 | 5.4 | 88.4 | 3.1 | 90.0 | 1.9 | 89.5 | 1.1 | 88.8 | 0.8 |
| 320 | 88.5 | 3.2 | 90.0 | 1.8 | 91.1 | 1.1 | 90.4 | 0.5 | 89.6 | 0.4 |
| 360 | 89.8 | 1.9 | 90.9 | 1.0 | 91.7 | 0.6 | 90.9 | 0.4 | 90.0 | 0.3 |
| 400 | 90.6 | 1.1 | 91.4 | 0.5 | 92.1 | 0.4 | 91.2 | 0.2 | 90.3 | 0.2 |
| 500 | 91.5 | 0.3 | 92.0 | 0.1 | 92.5 | <0.1 | 91.5 | <0.1 | 90.6 | <0.1 |

* From measurements by G. Hass and J. E. Waylonis; for similar tables of other metals see H. Mayer "Physik Duenner Schichten," vol. I, Wissenschaftliche Verlagsgesellschaft, Stuttgart, 1950.

TABLE 6g-5. THICKNESS OF AL FILMS FOR WHICH THE TRANSMITTANCE IS 0.5 PERCENT AT VARIOUS WAVELENGTHS

| *Wavelength, angstroms* | *Film thickness, angstroms* |
|---|---|
| 5,460 | 320 |
| 3,000 | 390 |
| 2,200 | 450 |
| 1,216 | 700 |
| 735 | ~7,000 |
| 585 | ~12,000 |

TABLE 6g-6. THE EXTREME ULTRAVIOLET REFLECTANCE OF EVAPORATED PLATINUM AND RHODIUM IN THE WAVELENGTH REGION FROM 585 TO 2,000 Å*

(Both film materials show very little aging during exposure to air)

| λ, angstroms | | 584 | 735 | 900 | 1,000 | 1,105 | 1,216 | 1,360 | 1,486 | 1,606 | 2,000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| R % | Pt | 20.9 | 12.9 | 16.1 | 17.5 | 20.6 | 23.0 | 24.3 | 25.7 | 26.0 | 30.0 |
| | Rh | 20.9 | 13.5 | 12.5 | 11.0 | 9.5 | 9.2 | 12.5 | 24.8 | 35.0 | 49.0 |

* G. Hass and R. Tousey, *J. Opt. Soc. Am.* **49**, 593 (1959).

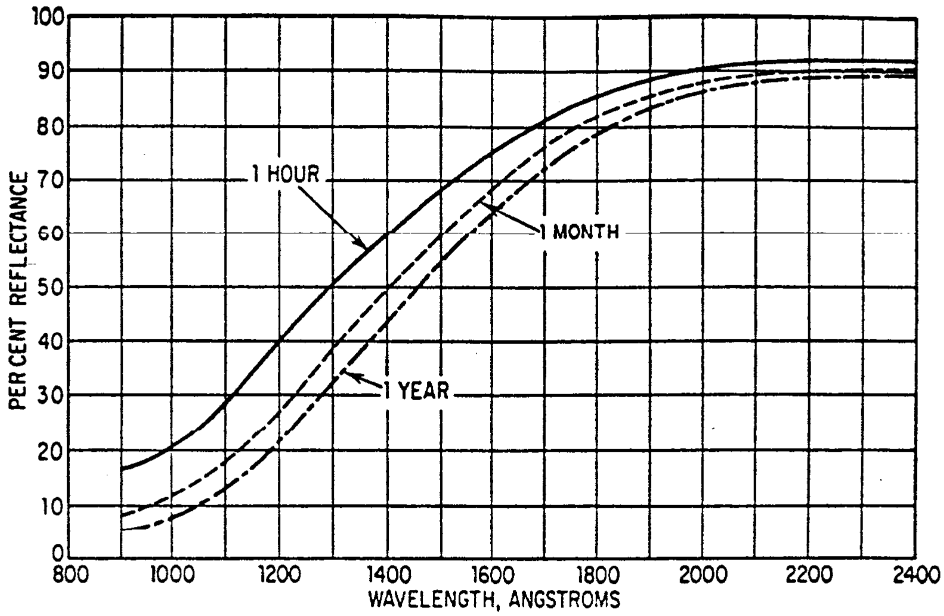



FIG. 6g-1. Extreme ultraviolet reflectance of best-quality aluminum films after 1 hour, 1 month, and 1 year exposure to air; wavelength region 900 to 2,400 Å. [*From G. Hass and R. Tousey, J. Opt. Soc. Am.* **49**, 593 (1959).]