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COMPILATION OF EXPERIMENTAL WORK
ON
THERMAL EMITTANCES OF MATERIALS

Part II — Non-Metals

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FOREWORD

This report is Part II of a series of three reports which consists of compilations of experimental work on thermal emittances of materials published in the literature through 1972. The three separate parts of the report are: Part I - Metals, Part II - Non-Metals, and Part III- Alloys.

All three reports categorize thermal emittances of materials covered as to whether the reported experimental work is on: a. hemispherical total emittance, b. normal total emittance, c. angular total emittance, d. hemispherical spectral emittance, e. normal spectral emittance, or f. angular spectral emittance.

Experimental results reported are tabulated chronologically and appear under the following headings: investigator and year of publication, temperature and wavelength over which work was done, sample specification including composition, preparation method, etc., the experimental method, and error boundaries.

The reported thermal emittance values are not included in the compilations for several reasons. First, the observed variation of thermal emittance with changes in temperatures and wavelengths (for spectral emittances) prevents the simple reporting of a single number in many cases. Second, the difference in surface finish, roughness, contamination and experimental conditions for the same material give rise to different thermal emittance. Finally, by going to the original articles, the user can judge which thermal emittance value is best for his use.

Because of the sheer volume of data to be reviewed in a work of this magnitude, the authors may have overlooked a number of reported results. We would appreciate hearing about any omissions and solicit any other reader comments which would make the reports more useful in a subsequent revision.

Dorab N. Baria and Renato G. Bautista

ABSTRACT

A compilation of the experimental work on thermal emittances of non-metals reported in the literature through 1972 are presented along with a brief review of the various experimental methods available for thermal emittance determinations.

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INTRODUCTION

The purpose of this tabulation is to make available information on the thermal emittances of materials classified as metals, nonmetals and alloys.

Thermal emittance of a substance is defined as the ratio of the heat flux radiated by a substance to that radiated by a perfect radiator or a blackbody at the same temperature. Emittance can be either spectral or total depending on whether the radiation is measured over a narrow band of wavelength or over the entire electromagnetic spectrum. Emittance is also classified as angular (directional) or hemispherical depending whether the radiation being emitted is measured at a given angle (direction) from the normal or over the entire hemisphere above it. The normal emittance is a special case of the angular emittance where the emitted radiation is measured normal to the surface.

The term emissivity is defined to mean the emittance of a substance whose surfaces are free from contamination, ideally smooth and optically polished. The emissivity of a substance is independent of the nature of the surface or surface contamination. Emittance of a substance depends on the surface conditions and contamination along with temperature of the surface and wavelength of radiation. Emissivity represents the lowest value emittance can have, since any surface contamination or surface roughness will increase the

emittance. The emittance values are reported in these tables since the surfaces of the substances are not optically polished.

The thermal emittances for each substance are classified under the following headings:

- (a) Hemispherical Total Emittance (ϵ_{ht}) - ratio of the heat flux emitted by a material over all the wavelengths of radiation over a hemisphere above the surface of the material, to that emitted by a perfect blackbody radiator at the same temperature and conditions.
- (b) Normal Total Emittance (ϵ_{nt}) - ratio of the heat flux emitted by a material over all the wavelengths of radiation in a direction normal to the surface, to that emitted by a perfect blackbody radiator at the same temperature and conditions.
- (c) Angular Total Emittance ($\epsilon_{\theta t}$) - ratio of the heat flux emitted by a material over all the wavelengths of radiation at an angle θ from the normal to the surface, to that emitted by a perfect blackbody radiator at the same temperature and conditions.
- (d) Hemispherical Spectral Emittance ($\epsilon_{h\lambda}$) - ratio of the heat flux emitted by a material over a narrow wavelength band λ and $\lambda + d\lambda$, over a hemisphere surrounding it, to that emitted by a perfect blackbody radiator at the same temperature and conditions.

- (e) Normal Spectral Emittance ($\epsilon_{n\lambda}$) - ratio of the heat flux emitted by a material over a narrow wavelength band λ and $\lambda + d\lambda$ in a direction normal to the surface, to that emitted by a perfect blackbody radiator at the same temperature and conditions.
- (f) Angular Spectral Emittance ($\epsilon_{\theta\lambda}$) - ratio of the heat flux emitted by a material over a narrow wavelength band λ and $\lambda + d\lambda$ at an angle θ from the normal to the surface, to that emitted by a perfect blackbody radiator at the same temperature and conditions.

The references in addition to the published journals also include government reports, etc. The literature was searched thoroughly up to 1972. The books by Touloukian and DeWitt (1970, 1972) and Wood, Deem and Lucks (1962) were also used to aid in the literature search. The references are tabulated chronologically, with the following subheadings: investigator and year of publication; temperature and wavelength range over which work was done; sample specification including composition, preparation method, etc.; and the experimental method used in the investigation and the error bounds.

The tabulation was performed on an IBM 360 computing system with the aid of the "TABLES" program available at Iowa State University. This program was modified by Benedict, Baria and Bautista (1974) to print phrases and sentences

together with numbers instead of numbers and a few words.

For most engineering purposes dealing with heat transfer problems, the hemispherical total emittance of the material under consideration is needed to calculate the radiant heat flux. In cases where it is not available, the hemispherical total emittance can be estimated from the thermal emittance available. The hemispherical spectral or hemispherical total emittance can be calculated from the angular spectral or angular total emittance using equation 1 or 2 respectively if they are known as a function of direction.

$$\epsilon_{h\lambda} = \frac{\int_0^{\pi/2} \epsilon_{\theta\lambda} 2\pi \sin \theta \cos \theta d\theta}{\int_0^{\pi/2} 2\pi \sin \theta \cos \theta d\theta} \quad (1)$$

$$\epsilon_{ht} = \frac{\int_0^{\pi/2} \epsilon_{\theta t} 2\pi \sin \theta \cos \theta d\theta}{\int_0^{\pi/2} 2\pi \sin \theta \cos \theta d\theta} \quad (2)$$

where $\epsilon_{h\lambda}$ = hemispherical spectral emittance

$\epsilon_{\theta\lambda}$ = angular spectral emittance

ϵ_{ht} = hemispherical total emittance

$\epsilon_{\theta t}$ = angular total emittance

θ = angle of emission measured from the normal to the surface

The hemispherical total emittance can also be calculated if the hemispherical spectral emittance is known as a function

of the wavelength.

$$\epsilon_{ht} = \frac{\int_0^{\infty} \epsilon_{h\lambda} \epsilon_{bh\lambda} d\lambda}{\sigma T^4} \quad (3)$$

$$\text{where } \epsilon_{bh\lambda} = \frac{C_1}{\lambda^5 [\exp(C_2/\lambda T) - 1]}$$

C_1 = Planck's first radiation constant = 3.740×10^{-12} watt cm^2

C_2 = Planck's second radiation constant = $1.4387 \text{ cm } ^\circ\text{K}$

λ = wavelength, cms

σ = Stefan-Boltzmann constant = 5.6693 watt/cm^2

T = temperature, $^\circ\text{K}$

Equation 3 is strictly valid for the hemispherical case, but it can also be used to calculate the normal total emittance if the normal spectral emittance is known as a function of the wavelength.

The hemispherical spectral emittance can be obtained directly from the normal spectral emittance by making use of Figure 1, which is a graph of the ratio of hemispherical to normal spectral emissivity plotted against the normal spectral emissivity. This graph is obtained from theoretical calculations making use of the electromagnetic theory of radiation, for optically polished surfaces. The plot for di-

Fig. 1. Ratio of hemispherical to normal spectral emissivity as a function of the normal spectral emissivity. The emissivities of metals ($k = n$) and insulators ($k = 0$) are calculated from the electromagnetic theory. (Siegel, Howell, 1972)

electrics or nonmetals is obtained by taking the extinction coefficient k as zero, for metals by assuming that the refractive index of the metal n is equal to its extinction coefficient. An empirical plot obtained by Jakob (1949) for metals is also shown in the figure. The term emissivity is used to indicate it is a theoretically calculated value.

A brief review of the different experimental methods available for determining emittances is presented.

MEASUREMENT OF EMITTANCE

The methods by which emittances can be determined fall into three main groups:

1. Reflectance methods
2. Calorimetric methods
3. Blackbody comparison methods

Each of the above main methods has its advantages and disadvantages which should be considered when selecting a particular method. It is not possible to describe all the methods in detail here, but a few general principles important to each method will be outlined. The reflectance method is an indirect method of measuring emittance, because it determines the reflectance of the surface from which the emittance can be calculated. The calorimetric and the radiometric methods are direct methods since they both determine emittance by measuring radiant heat flux. The calorimetric method measures the radiant flux in terms of the heat lost or gained by the sample, whereas the radiometric method measures the radiant flux directly by radiometric techniques. Love (1968), Eckert and Goldstein (1970), Touloukian and DeWitt (1970) and DeWitt and Richmond (1972) have also reviewed some of the methods for the measurement of emittances.

A. Reflectance Methods

Reflectance is defined as the fraction of radiant energy, incident on the surface, which is reflected. By Kirchhoff's law, for an opaque surface, the monochromatic directional spectral emittance is given by

$$\epsilon_{\theta\lambda} = 1 - \rho_{\theta\lambda} \quad (4)$$

where $\epsilon_{\theta\lambda}$ = directional spectral emittance

$\rho_{\theta\lambda}$ = directional spectral reflectance

The reflectance methods can be classified, according to the techniques involved, into (1) heated cavity reflectometers, (2) integrating sphere reflectometers, (3) integrating mirror reflectometers, (4) goniometric reflectometers and (5) specular reflectometers.

1. Heated-Cavity Reflectometer

The heated-cavity reflectometer was developed by Gier, Dunkle and Bevans (1954), and is shown in Figure 2. It consists of a heated hohlraum or cavity, a water-cooled sample and an optical system. The hohlraum is a cylindrical nickel cavity designed to approach an ideal blackbody enclosure. The water cooled sample holder is placed through an opening at the top of the cavity in such a way that the sample is flush with the interior cavity wall. The top of the cavity is inclined at an angle of 7° from the horizontal. The

Fig. 2. Cross-section of the heated cavity (hohlraum) reflectometer. (Gier, Dunkle, Bevans, 1954)

cavity is insulated on the outside by insulating materials like rock wool. The cavity can be heated to 1000°K by heating coils on all sides. The optical system consists of mirrors which focuses the energy from the cavity onto the entrance slits of a monochromator.

The sample, in the form of a disc, is held in place by the water-cooled sample holder. The sample is diffusely radiated by the hohlraum. The radiant energy reflected from the sample can be viewed through the viewing port. The sample holder can be positioned at any angle, such that the sample surface is at an angle with the normal to the surface. Angles usually used are between 5° and 25° . The reflectance is calculated by taking the ratio of the radiant flux measured by the monochromator viewing on the sample surface to that obtained by viewing on the cavity wall. The reflectance obtained by this method is actually the directional hemispherical reflectance.

The errors involved in this method have been discussed by Gier, Dunkle and Bevans (1954), Dunkle (1960), Hembach, Hemmerdinger and Katz (1963) and Streed, McKellar, Rolling and Smith (1963). The errors introduced are due to emission from the sample itself because of the higher temperature of the sample compared to that of the cavity, the temperature difference between the reference area of the cavity and the rest of the cavity, and the non-homogeneous field of view in

case of diffuse samples. Hembach, Hemmerdinger and Katz (1963) have modified the heated cavity reflectometer to correct for the errors inherent in the original design.

2. Integrating Sphere Reflectometer

Integrating sphere reflectometers have been more widely used than any other type of reflectometer. The basic instrument is shown in Figure 3. It consists of a hollow sphere with three openings. The interior of the sphere is coated with a thick layer of a material which has a diffuse and highly reflective characteristic like MgO .

The integrating sphere reflectometer can be operated in two modes, the direct or the indirect mode. In the direct mode, the sample surface, which is placed at one opening of the sphere, is irradiated by an incident beam of energy from an external source through another opening. The incident beam is reflected by the sample on to the sphere wall where it undergoes multiple diffuse reflection. The interior of the sphere has a uniform radiation density and a uniform brightness results over the inside surface of the sphere. This uniform brightness is viewed through the third opening by means of a monochromator detector system. A similar reading is then taken with a standard substance of known reflectance replacing the sample under study, under the same conditions. The directional-hemispherical reflectance is

Fig. 3. Schematic diagram of the Integrating Sphere Reflectometer (a) direct mode (b) indirect mode.

calculated as the ratio of the sample reading to the standard reading times the reflectance of the standard substance.

In the indirect mode, the incident energy beam is first directed on the inner sphere wall and the sample is irradiated uniformly over the hemisphere. The sample reflectance is measured by comparing the detector output for viewing the sample directly with that for a standard substance of known reflectance. The reflectance obtained is the directional hemispherical reflectance.

The wavelengths over which the integrating sphere reflectometer can be used depends on the reflectance characteristics of the coating material inside the sphere. Most common coatings used are magnesium oxide, magnesium carbonate and barium sulfate. They are assumed to reflect light according to Lambert's Cosine Law.

The reflectance standard commonly used is a piece of white vitrolite glass that has been calibrated against freshly smoked magnesium oxide. Another common standard is a slate of magnesium carbonate. The reflectances of both magnesium oxide and magnesium carbonate are greater than 0.95 and for most engineering purposes could be taken as unity in the visible and infrared region.

The errors involved in the integrating sphere reflectometer are:

- (1) The losses from the openings of the sphere which can

be minimized by keeping the ratio of the total area of the openings in the sphere to the area of the sphere walls to a minimum.

- (2) The degradation of the interior of the sphere and deviation of the coating from a perfect diffuse reflector, which can be reduced by proper choice of coating material although the coatings are never absolutely diffuse.
- (3) The direct impingement of radiant energy reflected by the sample surface onto the detector and the sphere wall viewed by the detector which can be reduced by having a suitable shield placed inside the sphere.

For well designed spheres, the errors should not exceed 2-3%.

Edwards, Gier, Nelson and Roddick (1961) modified the integrating sphere to measure directional reflectance from 0° to 80° from the normal. The specimen was located at the center of the hemisphere and the sphere wall coated with magnesium oxide. Magnesium oxide coating was used on the wall as the reflectance standard and this was achieved by translation and rotation of the sample such that the incident beam missed the sample and was incident on the wall.

Work has recently been done at the National Bureau of Standards using a laser-source integrating sphere reflectometer to measure directional-hemispherical

reflectance up to 2500°K (Kneissl, Richmond, Wiebelt, 1967; Kneissl, Richmond, 1968).

3. Integrating Mirror Reflectometers

In the integrating mirror reflectometers, the sphere of the integrating sphere reflectometer is replaced by an integrating mirror. The advantage of the mirror over the sphere is that the mirrors have a higher reflectance in the infrared than the spheres. The disadvantage is that it is usually impossible to get a parallel beam of energy of small cross section which has been reflected by the sample onto the mirror. This would require a detector with a larger surface area or one that is equally responsive to radiation coming from different directions. There are three kinds of integrating mirror reflectometers classified according to the shape of the mirrors: hemispherical, paraboloidal and ellipsoidal.

(a) Coblentz Hemispherical Mirror Reflectometer

This has been the oldest reflectometer used and was developed by Coblentz (1913). A schematic diagram of the reflectometer is shown in Figure 4. If a point source of light is placed near the center of a hemispherical mirror, then a small image of the point source is focused on a second point in the same plane at the same distance from the center diametrically opposite the first point (Brandenburg, 1964).

Fig. 4. Schematic diagram of the Coblentz hemispherical mirror reflectometer.

The two points are called conjugate focal points. The sample is placed at one of the conjugate focal points of the hemispherical mirror and the detector at the other focal point. A beam of incident radiation, from a small opening in the hemispherical mirror, is made incident on the sample surface. This is reflected from the sample surface onto the hemispherical mirror and is then focused on the detector. The detector is calibrated with a specimen of known reflectance or it is positioned in place of the sample to measure the incident energy directly.

The errors involved are due to the energy loss due to the openings in the hemisphere and the aberration of the mirror which causes the reflected energy to miss the detector. The errors are minimized by having the aperture as small as possible and using as a standard a material having similar reflectance function as the sample.

The Coblentz's reflectometer was modified by Janssen and Torborg (1963) by placing a diffuser in place of the detector at the second conjugate focal point. A beam of radiant energy is made incident on the diffuser and the diffuse reflection is focused on the sample by the hemispherical mirror. The specimen is viewed by the detector through a hole in the mirror. This modification permitted heating of the sample, which was not possible in the Coblentz's reflectometer, since the detector was too close to the

sample. The aberration errors and other inaccuracies of the previous system are still present in this modification.

Birkebak and Hartnett (1958) enlarged the hemisphere into nearly three-fourths of a sphere which permitted the sample and the detector to be rotated so that reflectance measurements at different angles of viewing could be obtained.

(b) Paraboloidal Mirror Reflectometers

The paraboloidal mirror reflectometer was first proposed by Dunkle and Gier (1955). The basic principle is the same as that for hemispherical mirror reflectometers. A schematic diagram of the paraboloidal reflectometer is shown in Figure 5. A collimated beam of radiant energy is passed between two paraboloid mirrors and strikes a plane mirror placed diagonally which reflects the beam vertically on the upper paraboloidal mirror which focuses it on the sample located at the focal point of that mirror. All the radiation reflected from the sample is reflected to the lower paraboloidal mirror which reflects it to the detector positioned at the focal point of the lower mirror. The movable plane mirror permits the angle of incidence on the sample to be changed. A standard substance with known reflectance is needed to calculate the reflectance of the sample. Neher and Edwards (1965) modified this method by using off-axis paraboloids. This method is subject to the same errors as the Coblentz

Fig. 5. Schematic diagram of the paraboloidal mirror reflectometer. (Dunkle, Gier, 1955)

reflectometer.

(c) Ellipsoidal Mirror Reflectometers

The advantage the ellipsoidal mirror reflectometer has over the hemispherical mirror reflectometer is that aberrations in the optical system are reduced because the ellipsoid has two distinct focal points. The sample is placed at one focal point and the detector at the other. The sample is irradiated by means of a monochromatic beam of radiation through a hole in the mirror. It is reflected onto the ellipsoidal mirror which focuses it on the detector at the other focal point. A comparison with a sample of known reflectance is needed to calculate the reflectance. Except for nearly eliminating the error due to aberration, the other errors inherent in the mirror reflectometers are present.

McMahon and Wilder (1963, 1968), Wilson (1965), Neu (1968) and Heinisch, Bradac and Perlick (1970) have constructed ellipsoidal mirror reflectometers to measure reflectances.

4. Goniometric Reflectometers

A goniometric reflectometer is used to measure the bidirectional reflectances as a function of incidence angles. Elaborate reflectometers have been built to measure the bidirectional reflectance over the entire hemisphere for any angle of incidence and the angle of incidence can be varied

from the normal direction to near grazing angles.

Brandenberg and Neu (1966), and Miller and Vunkannon (1967) have described reflectometers for uni- and bidirectional reflectances respectively.

5. Specular Reflectometers

The specular reflectometers make use of multiple reflection technique by using high quality mirrors. This is a very precise and highly accurate method to determine reflectance. The method was first developed by Strong (1938) and later refined by Bennett and Koehler (1960). It compares the intensity of a monochromatic beam of light which undergoes multiple reflection between reference mirrors and the sample mirror surface and that which undergoes multiple reflection between the reference mirrors. This method is used mainly to determine the reflectance of thin films or vacuum deposited mirrors.

B. Calorimetric Methods

In the calorimetric method, the emittance is measured from the heat lost or gained by a material under investigation by means of radiation heat transfer. This method yields the hemispherical total emittance. The sample is placed in an enclosure under vacuum or an inert atmosphere, such that

the major source of heat transfer is radiation. The rate of heat transferred by radiation can be evaluated either by means of power input or output to or from the material, or by means of the rate of change of temperature of the sample. The calorimetric methods can be classified into: (1) steady state methods and (2) transient methods.

1. Steady State Methods

In the steady state methods, the rate of heat lost by the specimen through radiation to its surroundings is equated to the power or heat input to the specimen. The steady state methods differ in the method of heat input to the specimen and the manner in which the enclosure walls are cooled and maintained at a constant temperature.

(a) Hot Filament Method

It consists of heating a filament, rod or tube of the specimen in vacuum by passing an electric current through it. This is shown in Figure 6. The specimen, of uniform cross-section, is placed in an evacuated enclosure, which is blackened from the inside and maintained at a constant temperature by cooling it with water. Potential taps are welded on the specimen filament, rod or tube at a known distance from the center of the specimen and a fine wire thermocouple welded midway between the two taps. The specimen is heated by passing an electric current through it. The power input

Fig. 6. Apparatus for measurement of hemispherical total emittance by steady state calorimetric hot filament method. (Richmond, 1960)

is held constant while the sample comes to thermal equilibrium with its surroundings. It is assumed that there are no temperature gradients near the center of the sample.

If the heat lost by the sample due to conduction through the ends of the specimen, thermocouple leads and potential taps and that lost due to convection and conduction through the atmosphere surrounding the sample is neglected, the heat balance can then be written as

$$Vi + A \alpha_{ht} \sigma T_e^4 = A \epsilon_{ht} \sigma T_s^4 \quad (5)$$

where V = the potential drop between the two taps across the midsection

i = the current flowing through the filament

A = surface area of the midsection of the filament

α_{ht} = hemispherical total absorptance of the filament

ϵ_{ht} = hemispherical total emittance of the filament

T_e = temperature of the enclosure

T_s = temperature of midsection of filament

σ = Stefan-Boltzmann constant

The heat input consists of the heat gained by the specimen due to resistance heating and the radiant energy absorbed by the specimen from the enclosure. The heat lost by the sample is due to radiation. If the temperature of the sample is equal to the temperature of the enclosure, then according to Kirchhoff's law $\alpha_{ht} = \epsilon_{ht}$. The hemispherical

total emittance changes very slightly with temperature, and when the temperature of the specimen is very much greater than the temperature of the enclosure, the entire term containing T_e becomes negligible. If in an actual case $\alpha_{ht} = 2 \epsilon_{ht}$ then an error of less than 10% is involved when $\alpha_{ht} = \epsilon_{ht}$ is assumed in Eq. 5. The hemispherical total emittance can then be written as

$$\epsilon_{ht} = \frac{V_i}{A \sigma (T_s^4 - T_e^4)} \quad (6)$$

Abbott, Alvares and Parker (1961) modified the above equation to include the correction when the absorptance to emittance ratio is not unity as assumed above.

$$\epsilon_{ht} = \frac{V_i}{A T \left[T_s^4 - (T_s/T_e)^{\frac{1}{4}} T_e^4 \right]} \quad (7)$$

Howl and Davis (1962) corrected for the temperature distribution along the length of the tube and for the temperature drop across the wall of the tube. Jain and Goel (1968) have also proposed a method to correct for the temperature distribution along the sample rod.

Taylor, Davis, Powell and Kimbrough (1969) solved the following second order non-linear differential equation which governs the steady state heat flow in an electrically heated wire using iterative techniques

$$k \frac{d^2 T}{dx^2} + V_i - A \epsilon_{ht} \sigma_s (T^4 - T_e^4) - \mu \frac{dT}{dx} = 0 \quad (8)$$

where k = the thermal conductivity of the sample

μ = the Thomson coefficient

T = the sample temperature at any point at location x
on the filament

A common variation of the hot filament method for dielectrics is to wrap the specimen, in the form of a thin foil, around a cylindrical heating element or have the specimen in the form of a sheet in good contact with the heating element (Drummeter, Goldstein, 1960).

The useful temperature range for the hot filament method can be as low as 270°K using liquid nitrogen to cool the enclosure walls (Nyland, 1963), and as high a temperature as can be attained by resistance heating. Measurements have been made as high as 3000°K by this method. At lower temperatures, where liquid nitrogen is used, conduction losses can become significant and precautions should be taken to reduce them. There is a considerable loss in accuracy due to the instability of the thermocouples at very high temperatures.

(b) Cryogenic Methods

For emittance measurements below 270°K the enclosure walls are cooled by liquid nitrogen or liquid helium. The heat input to the specimen is usually electrical (Caren,

1963; Fulk, Reynolds, Park, 1960; Zimmermann, 1955). In most cryogenic methods, the rate of heat transfer is measured by equating the rate of boil-off of the liquid nitrogen or liquid helium from the enclosure wall to the heat radiated from the specimen.

Figure 7 shows a helium cooled chamber used by Haury (1963) for determining the hemispherical total emittance between 20 to 300°K from the net heat transfer rate between two parallel plates at different temperatures. The lower sample is heated electrically to maintain it at 290°K and the upper sample is cooled by liquid nitrogen to about 80°K. The net heat transfer rate is measured by the boil-off of the liquid nitrogen from the Dewar and is measured by means of a wet gas meter. The emittance is computed from the equation

$$q = \sigma \frac{\epsilon_{ht}}{2 - \epsilon_{ht}} A (T_h^4 - T_c^4) \quad (9)$$

where T_h = the temperature of the hot sample

T_c = the temperature of the cold sample

A = the area of the cold sample

q = measured heat transfer rate

The factor $\epsilon_{ht} / (2 - \epsilon_{ht})$ arises from the geometrical view factor between infinite plates.

Fig. 7. Apparatus for measurement of hemispherical total emittance by a cryogenic steady state calorimetric method. (Haury, 1963)

(c) Other Methods

Peletskii and Druzhinin (1970) used electron beam heating of the sample to determine hemispherical total emittance of refractory metals at high temperatures. The specimen, placed in the center of a vacuum chamber, is heated by means of an electron beam which is accelerated by an electric field of controllable magnitude. At steady state, this energy is dissipated by radiation from the surface of the specimen. The hemispherical total emittance is given as

$$\epsilon_{ht} = \frac{V_e i_e}{\sigma A (T_s^4 - T_e^4)} \quad (10)$$

where V_e = the accelerating potential

i_e = the emission current

T_s = temperature of specimen

T_e = temperature of enclosure

A = surface area of specimen

Wittenberg (1965) heated the sample by surrounding the heating element on all four sides by the specimen. The specimen and the heating element are placed in an enclosure filled with liquid nitrogen. The heat transfer rate is measured by the rate of liquid nitrogen boil-off. The specimen is heated by means of radiation from the heating element.

The over-all accuracy of the different steady state calorimetric methods depends on the method of heating the specimen, cooling the enclosure walls and measurement of temperature of the specimen. The error usually is in the range of 2-5%.

2. Transient or Temperature Decay Methods

In the transient methods, the hemispherical total emittance is computed by equating the heat lost during cooling of the specimen to the rate of heat transferred by radiation of the specimen to its surroundings. The specimen is suspended by means of a very thin wire, usually the thermocouple lead wire itself, in the center of an evacuated enclosure which is blackened from the inside. The walls of the enclosure are kept at a constant temperature by cooling with either water or liquid nitrogen. A thermocouple is welded on the specimen to monitor its temperature. The specimen is heated, in a variety of ways, to a temperature above that of the walls. The power input is then turned off and the specimen is allowed to cool by radiating its heat to the surroundings. The rate of cooling of the specimen is measured.

The rate of heat lost by cooling of the specimen is equated to the net rate of heat transferred by the specimen radiating to its surroundings. The heat balance can be written as

$$MC_p \frac{dT_s}{dt} = A \epsilon_{ht} \sigma T_s^4 - A \alpha_{ht} \sigma T_e^4 \quad (11)$$

where M = mass of the specimen

C = specific heat of specimen

A = total surface area of specimen

T_s = temperature of specimen at any instant of time t

T_e = temperature of enclosure

ϵ_{ht} = hemispherical total emittance of specimen

α_{ht} = hemispherical total absorptance of specimen

dT_s/dt = rate of cooling of specimen

Since the enclosure walls are totally black, it is assumed that they absorb all the radiation they receive from the specimen. By Kirchhoff's law, $\alpha_{ht} = \epsilon_{ht}$ for the specimen. The hemispherical total emittance is then given by

$$\epsilon_{ht} = \frac{MC_p \frac{dT_s}{dt}}{\sigma A (T_s^4 - T_e^4)} \quad (12)$$

Rudkin, Parker and Jenkins (1962) have neglected the temperature T_e of the enclosure for the case where $T_s \gg T_e$, and obtained the hemispherical total emittance from the more precise equation

$$\epsilon_{ht} = \frac{3MC_p}{A\sigma} \frac{t_f - t_i}{(1/T_{sf}^3 - 1/T_{si}^3)} \quad (13)$$

where the subscripts f and i are for final and initial conditions. By plotting T_s^{-3} versus t , the slope at any temperature is a measure of the hemispherical total emittance if the specific heat of the material is known.

Narasimhamurty, Iyer and Hoch (1965) also used a similar approach, and obtained the expression for C_p/ϵ_{ht} in terms of the first and second linear thermal expansion coefficients.

The transient methods differ in the method of heating the specimen. The different methods are: (1) resistance heating of the wire specimen by passing an electric current (Rudkin, Parker, Jenkins, 1962); (2) radiation from a carbon arc source (Butler, Inn, 1960); (3) radiation from an arc imaging furnace (Butler, Jenkins, 1963); (4) radiation from a solar simulator (Thaler, Finn, Treado, Nakhleh, 1964); (5) induction heating (Narasimhamurty, Iyer, Hoch, 1965) (6) internal heating coil (Cairns, 1960); and (7) constant heater pads (Schleiger, 1967).

For measurements at temperatures above 270°K, a water cooled enclosure is used, whereas for temperatures below 270°K the enclosure walls are cooled either by liquid nitrogen or liquid helium. Figure 8 shows a water cooled appara-

Fig. 8. Apparatus for measurement of hemispherical total emittance by transient calorimetric method at high temperatures. (Butler, Inn, 1960)

tus used by Butler and Inn (1960) for measurements at temperatures up to 1300°K. The specimen is heated through a quartz window by means of a high intensity carbon arc image furnace. Figure 9 illustrates the liquid nitrogen cooled apparatus used by Butler and Jenkins (1963) for emittance measurements up to 190°K. The specimen is heated by radiation through a quartz window from a carbon image furnace.

Cezairliyan et. al. (Cezairliyan, 1960; Cezairliyan, Morse, Berman, Beckett, 1970) have described a high speed (millisecond resolution) method for measurement of hemispherical total emittance. The specimen, in the form of a wire, is heated by means of an electric power pulsing circuit and the temperature measurements are made by high speed measuring techniques, consisting of a single pulse of direct current of a millisecond duration and associated high speed measuring circuits. Schleiger (1967) measured the emittance of transparent materials like sodium chloride crystals and quartz from 75°K to 312°K. The sample is heated by heater pads, which are removed once the required temperature is reached and the sample is allowed to cool in a liquid helium cooled enclosure.

Fig. 9. Cross-section of the apparatus for measurement of hemispherical total emittance by transient calorimetric methods at cryogenic temperatures. (Butler, Jenkins, 1963)

C. Blackbody Comparison or Radiometric Methods

In this method, the emittance of a material is determined by comparing the radiation emitted by it to that emitted by a blackbody at the same temperature. The emittance measured by the blackbody comparison method is either hemispherical or directional depending on whether an optical pyrometer or a monochromator is used, and can either be spectral or total depending on the kind of detector used. When the detector used is confined to a narrow wavelength band, the emittance measured is spectral. If the detector has essentially the same response over all the wavelengths, the total emittance is measured.

When a monochromator or a total radiation detector is used to compare the radiation intensities emitted by the specimen and the blackbody at the same temperatures, the directional spectral or total emittance can be calculated by the following relation

$$\epsilon_{\theta\lambda} \text{ or } \epsilon_{\theta t} = \frac{R_s}{R_b} \quad (14)$$

where $\epsilon_{\theta t}$ = directional total emittance

$\epsilon_{\theta\lambda}$ = directional spectral emittance

R_s = response of monochromator or detector when
sighted on specimen

R_b = response of monochromator or detector when

sighted on blackbody

The optical pyrometer is often used to determine the normal spectral emittance of a specimen. The blackbody and the apparent or brightness temperatures are measured by the pyrometer. The normal spectral emittance is calculated from the Wien's equation

$$\epsilon_{h\lambda} = \frac{C_2}{\lambda} \exp \left[\frac{1}{T} - \frac{1}{T_a} \right] \quad (15)$$

where $\epsilon_{h\lambda}$ = normal spectral emittance

C_2 = Planck's second radiation constant

λ = wavelength of radiation

T = true temperature of surface °K

T_a = apparent temperature of surface °K

The blackbody comparison methods are classified according to whether the blackbody is an integral blackbody cavity whose walls are part of the sample or a separate blackbody maintained at the same temperature as the sample. The integral blackbody cavity method is usually preferred when working at higher temperatures, since temperature measurement and control is difficult especially at very short wavelengths, where extremely close temperature control is required. It is also preferred in cases where the sample is heated in vacuum and viewed through a window in the enclosure. The transmittance through the window may change due to fogging of

the window from the inside caused by condensation of the vaporized specimen. Fogging of the window causes a serious error in the measurements, but may be partly compensated for if the specimen surface and the blackbody is viewed through the same window. The separate blackbody technique is usually accurate below 1800°K where the temperature measurement and control is by means of thermocouples.

The problem of fogging of the viewing window is critical in cases where the material has a very high vapor pressure at the temperature under consideration. Fogging can be avoided by heating the specimen in an inert gas atmosphere such as argon, nitrogen or helium. This inert atmosphere is also very useful in cases where the specimen undergoes chemical decomposition at very low pressures. Riethof, Acchione and Branyan (1962) studied the emittance of tantalum carbide in an inert atmosphere of argon since the carbide loses carbon under vacuum at high temperatures.

1. Separate Blackbody Comparison Method

This method has been used by Maki, Stair and Johnston (1960), Guazzoni (1972), Richmond, Harrison and Shorten (1963), Fussel and Stair (1965) and others to determine normal spectral emittance. The most important aspect in this method is the design of the blackbody such that it approximates a perfect blackbody emitter. The blackbody furnace used by Maki, Stair and Johnston (1960) is shown in Figure 10. The blackbody cavity is constructed of chromel alloy. It is heated by a coil of electric heaters around the cavity. The low reflectance of this alloy together with the fact that the blackbody opening is only 0.3% of the total surface area, resulted in a blackbody of extremely high emittance (0.999 and above). The specimen consists of a metal strip which is clamped at both ends by two water cooled electrodes. It is heated by passage of electric current. The blackbody and the specimen are mounted side by side on an optical bench, so that they can be placed alternately at the focal point of the optical system. This ensures essentially equal optical paths and the use of identical optics for both the sample and the blackbody viewing. The temperatures of the blackbody and the specimen are kept essentially the same. A single beam monochromator measures the normal radiation intensity of the blackbody and the specimen for a given wavelength. The normal spectral emittance is determined by

Fig. 10. Cross-section of a separate type blackbody furnace. (Maki, Stair, Johnston, 1960)

taking the ratio of the readings for the sample to blackbody radiation.

Richmond, Harrison and Shorten (1963) used a double beam ratio recording spectrometer as the detecting device with the laboratory blackbody furnace and the heated specimen as the respective two sources for the two beams. This gives the emittance readings directly when the optical paths of the two beams are equal and the optics for both beams are similar. Since this is not so in most cases, a correction was made using a second reference blackbody furnace identical to the first comparison furnace.

2. Integral Blackbody Comparison Method

One of the simplest and most widely used methods to construct an integral blackbody cavity is to form a small cylindrical hole in the specimen. Weber (1941) indicates that the blackness of this cavity is greater than 99 percent for a depth to diameter ratio of 7.0 for a material of emittance 0.5. This method is used when the specimen is of sufficient thickness to drill a hole of that depth to diameter ratio. Mendenhall (1911) proposed an open-V wedge formed by bending a metal strip and the wedge cavity is assumed to behave as a blackbody. Worthing (1940) described a method for obtaining an integral blackbody hole by drilling a hole in the wall of a thin walled tube of the specimen under

study. DeVos (1954) studied this hole-in-tube method and analyzed the blackbody radiation of the hole in the side of the tube. Price (1947) used a thin slit in the thin walled cylinder of the specimen studied, as the source of blackbody radiation.

The specimen, if it is in the form of a hollow tube, can be heated by passing a current through it (DeVos, 1954), or if in the form of a solid disc or cylinder (Stretz, Bautista, 1972) can be heated by induction heating or by means of a furnace (Blau, Jasperse, 1964).

The integral blackbody apparatus used by Stretz and Bautista (1972) is shown in Figure 11. The specimen is contained in a tantalum crucible, which has a center post with a blackbody hole drilled in it. The crucible and its contents are heated in an evacuated glass enclosure by means of a high frequency induction furnace. The crucible is supported on a tantalum support. It is viewed from the top by means of an optical recording pyrometer through a quartz window. Two glass shutters are provided to protect the quartz window from fogging caused by sample vaporization at high temperatures. At thermal equilibrium, the optical pyrometer is focused first on the blackbody hole and then on the specimen surface with the shutters open. By this method Stretz and Bautista (1972) measured the normal spectral emittances for rare earth metals in the solid and liquid states.

Fig. 11. Cross-section of the apparatus for the measurement of normal spectral emittance by an integral blackbody radiometric method.

(Stretz, Bautista, 1972)

If a total radiation detector is used (Groll, Neuer, 1970; Abbott, 1963) which has the same response over all the wavelengths, the total normal emittance can be determined by taking the ratio of the radiation received from the specimen to the radiation received from the blackbody. Another method to determine total normal emittance is for the sample to be a gray body emitter. A gray body emitter has essentially the same spectral shape as a blackbody for the total energy radiated versus wavelength plot, but different in magnitude. The emittance of a gray body is constant for all the wavelengths since the ratio of the two ordinates of that plot is constant for all wavelengths. By using a monochromator, the normal total emittance can therefore be determined for a gray body. This method was used by Limperis, Szeles and Wolfe (1963) to determine normal total emittance of stainless steel and carbon steel.

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Carbon

Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Wilson, Spitzer (1969)	2450-3400	National Carbon Co., high purity L1135P and Grade 60 porous carbon, mechanically polished, oxidized in air	Calculated from hemi- spherical spectral data
Gupta, Prasad, Tyagi (1970)	1100-1350	Carbon arc electrode, 8 mm diameter, also Cu-coated carbon electrode	Steady state calorimetric method, 10 ⁻⁵ mm Hg vacuum

Carbon

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Barnes, Forsythe, Adams (1947)	373-773	Rough plated, graphitized, also rough lampblack deposit	Separate blackbody comparison method
Plunkett, Kingery (1960)	1180-2072	National Carbon Co. GA carbon, smooth and rough surfaces	Calculated from spec- tral data, 3×10^{-5} - 5×10^{-4} mm Hg vacuum

Carbon
Hemispherical Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Wilson (1965a)	2080-3186	0.56-0.716	National Carbon Co., L1135P carbon, high purity spectro- scopic grade, mechanically polished, oxidized in air	Reflectance method, double ellipsoidal mirror reflectometer
Wilson (1965b)	2120-3230	0.37-0.72	High purity carbon, mechanically polished, oxidized in air	Reflectance method, double ellipsoidal mirror reflectometer
Wilson, Spitzer (1968)	2350-3400	0.4-2.4	National Carbon Co., porous high purity L1135P and Grade 60 carbon, mechanically polished, oxidized in air	Reflectance method, double ellipsoidal mirror reflectometer
Wilson, Spitzer (1969)	2200-3450	0.4-3.2	National Carbon Co., high purity L1135P and Grade 60 porous carbon, mechanically polished, oxidized in air	Reflectance method, double ellipsoidal mirror reflectometer

Carbon
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Mendenhall, Forsythe (1913)	1273-2273	0.658	Carbon strip	Integral V-wedge blackbody comparison method, measured in vacuum; 3%
Chaney, Hamister, Glass (1935)	1800-2400	0.66	Carbon lamp filament	Integral blackbody comparison method
Thorn, Simpson (1953)	1313-2034	0.653	Carbon, polished, heated at 1800°K for 3 hrs	Integral blackbody hole comparison method, 5×10^{-6} mm Hg vacuum
Anacker, Mannkopff (1959)	3925	0.4-0.6	Carbon electrode	Separate blackbody comparison method
Plunkett, Kingery (1960)	1183-2073	0.665	Natural Carbon Co., G.A. carbon, smooth surface	3×10^{-5} - 5×10^{-4} mm Hg vacuum
Plunkett, Kingery (1960)	298	0.4-0.7	G.A. carbon, smooth and rough surface	3×10^{-5} - 5×10^{-4} mm Hg vacuum

Carbon

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Gupta, Prasad, Tyagi (1970)	1100-1250	0.55-0.65	Carbon arc electrode, 8 mm diameter	Integral blackbody hole comparison method, 10^{-5} mm Hg vacuum
Liebert, Hibbard (1970)	300-670	0.35-14.0	Soot from smoky flame deposited on polished Al and polished NaCl substrates, soot layer 0.03-2.0 microns thick	Transmittance meas- urements on NaCl substrate, separate blackbody comparison method for Al sub- strate; 5%

Carbon
Angular Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Null, Lozier (1963a)	1230-1250	0.4305-0.60	National Carbon Co., L1135P carbon, polished and rough surfaces; Angle 45°	Reflectance method, double ellipsoidal mirror reflectometer measured in argon
Null, Lozier (1963b)	3800	0.4305-0.60	National Carbon Co., L1135P carbon; Angle 45°	Reflectance method, double ellipsoidal mirror reflectometer measured in argon

Carbon (Graphite)
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Rusin, Orchinnikov (1967)	1000-2500	PPG graphite tube	Steady state calorimetric method; 10%
Khrustalev, Rakov (1968)	1173-2073	Graphite	
Wilson, Spitzer (1969)	2300-3450	AGKSP, ATJ graphites, pyrolytic graphite (a- and c-planes) mechanically polished, oxidized in air	Calulated from hemispherical spectral data
Chekhovskoi, Petrov, Petrova, Lyukshin (1970)	1200-2300	Pyrographite, deposited on graphite tube from methane at 2373°K, polished surface parallel to a-plane and c-plane, also unpolished surface	Steady state calorimetric method, 6 x 10 ⁻⁴ mm Hg vacuum; ≤9%
Petrov, Petrova, Chekhoskoi, Sheindlin (1970)	1100-2500	Pyrolytic carbon tube, surfaces parallel to a-plane and c-plane	Steady state calorimetric method, 6 x 10 ⁻⁴ mm Hg vacuum; ≤9%

Carbon (Graphite)
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Michaud (1954)	1273-1473	Graphite	Integral blackbody hole comparison method,
Ill. Inst. Tech (1956)	77	GBE, GBH, Speer 3474D, Speer 7087	
Olson, Morris (1958)	75-1075	GBE, GBH, Speer 3474D, Speer 7087	Separate blackbody comparison method, measured in air
Brenden, Newkirk (1959)	1696-2271	Spectroscopic grade graphite rod	Integral blackbody hole comparison method, 10 ⁻³ mm Hg vacuum
Grenis, Levitt (1959)	1873-3172	AGX, Speer 580, graphite rods, machined surfaces	Integral blackbody hole comparison method, for temp. <2273°K meas- ured in vacuum, for temp. >2273°K measured in argon (460 mm Hg)
Blau, Chaffee, Jasperse, Martin (1960)	1026-1856	Speer 7100 graphite, highly rough surface	Measured in argon- hydrogen mixture

Carbon (Graphite)
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Fieldhouse, Lang, Blau (1960)	1015-1860	ATJ graphite	Measured in 90% argon, 10% hydrogen mixture at 780 mm Hg; 5%
Plunkett, Kingery (1960)		AUC graphite, polished	Calc. from spectral data, measured in 3×10^{-5} - 5×10^{-4} mm Hg vacuum
Engelke, Pears (1962)	819-1608	Carbon char, sandpaper polish	Measured in nitrogen
Grenis, Levitt (1962)	1873-3172	AGX, H1LM, H3LM, Speer 580 and Speer 7100 graphite rod samples, machined surfaces, also polished surfaces	Integral blackbody hole comparison method, for temp. <2273°K measured in vacuum, for temp. >2273°K measured in argon
Pears (1962b)	711-2700	(a) ATJ graphite, smooth finish (b) Electrode graphite, sandpapered surface	Separate blackbody comparison method (a) measured in dry helium (b) dry nitrogen purge

Carbon (Graphite)
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Kibler, Lyon, Linevsky, DeSantis (1963)	1587-2737	Pyrolytic graphite, polished, c and a-b planes	Calc. from spectral data, 5×10^{-6} mmHg vacuum
Kibler, Lyon, Linevsky, DeSantis (1964)	1409-2735	Pyrolytic graphite, c and a-b crystal planes	Calc. from spectral data, 10^{-6} mm Hg vacuum
Petrov, Reznik (1972a)	900-1200	R.V. Graphite	Separate blackbody comparison method; 1%

Carbon (Graphite)
Angular Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Fieldhouse, Lang, Blau (1960)	1043-1633	ATJ graphite; Angle 30-60°	Measured in 90% argon, 10% hydrogen atm. (780 mm Hg); 5%
Blau, Chaffee, Jasperse, Martin (1960)	1050	Speer 7100 graphite, highly rough surface; Angle 0-60°	Measured in argon- hydrogen mixture

Carbon (Graphite)
Hemispherical Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Wilson (1965a)	2061-2953	0.56-0.716	AGKSP graphite, high purity spectroscopic grade, mechanically polished, oxidized in air	Reflectance method, double ellipsoidal mirror reflectometer
Wilson (1965b)	2100-3700	0.37-0.72	Spectroscopic grade graphite, mechanically polished, oxidized in air	Reflectance method, double ellipsoidal mirror reflectometer
Wilson, Spitzer (1968)	2200-2900	0.4-2.4	ATJ, AGKSP graphite, pyrolytic graphite, polished a- and c-planes, mechanically polished, oxidized in air	Reflectance method, double ellipsoidal mirror reflectometer
Wilson, Spitzer (1969)	2200-3450	0.4-3.2	ATJ, AGKSP graphite, pyrolytic graphite (a- and c-plane) mechanically polished, oxidized in air	Reflectance method, double ellipsoidal mirror reflectometer

Carbon (Graphite)
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Prescott, Hincke (1928)	1525-2260	0.66	Acheson graphite	Integral blackbody hole comparison method
Thorn, Simpson (1953)	1309-2030	0.653	High purity graphite, polished	Integral blackbody hole comparison method, 5×10^{-6} mm Hg vacuum; 1.15%
Betz, Olson, Schurin, Morris (1957)	1091-1922	0.665	GBE, GBH, Speer 3474D, Speer 7087 graphite, as recd.	Integral blackbody hole comparison method, 5×10^{-4} mm Hg mm vacuum
Blau, Chaffee, Jasperse, Martin (1960)	1105-1420	2.05-13.98	Pure graphite	Separate blackbody comparison method, measured in 90% argon, 10% hydrogen mixture
Brenden, Newkirk (1959)	1228-2168	0.65	Spectroscopic grade graphite	Integral blackbody hole comparison method, 10^{-3} mm Hg vacuum

Carbon (Graphite)
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Grenis, Levitt (1959)	1289-3191	0.65	AGX, Speer 580 graphite rods, machined and also polished surfaces	Integral blackbody comparison method, for temp. <2273°K measured in vacuum, for temp. >2273°K measured in argon (760 mm Hg)
Plunkett, Kingery (1960)	298	0.4-0.7	Pyrolytic graphite, rough and machined and polished surfaces	Integral blackbody hole comparison method, 3×10^{-5} - 5×10^{-4} mm Hg vacuum
Plunkett, Kingery (1960)	1149-2072	0.665	AUC graphite, polished, one sample oxidized in air	Integral blackbody hole comparison method, 3×10^{-5} - 5×10^{-4} mm Hg vacuum

Carbon (Graphite)
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Grenis, Levitt (1962)	1273-3273	0.65	AGX, H1LM, H3LM, Speer 580, Speer 7100 graphite rods, machined, also polished surfaces	Integral blackbody hole comparison method, for temp. <2273°K measured in vacuum, for temp. >2273°K measured in argon (780 mm Hg)
Pears (1962b)	2311-2617	0.69	ATJ graphite, ground to smooth finish	Separate blackbody comparison method, measured in dry helium or argon
Kibler, Lyon, Linevsky, DeSantis (1963)	1409-2054	0.4-5.6	Pyrolytic graphite, polished, c-plane	5 x 10 ⁻⁶ mm Hg vacuum
Kibler, Lyon, Linevsky, DeSantis (1964)	1611-2404	0.389-5.09	Pyrolytic graphite, a-b and c-planes, polished	Integral blackbody hole comparison method, measured in argon

Carbon (Graphite)
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Senkara (1965)	1273-2273	0.65	Graphite, four types	Radiometric comparison with temp. measured with a Pt thermoelement
Autio, Scala (1966)	1117-1447	1.5-13.0	(a) Ultra pure UF-4-S grade graphite, ground on 180 grit paper (b) Pyrolytic graphite vapor deposited at 2473°K on a plate, (a-and c-plane) mechanically polished	Separate blackbody cavity comparison method, measured in hydrogen atm.; 4%
Rusin, Orchinnikov (1967)	1000-2500	0.665	PPG graphite tube	Integral blackbody hole comparison method; 20%
Yamada (1967)	1273-1873	0.63-5.5	Speer 866 graphite	Integral blackbody hole comparison method, measured in argon

Carbon (Graphite)
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Chang, Sutton (1968)	2400-2700	0.3-10.5	Ablating phenolic graphite, milled and polished	Compared spectral radiance with calc. values obtained from Planck's radiation law
Schurer (1968)	3775-3865	0.28-1.692	AGKSP, SPK, U1, U2, RW0 RWI, RWII graphites, also lampblack and coke samples used. Measurements taken on burning arc and also on cold electrodes	Reflectance method, integrating sphere reflectometer
Barykin, Romanov, Spiridonov (1969a)	1423-3073	0.55	Pyrographite, vacuum deposited on graphite at 1873-2473°K, measured perpendicular to c-axis	Reflectance method
Barykin, Romanov, Spiridonov (1969b)	1400-3000	0.546	Silicized graphite	Integral blackbody hole comparison method

Carbon (Graphite)
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Barykin, Romanov, Spiridonov (1969b)	1400-3000	3.0-11.0	Silicized graphite	Integral blackbody hole comparison method
Spiridonov, Barykin, Abramov (1969)	1300-2300	0.546	Natural graphite, pyro- graphite, polycrystalline graphite	Reflectance method
Spiridonov, Barykin, Abramov (1969)	1300-2300	3.0-11.0	Natural graphite, pyro- graphite, polycrystalline graphite	Reflectance method
Chekhovskoi, Petrov, Petrova, Lyukshin (1970)	1200-2000	0.65	Pyrographite, deposited on graphite tube from methane at 2373°K, polished surface	Integral blackbody hole-in-tube comparison method, 6 x 10 ⁻⁴ mm Hg vacuum; ≤13%

Carbon (Graphite)
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Petrov, Petrova, Chekhovskoi, Sheindlin (1970)	1200-2200	0.65	Pyrolytic carbon tube	Integral blackbody hole-in-tube comparison method, 6 x 10 ⁻⁴ mm Hg vacuum; ≤13%

Carbon (Graphite)
Angular Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Null, Lozier (1963a)	1180-1220	0.435-0.608	AGKSP graphite, polished; Angle 45°	Reflectance method, double ellipsoidal mirror reflectometer measured in argon
Null, Lozier (1963b)	3800	0.4305-0.60	AGKSP graphite; Angle 45°	Reflectance method, double ellipsoidal mirror reflectometer measured in argon

Aluminum Oxide Al_2O_3
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Frenkel (1957)	1273-1873	W wire coated with Al_2O_3	Steady state calorimetric method, measured in vacuum
Wade (1959)	589-1366	Al_2O_3 flame sprayed coating	Calculated from direc- tional total emittances
Haury, Rutner (1967)	79-238	Al_2O_3	Steady state cryogenic calorimetric method, 10^{-7} mm Hg vacuum

Aluminum Oxide Al_2O_3

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Sully, Brandes, Waterhouse (1952)	673-1073	Spectrographically pure alumina, also alumina coating	Separate blackbody comparison method
Michaud (1954)	1273-1873	Norton RA 98, 360, 84, Al 90, 1194S, P, ADE, etc., cylindrical samples	Integral blackbody hole comparison method, measured in air
Kingery, Norton (1955)	973-1683	Dense alumina cylinder	Measured in vacuum
Pattison (1955)	1213-1751	Sintered alumina	Integral blackbody hole comparison method, 1%
Olson, Morris (1959)	68.7-73.2 and 336-1780	Norton LA alumina and Norton RA 4213 alumina	Measured in air
Wade (1959)	589-1366	Al_2O_3 flame sprayed coating	Separate blackbody comparison method

Aluminum Oxide Al_2O_3

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Blair (1960)	675-1930	Frenchtown and Coors alumina, ground, surface polished with 1-5 microns diamond polishing compound	Integral blackbody hole comparison method, measured in vacuum; 10%
Childers, Cerceo (1961)	875-1408	Polycrystalline alumina, clean	10^{-5} mm Hg vacuum
Gannon, Linder (1964)	958-1158	Alumina, cold pressed and sintered at 1973°K, porosity 9-30%, surface roughness < and > 20 microinches	Separate blackbody comparison method
Laszlo, Gannon, Sheehan (1964)	1563-1573	Pure alumina	Radiometric method using solar furnace
Clark, Moore (1965)	1200	(a) coarse grained, 79.5% Al_2O_3 (b) fine grained 96% Al_2O_3 (c) fine grained 99+% Al_2O_3 cylinders, smooth surfaces	Calculated from spectral data, measured in air
Grenis, Levitt (1965)	1300	98.55% Al_2O_3 flame sprayed coating (12-15 mils thick), rough and polished surfaces	Calculated from spectral data, 3-5 x 10^{-2} mm Hg vacuum

Aluminum Oxide Al_2O_3
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Zhorov, Kovalev, Sivakova (1966)	1000-2200	98.5% Al_2O_3 coating, 130-300 microns thick, sprayed on Mo rod	Blackbody comparison method, 10^{-4} - 10^{-5} mm Hg vacuum
Sacadura (1971)	1331-1713	Alcor, 99.5% Al_2O_3	Calculated from spectral data

Aluminum Oxide Al_2O_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Michaud (1954)	1273-1873	0.655	RA 98, 360, 84, AI 90, etc.	Integral blackbody hole comparison method; 10%
Olson, Morris (1959)	1050-1773	0.665	Norton LA603 and RA4213 alumina	Integral blackbody hole comparison method, measured in air
Blair (1960)	773-1953	0.64 and 1.0	Frenchtown alumina 4402 and Coors alumina AD99, ground to size, polished surface	Radiometric method, with thermocouple used for actual temp. measurement, measured in vacuum; 10%
Blau, March, Martin, Jasperse, Chaffee (1960)	873-1373	1.0-14.0	Coors alumina AD85, AD99 (99% Al_2O_3) and Norton A402 TWA No. 2 (98.56% Al_2O_3)	Measured in air; 4%
Noguchi, Kozuka (1960)	2322	0.65	99.8% α - Al_2O_3 , dry pressed	Reflectance method, using solar furnace

Aluminum Oxide Al_2O_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Blau, Jasperse (1964)	1303-1323	0.92-14.0	Coors AD 85, 99 and Norton TWA No. 2, ultrasonically machined	Separate blackbody comparison method, measured in air; ≤4%
Slemp, Wade (1962)	823	1.01-14.9	Norton 5190 alumina	Separate blackbody comparison method
Folweiler (1964)	813-1591	1.0-14.0	Coors AD995, 99, 96, 94, 85; McDanel AP 35, AV 30	0.5%
Schatz, Counts, Burks (1964)	373-1273	1.0-15.0	99.9% pure Al_2O_3 , sintered for 2 hrs at 2023°K	Reflectance method, heated cavity reflectometer
Clark (1965)	1400	2.0-14.0	No details given	Separate blackbody comparison method, heated in air
Clark, Moore (1965)	1200	1.0-15.0	(a) Coarse grained >95% Al_2O_3 (b) fine grained 96% Al_2O_3 (c) fine grained 99+% Al_2O_3 , cylinders with smooth surface	Separate blackbody comparison method, measured in air

Aluminum Oxide Al_2O_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Grenis, Levitt (1965)	1300	1.0-10.0	98.55% Al_2O_3 flame sprayed coating (12-15 mils thick), rough and polished surfaces	Integral V-wedge blackbody comparison method, $3-5 \times 10^{-2}$ m Hg vacuum
Schatz, Alvarez, Counts, Hoppke (1965)	1273	1.0-15.0	Al_2O_3 , sintered for 1 hr at 1273°K	Reflectance method, heated cavity reflectometer
Clarke, Moore (1966)	1200-1600	1.0-15.0	Polycrystalline alumina (>99% pure) cylinder, smooth surface, sintered at 1865°K for 27 hrs, 30% porosity	Separate blackbody comparison method
Lewis, Wade, Slomp, Progr (1966)	1255	1.0-14.5	Pure Al_2O_3 slab	
Richmond (1966)	298	1.0-15.0	AD-5 alumina (a) polished (b) grit blasted	
Schatz (1966a)	1273	1.0-15.0	Al_2O_3 , cold pressed, sintered at 2123°K for 2 hrs	Reflectance method, heated cavity reflectometer

Aluminum Oxide Al_2O_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Shcherbina (1967)	2300	0.65	Pure Al_2O_3	Reflectance method; 3%
Abramov, Barykin, Romanov, Spiridonov (1969a)	1000-2200	0.436 and 0.546	Pure Al_2O_3	Reflectance method
Sacadura (1971)	1331-1713	1.0-15.0	Alcor, 99.5% Al_2O_3	Integral blackbody hole comparison method

Aluminum Oxide (Sapphire)
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Wittenberg (1965)	204-374	Linde sapphire, polished flat (a) c-axis parallel to surface normal (b) c-axis perpendicu- lar to surface normal	Steady state calorimetric method, 10 ⁻⁷ mm Hg vacuum; 3%

Aluminum Oxide (Sapphire)

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1223	Sintered at 2023°K for two hours	Calculated from spectral data
Stierwalt (1966b)	4.2-473	0.79 mm thick, sapphire	Calculated from spectral data

Aluminum Oxide (Sapphire)

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1273	1.0-15.0	Sintered at 2023°K for 2 hrs	Reflectance method, integrating sphere reflectometer
Stierwalt (1966a)	203.0	16.0-44.0	Sapphire crystal, 0.79 mm thick	Separate blackbody comparison method, measured in air
Stierwalt (1966b)	4.2-200	3.97-43.2	Sapphire crystal, 0.79 mm thick	Separate blackbody comparison method measured in air

Beryllium Oxide BeO

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Siefert (1948)	1200-2150	Powdered BeO, hot pressed, ground parallel and polished, heat treated in air and vacuum	Steady state calorimetric method, 10 ⁻⁶ mm Hg vacuum; 20%
Olson, Morris (1959)	548-589	BeO	Measured in air
Pears (1962a)	1171-2210	BeO, pressed and sintered	Separate blackbody cavity comparison method, measured in argon; 10%
Schatz, Goldberg, Pearson, Burks (1963)	1023	BeO, sintered at 1973°K for two hours	Calculated from spectral data

Beryllium Oxide BeO
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Burgess, Waltenberg (1915)	1743	0.65	BeO, smooth surface	Radiometric compar- ison with Pt as reference, measured in air
Siefert (1948)	1200-1900	0.665	Powdered BeO (a) hot pressed (b) cold pressed, ground and polished	Radiometric compar- ison with Pt as reference; 10%
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	BeO, sintered	Reflectance method, integrating sphere reflectometer
Foweler (1964)	812-1587	1.0-14.0	Coors BD 98, Coors BD 96 beryllia	

Cadmium Oxide CdO
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz, Alvarez, Counts, Hoppke (1955)	1273	1.0-15.0	CdO (a) sintered for 2 hrs at 1273°K (b) heated at 1273°K for 0.5 hr, 1 hr, 2 hrs, 4 hrs	Reflectance method, heated cavity reflectometer

Cerium Oxide CeO_2
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Sully, Brandes, Waterhouse (1952)	673-1073	Pure CeO_2 , thick coating, applied to Nimonic 75 strip	Separate blackbody comparison method
Pears (1962a)	1128-2255	CeO_2 , pressed and sintered	Separate blackbody comparison method, measured in argon; 10%

Cerium Oxide CeO_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Uzan (1952)	1750	0.665	White and yellow CeO_2	

Chromium Oxide Cr_2O_3

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schatz, McCandless (1962)	1273	99.5% Cr_2O_3 , 1.3 mm thick plate, sintered at 2123°K for two hours	Calculated from spectral data
Schatz, Goldberg, Pearson, Burks (1963)	1023	Cr_2O_3 , sintered at 2173°K for two hours	Calculated from spectral data
Schatz, Counts, Burks (1964)	873-1273	99.5% Cr_2O_3 , sintered at 2173°K for two hours	Calculated from spectral data
Grenis, Levitt (1965)	1300	92.94% Cr_2O_3 , flame sprayed coating (12-15 mils thick), polished and rough surfaces	Calculated from spectral data, 3-5 x 10 ⁻² mm Hg vacuum

Chromium Oxide Cr_2O_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Burgess, Waltenberg (1915)	1703	0.65	Cr_2O_3 , smooth surface	Radiometric comparison method with Pt reference, measured in air
Schatz, McCandless (1962)	1273	1.0-15.0	99.5% Cr_2O_3 , 1.3 mm thick plate, sintered for 2 hrs at 2123°K	Reflectance method, heated cavity reflectometer
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	Cr_2O_3 , sintered at 2173°K for 2 hrs	Reflectance method, heated cavity reflectometer
Schatz, Counts, Burks (1964)	878-1273	1.0-15.0	99.5% Cr_2O_3 , sintered for 2 hrs at 2173°K	Reflectance method, heated cavity reflectometer
Grenis, Levitt (1965)	1300	1.0-10.0	82.9% Cr_2O_3 flame sprayed coating (12-15 mils thick), rough and polished surfaces	Integral blackbody V-wedge comparison method, 3 - 5 x 10 ⁻² mm Hg vacuum

Chromium Oxide Cr_2O_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz, Alvarez, Counts, Hoppke (1965)	1273	1.0-15.0	Cr_2O_3 , sintered for 15 hrs at 1273°K	Reflectance method, heated cavity reflectometer
Schatz (1966a)	1273	1.0-15.0	Cr_2O_3 , cold pressed and sintered at 2123°K for 2 hrs, polyvinyl binder added	Reflectance method, heated cavity reflectometer

Cobalt Oxide CoO
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Gillete (1960)	561-894	CoO coating, 0.025 to 0.2 mil thick on a Ni coated Cu plate	Transient calorimet- ric method, solar emis- someter, 1-10 microns vacuum; 15%

Cobalt Oxide CoO
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schatz, Counts, Burks (1964)	873-1273	99% CoO, sintered for two hours at 1773°K	Calculated from spectral data

Cobalt Oxide CoO
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Burgess, Waltenberg (1915)	1593	0.65	CoO, smooth surface, solid and liquid phases	Radiometric comparison with Pt as reference, measured in air
Schatz, Counts, Burks (1964)	373-1273	1.0-15.0	99% CoO powder, sintered at 1773°K for 2 hrs	Reflectance method, heated cavity reflectometer

Copper Oxides
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Kahanowicz (1921)	600-1400	CuO	

Copper Oxides
Angular Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Burgess (1909)	1073-1373	Molten Cu ₂ O; Angle 25-30°	Radiometric comparison using thermocouples to determine true temp., measured in air

Copper Oxides
Angular Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Burgess (1909)	1273-1473	0.55-0.65	Molten Cu ₂ O; Angle 25-30°	Radiometric comparison using thermocouple to measure true temp., measured in air

Erbium Oxide Er_2O_3
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Blair (1960)	806-1773	99.9% Er_2O_3 , compacted, fired at 2123°K for one hour, sample polished and cleaned	Integral blackbody hole comparison method, measured in vacuum; 10%

Erbium Oxide Er_2O_3
Hemispherical Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
McMahon, Wilder (1963)	523-1822	0.445-0.680	Er_2O_3 powder, dry pressed, fired at 1773°K for 24 hrs, ground	Reflectance method, double ellipsoidal mirror reflectometer
McMahon, Wilder (1968)	1753-3000	0.488-0.676	Er_2O_3 powder, dry pressed and fused	Reflectance method, double ellipsoidal mirror reflectometer

Erbium Oxide Er_2O_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Blair (1960)	1005-1773	0.64-1.0	99.9% Er_2O_3 , compacted, fired at 2123°K, polished and cleaned	Integral blackbody hole comparison method, measured in vacuum; 10%
Guazzoni (1972)	1540-1873	0.48-5.0	99.9% Er_2O_3 , pressed at high pressure, heated from 1530 to 1870°K	Integral blackbody cavity comparison method

Gadolinium Oxide Gd_2O_3

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Blair (1960)	798-1928	99.9% Gd_2O_3 , compacted, fired at 2123°K for one hour, ground, polished, cleaned	Integral blackbody hole comparison method, measured in vacuum; 10%

Gadolinium Oxide Gd_2O_3
Hemispherical Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
McMahon, Wilder (1963)	525-1872	0.445-0.680	Gd_2O_3 powder, dry pressed, fired at 1773°K for 24 hrs, ground	Reflectance method, double ellipsoidal mirror reflectometer
McMahon, Wilder (1968)	514-3000	0.488-0.676	Gd_2O_3 , dry pressed and fused	Reflectance method, double ellipsoidal mirror reflectometer

Gadolinium Oxide Gd_2O_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Blair (1960)	1038-1927	0.64-1.0	99.9% Gd_2O_3 , compacted, fired at 2123°K for 1 hr, ground, polished and cleaned	Integral blackbody hole comparison method, measured in vacuum; 10%

Hafnium Dioxide HfO_2
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	1122-2422	HfO_2 , pressed and sintered	Separate blackbody comparison method, measured in argon; 10%

Hafnium Dioxide HfO_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Noguchi, Kozuka (1966)	2500-3400	0.65	99.9% HfO_2 , dry pressed	Reflectance method, using solar furnace

Iron Oxides
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Kahanowicz (1921)	600-1400	Fe ₃ O ₄	

Iron Oxides
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Burgess, Foote (1915)	773-1473	Fe tube, oxidized to form FeO and Fe ₃ O ₄	Radiometric comparison with Pt as reference, measured in air
Schatz, Counts, Burks (1964)	873-1273	99% Fe ₂ O ₃ , sintered for four hours at 1573°K	Calculated from spectral data

Iron Oxides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Burgess, Foote (1915)	1073-1473	0.65	Fe tube oxidized to FeO and Fe ₃ O ₄	Radiometric compar- ison with Pt as reference, measured in air
Burgess, Waltenberg (1915)	1473 and 1883	0.65	Fe ₃ O ₄ , smooth solid and liquid phases	Radiometric compar- ison with Pt as reference, measured in air
Schatz, Counts, Burks (1964)	373-1253	1.0-15.0	99% Fe ₂ O ₃ powder, sintered for 4 hrs at 1573°K	Reflectance method, heated cavity reflectometer
Schatz, Alvarez, Counts, Hoppke (1965)	1273	1.0-15.0	Fe ₃ O ₄ , sintered for 0.5 hr at 1502°K	Reflectance method, heated cavity reflectometer

Lutetium Oxide Lu_2O_3
Hemispherical Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
McMahon, Wilder (1963)	521-1473	0.445-0.68	Lu_2O_3 powder, dry pressed, fired at 1773°K for 24 hrs, ground	Reflectance method, double ellipsoidal mirror reflectometer

Magnesium Oxide MgO
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Holden (1965)	2000	MgO	

Magnesium Oxide MgO
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Sully, Brandes, Waterhouse (1952)	673-1073	Super pure MgO, thick coating applied to oxidized Nimonic 75 strip	Separate blackbody comparison method
Olson, Morris (1958)	75.2-1019	MgO refractory	Separate blackbody comparison method, measured in air
Olson, Morris (1959)	38.2 and 502-1776	Fused MgO	Separate blackbody comparison method, measured in air
Pears (1962a)	1168-2344	MgO, pressed and sintered	Separate blackbody hole comparison method, measured in argon; 10- 20%
Clark, Moore (1965)	1200	99.2% MgO cylinders	Calculated from spectral data
Sacadura (1971)	1331-1798	Magnesia, 99% MgO	Calculated from spectral data

Magnesium Oxide MgO
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Olson, Morris (1959)	1098-1785	0.665	Fused MgO	Integral blackbody hole comparison method, measured in air
Blau, March, Martin, Jasperse, Chaffee (1960)	873-1298	1.0-14.0	97% MgO with CaO impurity	Integral blackbody hole comparison method, measured in air; 4%
Blau, Jasperse (1964)	873-1298	1.0-14.0	97% MgO with CaO impurities, ultrasonically machined	Integral blackbody hole comparison method measured in air; ≤4%
Clark, Moore (1965)	1200	1.0-15.0	99.2% MgO	Separate blackbody comparison method, measured in air
Stierwalt (1966a)	77	4.0-45.0	Irtran 5	Separate blackbody comparison method

Magnesium Oxide MgO
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Clark, Moore (1966)	1200-1600	1.0-15.0	99.2% polycrystalline MgO cylinder, smooth surface	Separate blackbody comparison method, measured in air
Janulis (1967)	1973-3473	0.65	MgO	
Abramov, Barykin, Romanov, Spiridonov (1969a)	1000-2200	0.436-0.546	Pure MgO	Reflectance method
Sacadura (1971)	1331-1798	1.0-15.0	Magnesia, 99% MgO	Integral blackbody hole comparison method

Manganese Oxide Mn_3O_4
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Burgess, Waltenberg (1915)	1873	0.65	Mn_3O_4 , liquid phase	Radiometric comparison with Pt as reference, measured in air

Neodymium Trioxide Nd_2O_3

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Guazzoni (1972)	1595-1693	0.55-5.0	99.9% Nd_2O_3 powder, die- pressed, heated from 1530 to 1873°K	Separate blackbody comparison method; 1%

Nickel Oxide NiO
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Kahanowicz (1921)	600-1400	NiO	

Nickel Oxide NiO
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Burgess, Foote (1914)	873-1573	NiO layer on Ni strips	Integral blackbody V-wedge comparison method, measured in air
Schatz, Goldberg, Pearson, Burks (1963)	1023	NiO, sintered at 1673°K for two hours	Calculated from spectral data

Nickel Oxide NiO
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Burgess, Foote (1914)	873-1573	0.5-0.7	NiO layer on Ni and also pure NiO	Integral blackbody V-wedge comparison method, measured in air
Burgess, Waltenberg (1915)	1273-1823	0.55-0.65	NiO, smooth surface, solid and liquid phases	Radiometric comparison with Pt as reference, measured in air
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	NiO, sintered at 1673°K for for 2 hrs	Reflectance method, heated cavity reflectometer
Schatz, Alvarez, Counts, Hoppke (1965)	1273	1.0-15.0	NiO, sintered at 1673°K for 2 hrs	Reflectance method, heated cavity reflectometer
Schatz (1966a)	1273	1.0-15.0	NiO, cold pressed and sintered at 1673°K for 2 hrs, with polyvinyl binder	Reflectance method, heated cavity reflectometer

Niobium Pentoxide Nb_2O_5
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Burgess, Waltenberg (1915)	1823	0.65	Nb_2O_5 , smooth surface	Radiometric comparison with Pt as reference, measured in air
Schatz, Alvarez, Counts, Hoppke (1965)	1273	1.0-15.0	Nb_2O_5 powder, sintered at 1273°K for 2 hrs	Reflectance method, heated cavity reflectometer

Samarium Trioxide Sm_2O_3

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Blair (1960)	624-1929	99.9% Sm_2O_3 powder, compacted and fired at 2123°K for one hour, ultrasonically cleaned and machine polished surface	Integral blackbody hole comparison method, measured in vacuum; 10%

Samarium Trioxide Sm_2O_3
Hemispherical Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
McMahon, Wilder (1963)	514-1523	0.488-0.68	Sm_2O_3 powder, dry pressed and fired at 1773°K for 24 hrs and ground	Reflectance method, double ellipsoidal mirror reflectometer
McMahon, Wilder (1968)	521-2929	0.488-0.676	Sm_2O_3 , dry pressed and fused	Reflectance method, double ellipsoidal mirror reflectometer

Samarium Trioxide Sm_2O_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Blair (1960)	999-1929	0.64-1.0	99.9% Sm_2O_3 powder, compacted and fired at 2123°K for 1 hr, ultrasonically cleaned, and machine polished surface	Integral blackbody hole comparison method, measured in vacuum; 10%
Schatz, Alvarez, Counts, Hoppke (1965)	1273	1.0-15.0	Sm_2O_3 , sintered at 1373°K for 10 hrs	Reflectance method, heated cavity reflectometer
Guazzoni (1972)	1531-1823	0.6-5.0	99.9% Sm_2O_3 , pressed and heated from 1530 to 1870°K	Separate blackbody comparison method

Silicon Monoxide SiO
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Blau, Jasperse, (1964)	873-1273	1.03-13.96	SiO on polished Pt (1000Å ^o thick) and SiO on polished inconel (1000Å ^o thick)	Integral blackbody hole comparison method, measured in air; ≤4%

Silicon Dioxide SiO_2
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schleiger (1966)	74.9-312	Fused quartz crystal, 0.33- 0.64 cm thick	Transient calorimetric method, 10^{-9} mm Hg vacuum; 5%

Silicon Dioxide SiO₂
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Sully, Brandes, Waterhouse (1952)	673-1073	Fused silica, paste applied to oxidized strip of Nimonic 75	Separate blackbody comparison method
Michaud (1954)	1273-1873	Silica refractories, different varieties containing Al ₂ O ₃ , Fe ₃ O ₄ , TiO ₂ , CaO, MgO, etc.	Integral blackbody hole comparison method
Schatz, Goldberg, Pearson, Burks (1963)	1023	Crystalline SiO ₂ , sintered at 1823°K for one hour	Calculated from spectral data
Clark, Moore (1965)	1200	Fine grained silica, 94% SiO ₂ cylinders	Calculated from spectral data, measured in air
Voishvillo, Mironova (1968)	373	Quartz, 3 mm thick	Separate blackbody comparison method; 3%
Petrov, Reznik (1972b)	600-1400	KI quartz glass, thickness varying from 1.75 to 9.76 mm, highly polished	Separate blackbody comparison method; 4.35%

Silicon Dioxide SiO₂
Angular Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Men, Settarova (1972)	700-1100	Quartz glass, 1 cm thick; Angle 0-90°	Calc. from optical constants using theory of transparent materials

Silicon Dioxide SiO_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Michaud (1954)	1273-1873	0.655	Silica refractories, various kinds	Integral blackbody hole comparison method
Stierwalt (1961)	313	3.0-14.0	Fused quartz plate (0.04 mm thick)	Separate blackbody comparison method, measured in vacuum
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	Crystalline silica, sintered at 1823°K for 1 hr	Reflectance method, heated cavity reflectometer
Clark, Moore (1965)	1200	1.0-15.0	Fine grained silica (95% SiO_2) cylinder	Separate blackbody comparison method, measured in air
Schatz (1966a)	1273	1.0-15.0	SiO_2 , cold pressed and sintered	Reflectance method, heated cavity reflectometer

Silicon Dioxide SiO₂
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Abramov, Barykin, Romanov, Spiridonov (1969b)	1773-2373	5.0	Silica	Radiometric method
Men, Settarova (1972)	293-1073	2.5-11.0	Quartz glass, KV and KI types, 1 cm thick	Calc. from optical constants using theory of trans- parent materials
Men, Settarova (1972)	1400	2.5-11.0	Quartz, 1 cm thick	Calc. from optical constants using theory of trans- parent materials
Pukhonin, Chaikni (1972)	373-673	2.0-25.0	Fused quartz crystal, semi- transparent	Separate blackbody comparison method

Silicon Dioxide SiO₂
Angular Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Men, Settarova (1972)	293-1073	3.0-7.5	Quartz glass, thickness varying from 2.5 to 75 mm; Angle 0-90°	Calc. from optical constants using theory of transparent material

Tantalum Oxide Ta₂O₅

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1023	Ta ₂ O ₅ , sintered at 1673°K for two hours	Calculated from spectral data

Tantalum Oxide Ta₂O₅
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	Ta ₂ O ₅ , sintered at 1673°K for 2 hrs	Reflectance method, heated cavity reflectometer
Schatz, Alvarez, Counts, Hoppke (1965)	1273	1.0-15.0	Ta ₂ O ₅ , sintered at 1273°K for 15 hrs	Reflectance method, heated cavity reflectometer

Tellurium Oxide TeO_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Mergerian, Olson, Weigandt (1960)	533-643	2.5-12.0	TeO_2 from G.E. Co., RIR-2, 3.05 and 7.65 mm thick	

Thorium Oxide ThO_2
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Sully, Brandes, Waterhouse (1952)	673-1073	Ultrapure thoria, applied in form of paste on oxidized Nimonic strip	Separate blackbody comparison method
Pears (1962a)	1213-2266	Thoria, pressed and sintered	Separate blackbody comparison method; 10- 20%
Clark, Moore (1965)	1200	Fine grained thoria >99%, cylinders	Calculated from spectral data

Thorium Oxide ThO_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Burgess, Waltenberg (1915)	1623	0.55-0.65	ThO_2	Radiometric comparison with Pt as reference, measured in air
Forsythe (1925)	1400-1800	0.655	ThO_2 , tube	Integral blackbody hole comparison method, measured in air, oxygen, hydrogen
Morgan (1951)	1473-2373	0.655	ThO_2 , coated on Ta sleeve	Integral blackbody hole comparison method, measured in vacuum
Michaud (1954)	1573	0.655	ThO_2	Integral blackbody hole comparison method
Clark, Moore (1965)	1200	1.0-15.0	Fine grained thoria 99%, cylinders	Separate blackbody comparison method

Thorium Oxide ThO₂
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Clark, Moore (1966)	1200-1600	1.0-15.0	>99% Thoria polycrystalline, cylinder, sintered at 1865°K for 27 hrs, smooth outer surface	Separate blackbody comparison method

Titanium Dioxide TiO_2
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1023	TiO_2 , sintered at 1673°K for two hours	Calculated from spectral data
Schatz, Counts, Burks (1964)	873-1273	99.9% TiO_2 powder, sintered for four hours at 1723°K	Calculated from spectral data and reflectance method

Titanium Dioxide TiO_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Burgess, Waltenberg (1915)	1723	0.55-0.65	TiO_2 , smooth surface	Radiometric comparison with Pt as reference, measured in air
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	TiO_2 , sintered at 1673°K for 2 hrs	Reflectance method, heated cavity reflectometer
Schatz, Counts, Burks (1964)	373-1273	1.0-15.0	99.9% TiO_2 , sintered for 4 hrs at 1723°K	Reflectance method, heated cavity reflectometer
Schatz, Alvarez, Counts, Hoppke (1965)	1273	1.0-15.0	TiO_2 powder, sintered for 2 hrs at 1573°K	Reflectance method, heated cavity reflectometer

Thulium Oxide Tm_2O_3
Hemispherical Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
McMahon, Wilder (1968)	1554-2924	0.488-0.676	Tm_2O_3 , dry pressed and fused	Reflectance method, double ellipsoidal mirror reflectometer
Stewart, McMahon, Wilder (1967)	2278-2970	0.488-0.676	99.5% Tm_2O_3 , dry pressed	Reflectance method, double ellipsoidal mirror reflectometer

Uranium Dioxide UO_2
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Brenden, Newkirk (1959)	1385-2078	UO_2 cylinder, sandblasted surface	Integral blackbody hole comparison method, 10^{-3} mm Hg vacuum

Uranium Dioxide UO_2
Hemispherical Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Held, Wilder (1969)	450-2557	0.656-0.7	UO_2 powder, <35 ppm impurities, pressed and sintered in helium from 1573-2273°K for 4 hrs, ground flat and polished	Reflectance method, double ellipsoidal mirror reflectometer

Uranium Dioxide UO_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Burgess, Waltenberg (1915)	1923-1973	0.65	UO_2 , solid, smooth surface	Radiometric comparison with Pt as reference, measured in air
Ehlert, Margrave (1958)	2173-2373	0.65	UO_2 , powdered and also polished solid	Radiometric comparison method at melting point; 0.03%
Brenden, Newkirk (1959)	1243-2248	0.65	UO_2 , solid cylinder	Integral blackbody hole comparison method, 10^{-3} mm Hg vacuum

Ytterbium Oxide Yb_2O_3
Hemispherical Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
McMahon, Wilder (1968)	1852-2975	0.488-0.676	Yb_2O_3 , dry pressed and fused	Reflectance method, double ellipsoidal mirror reflectometer

Ytterbium Oxide Yb_2O_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Guazzoni (1972)	1598-1850	0.4-5.0	99.9% Yb_2O_3 , powder pressed into discs	Separate blackbody comparison method; 1%

Yttrium Oxide Y_2O_3
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schatz, McCandless (1962)	1273	99.5% Y_2O_3 , sintered at 2023°K for two hours	Calculated from spectral data
Schatz, Counts, Burks (1964)	873-1273	99.9% Y_2O_3 powder, sintered at 1773°K for two hours	Calculated from spectral data and reflectance method

Yttrium Oxide Y_2O_3
Hemispherical Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
McMahon, Wilder (1963)	523-1823	0.445-0.68	Y_2O_3 powder, dry pressed, fired at 1773°K for 24 hrs, ground	Reflectance method, double ellipsoidal mirror reflectometer
McMahon, Wilder (1968)	471-2974	0.488-0.676	Y_2O_3 powder, dry pressed and fused	Reflectance method, double ellipsoidal mirror reflectometer

Yttrium Oxide Y_2O_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Burgess, Waltenberg (1915)	1673	0.65	Y_2O_3 , fused, smooth surface	Radiometric comparison with Pt as reference, measured in air
Schatz, McCandless (1962)	1273	1.0-15.0	99.9% Y_2O_3 , sintered at 2023°K for 2 hrs	Reflectance method, heated cavity reflectometer
Schatz, Counts, Burks (1964)	373 and 873-1273	1.0-15.0	99.9% Y_2O_3 powder, sintered for 2 hrs at 1773°K	Reflectance method, heated cavity reflectometer
Schatz (1966a)	1273	1.0-15.0	Y_2O_3 powder, cold pressed and sintered at 2023°K for 2 hrs (a) pure (b) small amounts of TiO_2 , Al_2O_3 , Cr_2O_3 NiO added	Reflectance method, heated cavity reflectometer

Zirconium Dioxide ZrO_2
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Wade (1959)	700-1366	ZrO_2 , flame sprayed coating	Calculated from normal total emittance
Gebhardt, Seghezzi, Duerrschnabel (1961)	1500-2000	ZrO_2	Steady state calorimetric method
Holden (1965)	2000	No details	

Zirconium Dioxide ZrO_2

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Sully, Brandes, Waterhouse (1952)	673-1073	Pure ZrO_2 powder coated on Nimonic 75 strip	Integral blackbody hole comparison method
Olson, Morris (1959)	35.4-1786	ZrO_2 (a) Ca stabilized (b) Mg stabilized	Separate blackbody comparison method, measured in air
Wade (1959)	700-1366	ZrO_2 , flame sprayed coating	Separate blackbody comparison method
Pears (1962a)	1153-2438	ZrO_2 , pressed and sintered	Separate blackbody comparison method, measured in argon and air; 10%
Pears (1962b)	811-2811	ZrO_2 , ground to a smooth finish	Separate blackbody comparison method, measured in argon or helium
Schatz, Counts, Burks (1964)	873-1273	95% ZrO_2 , 5% CaO , sintered	Calculated from spectral data and reflectance method, measured in air

Zirconium Dioxide ZrO_2

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Clark, Moore (1965)	1200	94% ZrO_2 - HfO_2 fine grained, cylinders, smooth surface	Calculated from spectral data
Grenis, Levitt (1965)	1300	94.5% ZrO_2 flame sprayed coating (12-15 mils thick), rough and polished surfaces	Calculated from spectral data, 3-5 x 10^{-2} mm Hg vacuum

Zirconium Dioxide ZrO_2
Hemispherical Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Wilson (1965b)	2100-3700	0.37-0.72	ZrO_2 discs, polished and rough samples	Reflectance method, double ellipsoidal mirror reflectometer 5%
McMahon, Wilder (1968)	1800-2984	0.488-0.676	ZrO_2 , dry pressed and fused	Reflectance method, double ellipsoidal mirror reflectometer

Zirconium Dioxide ZrO_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Olson, Morris (1959)	1192-1785	0.665	ZrO_2 (a) Ca stabilized (b) Mg stabilized	Integral blackbody hole comparison method, measured in air
Pears (1962b)	1939-2517	0.69	ZrO_2 , ground to a smooth finish	Separate blackbody comparison method, measured in helium or argon
Folweiler (1964)	867-1298	1.0-14.0	ZrO_2 -H, stabilized, ground and leached, fired at 2023°K	
Blau, Jasperse (1964)	873-1298	0.94-15.07	92% ZrO_2 , 4.5% CaO, ultrasonically machined	Integral blackbody hole comparison method, measured in air; <4%
Schatz, Counts, Burks (1964)	373 and 881-1496	1.0-15.0	95% ZrO_2 , 5% CaO, sintered	Reflectance method, heated cavity reflectometer
Clark, Moore (1965)	1200	1.0-14.0	94% $ZrO_2 \cdot HfO_2$ fine grained cylinders, smooth surface	Separate blackbody comparison method

Zirconium Dioxide ZrO_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Grenis, Levitt (1965)	1300	1.0-10.0	94.5% ZrO_2 , flame sprayed coating (12-15 mils thick), polished and rough surfaces	Integral blackbody V-wedge comparison method, 3 - 5 x 10 ⁻² mm Hg vacuum
Schatz, Alvarez, Counts, Hoppke (1965)	1273	1.0-15.0	ZrO_2 , sintered for 15 hrs at 1273°K	Reflectance method, heated cavity reflectometer
Clark, Moore (1966)	1200-1600	1.0-15.0	94.2% $ZrO_2.HfO_2$, 4.5% CaO polycrystalline, smooth cylinder	Separate blackbody comparison method
Noguchi, Kozuka (1966)	2500-3100	0.65	99.5% ZrO_2 , dry pressed	Reflectance method, using solar furnace
Janulis (1967)	1973-3473	0.65	ZrO_2 (unspecified purity)	

Zirconium Dioxide ZrO_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Faucher, Cabannes, Anthony, Pirou, Simcnato (1970)	1800-3000	0.65	Pure ZrO_2	Reflectance method

Aluminum Oxide-Chromium Oxide $\text{Al}_2\text{O}_3\text{-Cr}_2\text{O}_3$

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz (1966a)	1273	1.0-15.0	$\text{Al}_2\text{O}_3\text{-Cr}_2\text{O}_3$ mixtures, cold pressed, sintered, 100% Al_2O_3 to 100% Cr_2O_3	Reflectance method, heated cavity reflectometer

Aluminum Oxide-Nickel Oxide $\text{Al}_2\text{O}_3\text{-NiO}$

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz (1966a)	1273	1.0-15.0	$\text{Al}_2\text{O}_3\text{-NiO}$, cold pressed and sintered, 100, 99, 70, 50, 0% Al_2O_3	Reflectance method, heated cavity reflectometer

Aluminum Oxide-Silicon Dioxide $\text{Al}_2\text{O}_3\text{-SiO}_2$

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Sacadura (1971)	1331-1718	86% Al_2O_3 , 13% SiO_2	Calculated from spectral data

Aluminum Oxide-Silicon Dioxide $\text{Al}_2\text{O}_3\text{SiO}_2$

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz (1966a)	1273	1.0-15.0	$\text{Al}_2\text{O}_3\text{-SiO}_2$, cold pressed and sintered, 100, 99, 80, 33, 0% Al_2O_3	Reflectance method, heated cavity reflectometer
Sacadura (1971)	1331-1718	1.0-15.0	86% Al_2O_3 , 13% SiO_2	Integral blackbody hole comparison method

Yttrium Oxide-Chromium Oxide $\text{Y}_2\text{O}_3\text{-Cr}_2\text{O}_3$

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz (1966a)	1273	1.0-15.0	$\text{Y}_2\text{O}_3\text{-Cr}_2\text{O}_3$, cold pressed and sintered, 99, 50, 30, 0% Y_2O_3	Reflectance method, heated cavity reflectometer

Yttrium Oxide-Zirconium Dioxide $Y_2O_3-ZrO_2$

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Faucher, Cabannis, Anthony, Piriau, Simonato (1970)	1800-2300	0.65	20% Y_2O_3 , 80% ZrO_2	Reflectance method

Magnesium Aluminate MgAl_2O_4

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Clark, Moore (1965)	1200	Spinel, 71% Al_2O_3 , 28% MgO , fine grained, smooth cylinders	Calculated from spectral data

Magnesium Aluminate MgAl_2O_4

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Clark, Moore (1965)	1200	1.0-15.0	Spinel, 71% Al_2O_3 , 28% MgO , fine grained, smooth cylinder	Separate blackbody comparison method

Aluminum Silicate $\text{Al}_2(\text{SiO}_4)_3$

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Clark, Moore (1965)	1200	Mullite, 67% Al_2O_3 , 30% SiO_2 , fine grained, cylinders, smooth surfaces	Calculated from spectral data
Sacadura (1971)	1331-1718	Mullite, 55% Al_2O_3 , 33% SiO_2	Calculated from spectral data

Alumunium Silicate $\text{Al}_2(\text{SiO}_4)_3$

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Clark, Moore (1965)	1200	1.0-15.0	Mullite, 67% Al_2O_3 , 30% SiO_2 , fine grained, cylinders, smooth surfaces	Separate blackbody comparison method
Sacadura (1971)	1331-1718	1.0-15.0	Mullite, 55% Al_2O_3 , 33% SiO_2	Integral blackbody hole comparison method

Zirconium Silicate ZrSiO_4
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Curtis (1966)	280-600	ZrSiO_4 , bonded on 1 in. square Al slab	Steady state calorimetric method, 10^{-4} mm Hg vacuum

Zirconium Silicate ZrSiO_4

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Clark, Moore (1965)	1200	Zircon, 62% ZrO_2 , 32% SiO_2 , fine grained, smooth surface cylinders	Calculated from spectral data
Sacadura (1971)	1357-1723	Zircon, 99% ZrSiO_4	Calculated from spectral data

Zirconium Silicate ZrSiO_4

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Folweiler (1964)	867-1263	1.0-14.0	Ziropax, slip cast, fired at 1773°K	0.5%
Clark, Moore (1965)	1200	1.0-15.0	Zircon, 66% ZrO_2 , 32% SiO_2 , fine grained, smooth surface cylinders	Separate blackbody comparison method
Sacadura (1971)	1357-1723	1.0-15.0	Zircon, 99% ZrSiO_4	Integral blackbody hole comparison method

Barium Titanate BaTiO₃
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Curtis (1966)	280-600	BaTiO ₃ , bonded on 1 in. square Al slab	Steady state calorimetric method, 10 ⁻⁴ mm Hg vacuum

Calcium Titanate CaTiO_3
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Curtis (1966)	280-600	CaTiO_3 , bonded on 1 in. square Al slab	Steady state calorimetric method, 10^{-7} mm Hg vacuum

Stronium Titanate SrTiO_3
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Curtis (1966)	280-600	SrTiO_3 , bonded on 1 in. square Al slab	Steady state calorimetric method, 10^{-4} mm Hg vacuum

Strontium Titanate SrTiO_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz, Alvarez, Counts, Hoppke (1965)	1273	1.0-15.0	SrTiO_3 , sintered for 1 hr at 1502°K	Reflectance method, heated cavity reflectometer, measured in argon

Yttrium Vanadate YVO_4
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Rast, Caspers, Miller (1968)	77	4.05-46.6	Single crystals (a) cut parallel to c-axis (b) cut perpendicular to c-axis	Separate blackbody comparison method

Calcium Zirconate CaZrO_3

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Clark, Moore (1965)	1200	31% CaO, 68% ZrO_2 , fine grained, smooth cylinders	Calculated from spectral data

Calcium Zirconate CaZrO_3

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Clark, Moore (1965)	1200	1.0-15.0	31% CaO , 68% ZrO_2 , fine grained, smooth cylinders	Separate blackbody comparison method

Aluminum Boride AlB_{12}
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1873	0.65	Layer of paste (100 microns) on Ta cylinder and dried at 313-333°K	Integral blackbody comparison method

Barium Hexaboride BaB₆
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samasonov, Fomenko, Paderno (1962)	1073-1773	0.65	Layer of paste (100 microns) on Ta cylinder and dried at 313-333°K	Integral blackbody comparison method

Beryllium Boride Be_2B
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1873	0.65	Layer of paste (100 microns) on Ta cylinder and dried at 313-333°K	Integral blackbody comparison method

Calcium Hexaboride CaB_6

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	Layer of paste (100 microns) on Ta cylinder and dried at 313-333°K	Integral blackbody comparison method

Cerium Hexaboride CeB_6
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	Layer of paste (100 microns) on Ta cylinder and dried at 313-333°K	Integral blackbody comparison method

Chromium Boride CrB₂
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	Layer of paste (100 microns) on Ta cylinder and dried at 313-333°K	Integral blackbody comparison method

Cobalt Boride Co_2B
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2273	0.65	Layer of paste (100 microns) on Ta cylinder and dried at 313-333°K	Integral blackbody comparison method

Europium Hexaboride EuB_6
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	Layer of paste (100 microns) on Ta cylinder and dried at 313-333°K	Integral blackbody comparison method

Gadolinium Hexaboride GdB₆

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Serebryakova, Paderno, Samsonov (1960)	1123-1923	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody comparison method
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	Layer of paste (100 microns) on Ta cylinder and dried at 313-333°K	Integral blackbody comparison method

Hafnium Boride HfB_2

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	836-2928	HfB_2 , hot pressed	Separate blackbody comparison method, measured in argon; 10%

Hafnium Boride HfB_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Serebryakova, Paderno, Samsonov (1960)	1123-1923	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	Layer of paste (100 microns) on Ta cylinder and dried at 313-333°K	Integral blackbody comparison method

Lanthanum Hexaboride LaB_6

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Serebryakova, Paderno, Samsonov (1960)	1123-1923	0.65	Layer of paste (100 microns) on Ta cylinders, dried at 313-333°K	Integral blackbody comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	Layer of paste (100 microns) on Ta cylinder and dried at 313-333°K	Integral blackbody comparison method

Molybdenum Boride Mo_2B_5
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	Mo_2B_5 , layer of paste (100 microns thick) on Ta cylinder dried at 313-333°K	Integral blackbody comparison method

Neodymium Hexaboride NdB_6

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Serebryakova, Paderno, Samsonov (1960)	1123-1923	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1873	0.65	Layer of paste (100 microns) on Ta cylinder and dried at 313-333°K	Integral blackbody comparison method

Niobium Diboride NbB₂

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Riethof, DeSantis (1963)	1540-2440	NbB ₂ , prepared from micronized powder, hot pressed into cylinders at 2273°K, sintered, polished, etched, and degassed	Calculated from spectral data, measured in argon
Kibler, Lyon, Linevsky, DeSantis (1964)	1536-2289	NbB ₂	Calculated from spectral data, measured in argon

Niobium Diboride NbB₂
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Pomenko, Paderno (1962)	1073-2273	0.65	NbB ₂ paste on Ta cylinder, dried at 313-333°K	Integral blackbody comparison method
Riethof, Desantis (1963)	1594-2415	0.4-5.0	NbB ₂ , prepared from micro- nized powder, hot pressed into cylinder, polished, etched and degassed	Integral blackbody hole comparison method, measured in argon

Praseodymium Hexaboride PrB_6

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2173	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Samarium Hexaboride SmB_6
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Serebryakova, Paderno, Samsonov (1960)	1123-1923	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody comparison method

Scandium Diboride ScB_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov (1960)	1308-2043	0.65	ScB_2	Integral blackbody hole comparison method
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Strontium Hexaboride SrB_6

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Tantalum Diboride TaB_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Morgan (1951)	1273-1973	0.655	TaB_2 , coated on Ta sleeve	Integral blackbody hole comparison method, measured in vacuum

Terbium Hexaboride TbB₆
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2173	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Thulium Hexaboride TmB_6
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2173	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Thorium Tetraboride ThB_4

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	1128-2333	ThB_4 hot pressed	Separate blackbody comparison method, measured in argon; 10%

Titanium Diboride TiB_2

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	847-2977	TiB_2 , hot pressed into cylinders	Separate blackbody comparison method, measured in argon; 10%
Schatz, Goldberg, Pearson, Burks (1963)	1023-1273	TiB_2 , sintered at 2073°K	Calculated from spectral data, measured in argon
Riethof, DeSantis (1963)	1650-2015	TiB_2 , prepared from micronized powder, hot pressed into cylinder at 2273°K, sintered, polished, etched and degassed	Calculated from spectral data, measured in argon

Titanium Diboride TiB_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	TiB_2 paste layer, on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Riethof, Desantis (1963)	1648-2022	0.44-4.10	TiB_2 , prepared from micro- nized powder, hot pressed into cylinder at 2273°K, sintered, polished, etched and degassed	Integral blackbody hole comparison method, measured in argon
Schatz, Goldberg, Pearson, Burks (1963)	1023-1273	1.0-15.0	TiB_2 , sintered at 2073°K	Reflectance method, heated cavity reflectometer
Schatz, Alvarez, Counts, Hoppke (1965)	873-1423	1.0-15.0	TiB_2 , sintered for 2 hrs at 1623°K	Reflectance method, heated cavity reflectometer, measured in argon

Tungsten Boride WB
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	797-2716	WB, hot pressed	Separate blackbody comparison method, measured in argon; 10-20%

Tungsten Boride W_2B_5
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Uranium Boride UB_{12}
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2173	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Vanadium Diboride VB_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Ytterbium Hexaboride YbB₆

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Yttrium Hexaboride YB₆
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Serebryakova, Paderno, Samsonov (1960)	1123-1923	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	Layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Zirconium Diboride ZrB_2
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Vinnikova, Petrov, Sheindlen (1970)	1300-2500	ZrB_2 rod, 8 mm diameter	Steady state calorimetric method, 10^{-4} mm Hg vacuum; 8%

Zirconium Diboride ZrB_2

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	805-3033	ZrB_2 , hot pressed into cylinder	Separate blackbody comparison method, measured in argon; 10%
Schatz, Goldberg Pearson, Burks (1963)	1023	ZrB_2 , sintered at 2073°K for one hour	Calculated from spectral data, measured in argon
Riethof, DeSantis (1963)	1600-2490	ZrB_2 , prepared from micronized powder, hot pressed at 2273°K into cylinder, sintered polished, etched and degassed	Calculated from spectral data, measured in argon
Vinnikova, Petrov, Sheindlin (1970)	1300-2500	ZrB_2 cylinder, annealed at 2400°K for 1-5 hours	Integral blackbody hole comparison method, 10^{-4} mm Hg vacuum

Zirconium Diboride ZrB_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Morgan (1951)	1273-1973	0.655	ZrB_2 , coated on Ta sleeve	Blackbody comparison method, measured in vacuum
Serebryakova, Paderno, Samsonov (1960)	1123-1923	0.65	ZrB_2 , layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	ZrB_2 , layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Riethof, DeSantis (1963)	1604-2480	0.32-5.75	ZrB_2 , prepared from micronized powder, hot pressed at 2273°K into cylinder, sintered, polished, etched and degassed	Integral blackbody hole comparison method, measured in argon
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	ZrB_2 , sintered at 2073°K for 1 hr	Reflectance method, heated cavity reflectometer, measured in argon

Zirconium Diboride ZrB_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz, Alvarez, Counts, Hoppke (1965)	673-1423	1.0-15.0	ZrB_2 , sintered at 1423°K for 2 hrs	Reflectance method, heated cavity reflectometer, meas- ured in argon
Vinnikova, Petrov, Sheindlin (1970)	1300-2500	0.65	ZrB_2 cylinders, 18 mm diameter, annealed at 2400°K for 1 hr	Integral blackbody hole comparison method, 10- mm Hg Hg vacuum; 7%

Potassium Bromide KBr
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Bernstein, Kirk, Stierwalt (1964)	373	2.4-16.9	KBr crystal (4.65 mm thick)	Separate blackbody comparison method

Rubidium Bromide RbBr
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Bernstein, Kirk, Stierwalt (1964)	373	2.48-16.9	RbBr crystal (5.31 mm thick)	Separate blackbody comparison method

Boron Carbide B_4C
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Serebryakova, Paderno, Samsonov (1960)	1123-1923	0.65	B_4C , layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1773	0.65	B_4C , layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Chromium Carbides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Serebryakova, Paderno, Samaonov (1960)	1123-1923	0.65	Cr ₇ C ₃ , layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1673	0.65	Cr ₇ C ₃ , layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1773	0.65	Cr ₃ C ₂ , layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Hafnium Carbide HfC
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	1114-2825	HfC, hot pressed	Separate blackbody comparison method, measured in argon; 10%
Sheindlin, Petrov, Vinnikova, Nikolaeva (1969)	1300-3000	HfC cylinders, 18 mm diameter	Integral blackbody hole comparison method, 5 x 10 ⁻⁵ mm Hg vacuum; 6%

Hafnium Carbide HfC
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Paderno (1961)	1073-1873	0.655	HfC, hot pressed at 3000°K for 10 min., 8 mm diameter pellet, annealed at 2223°K for 3 hours	Integral blackbody hole comparison method
Samsonov, Fomenko, (1962)	1073-1873	0.65	HfC, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Deadmore (1964)	1978-2959	0.65	HfC, ring shape, 5/8 in. diameter, polished	Integral blackbody hole comparison method, 10 ⁻⁵ -10 ⁻⁶ mm Hg vacuum

Molybdenum Carbide Mo_2C

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	713-2661	Mo_2C , hot pressed, polished	Separate blackbody comparison method, measured in argon; 10%

Molybdenum Carbide Mo₂C

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1773	0.65	Mo ₂ C, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Niobium Carbide NbC
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Petrov, Chekhovskoi, Sheindlin, Nikolaeva, Fomina (1967)	1353-3473	NbC, cold compacted in form of rod, 5.3 cm diameter	Steady state calorimetric method, measured in vacuum and argon; 10%
Khrustalev, Rakov (1968)	1173-3173	NbC, no details given	
Petrov, Chekhovskoi, Sheindlin (1968)	1300-3300	NbC rod, cold pressed, 5.3 cm diameter, sintered at 2800°K	Steady state calorimetric method, $7 \times 10^{-5} - 4 \times 10^{-4}$ mm Hg vacuum and also in argon

Niobium Carbide NbC

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	817-2933	NbC, hot pressed, polished surface	Separate blackbody comparison method, measured in argon; 10%

Niobium Carbide NbC
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	NbC, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Petrov, Chekhovskoi, Sheindlin, Nikolaeva, Fomina (1967)	1352-3471	0.65	NbC, powder compacted in form of rod 5.3 mm diameter, sintered in argon at 2773°K	Integral blackbody hole comparison method, measured in vacuum and argon
Khrustalev, Rakov (1968)	1173-3173	0.365-0.655	NbC	
Petrov, Chekhovskoy, Sheindlin (1968)	1300-3500	0.65	NbC, powder compacted into rod 5.3 mm diameter, sintered at 2800°K in argon	Integral blackbody hole comparison method, 7×10^{-5} - 4×10^{-4} mm Hg vacuum and in argon
Okhremchuk, Podchernyaeva Upadkaya, Fomenko (1969)	1200-2100	0.655	NbC	

Silicon Carbide SiC
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Holden (1965)	2000	No details given	
Petrov, Chekhovskoi, Dymov, Emyashev (1969)	1200-2600	SiC, coated (0.5 mm thick) on graphite rod 6 mm thick	Steady state calorimetric method, measured in vacuum; 4%

Silicon Carbide SiC
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Michaud (1954)	1273-1773	SiC pressed into rod 20 mm diameter	Integral blackbody hole comparison method
Olson, Morris (1959)	73.2 and 434-1813	Carborundum	Separate blackbody comparison method, measured in air
Anthony, Pearl (1960)	644-1644	92.98% SiC	Separate blackbody comparison method, measured in dry helium; 20%
Wade, Slempe (1962)	589-1255	Norton SiC, ground and polished, heated in air at 1255°K for three minutes	Separate blackbody comparison method
Schatz, Goldberg, Pearson, Burks (1963)	1023	SiC, sintered at 2173°K for one hour	Calculated from spectral data, measured in argon

Silicon Carbide SiC
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Silverman (1948)	1375	1.7-15.0	Globar tube, 1 in. O.D.	Integral blackbody comparison method
Brugel (1950)	1000-1800	0.665-15.0	Globar	Separate blackbody comparison method
Michaud (1954)	1273-1873	0.655	Carborundum, pressed into a rod 20 mm diameter	Integral blackbody comparison method
Stewart, Richmond (1957)	755-1255	1.2-15.2	Globar heating element rod	Separate blackbody comparison method
Olson, Morris (1959)	1050-1736	0.655	SiC	Integral blackbody hole comparison method, measured in air
Blau, Chaffee, Jasperse, Martin (1960)	873-1298	0.91-13.9	80% SiC, nitride bonded, and 99% pure SiC, ultrasonically machined	Separate blackbody comparison method, measured in air; 4%
Mitchell (1962)	1358	0.65-14.9	Globar, 1 in. o.d. tube	Integral blackbody comparison method

Silicon Carbide SiC
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	SiC, sintered at 2173°K for 1 hr	Reflectance method, heated cavity reflectometer, meas- ured in argon
Blau, Jasperse (1964)	873-1298	1.0-14.0	80% SiC, nitride bonded, and 99% SiC, ultrasonically polished	Separate blackbody comparison method, measured in air; 4%
Janulis (1967)	1973-2973	0.65	SiC, unspecified purity	Integral blackbody comparison method

Tantalum Carbide TaC
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Petrov, Chekhovskoi, Sheindlin (1968)	1382-3190	TaC, cold pressed into rods, 5.3 mm diameter, sintered at 2900°K	Steady state calorimetric method, $7 \times 10^{-5} - 4 \times 10^{-4}$ mm Hg vacuum and argon
Petrov, Chekhovskoi, Sheindlin, Nikolaeva (1969)	1200-3700	TaC rods, 5.3 mm diameter	Steady state calorimetric method, $2-4 \times 10^{-4}$ mm Hg vacuum and argon atm.; 15%

Tantalum Carbide TaC
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Riethof, Acchione, Branyan (1962)	1600-2900	TaC, hot pressed at 2273°K, sintered, polished, etched and degassed	Calculated from spectral data, measured in argon
Pears (1962a)	767-3022	TaC, hot pressed	Separate blackbody comparison method measured in argon; 10%
Riethof, DeSantis (1963)	1600-2900	TaC, hot pressed at >2273°K, sintered, polished, etched and degassed	Calculated from spectral data, measured in argon
Sheindlin, Petrov, Vinnikova, Nikolaeva (1969)	1300-3000	TaC cylinders, 18 mm diameter	Integral blackbody comparison method, 5 x 10 ⁻⁵ mm Hg vacuum; 6%

Tantalum Carbide TaC
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Morgan (1951)	1273-2073	0.655	TiC coated on Ta sleeve	Integral blackbody comparison method, measured in vacuum
Blau, Chaffee, Jasperse, Martin (1960)	1350-3234	2.04-13.9	TaC, smooth and flat surface	Integral blackbody comparison method, measured in argon-hydrogen atm.
Shaffer (1961)	1824-3902	0.65	TaC, polished	
Riethof, Acchione, Branyan (1962)	1830-2880	0.46-4.0	TaC, hot pressed at 2273°K	Integral blackbody comparison method, measured in argon
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	TaC, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody comparison method
Riethof, DeSantis (1963)	1830-2880	0.46-4.00	TaC, hot pressed at 2273°K	Integral blackbody comparison method, measured in argon

Tantalum Carbide TaC
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Deadmore (1964)	1884-3012	0.65	99% TaC, polished, ring shaped, 5/8 in. diameter	Integral blackbody comparison method, 10 ⁻⁵ -10 ⁻⁶ mm Hg vacuum
Petrov, Chekhovskoi, Sheindlin (1968)	1300-3300	0.65	TaC, cold pressed into rod 5.3 mm diameter, sintered at 2900°K	Integral blackbody comparison method, 7 x 10 ⁻⁵ - 4 x 10 ⁻⁴ mm Hg vacuum and argon
Petrov, Chekhovskoi, Sheindlin, Nikolaeva (1969)	1200-3700	0.65	TaC rods, 5.3 mm diameter	Integral blackbody comparison method, 2-4 x 10 ⁻⁴ mm Hg vacuum and also argon

Thorium Carbides
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Grossman (1963c)	1800-2150	ThC ₂ , thermally polished	Steady state calorimetric temp. gradient method, 10 ⁻⁷ mm Hg vacuum

Thorium Carbides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Grossman, Hoyt, Ingold, Kaznoff, Sanderson (1962)	1350-2330	0.65	ThC, heated to 2335°K	Integral blackbody comparison method, 10 ⁻⁷ mm Hg vacuum; 5%
Grossman (1963c)	1500-2100	0.65	ThC ₂ , thermally polished	Integral blackbody comparison method, 10 ⁻⁷ mm Hg vacuum; 5%

Titanium Carbide TiC
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Petrov, Chekhovskoi, Sheindlin (1968)	1290-2894	TiC, cold pressed into tube, 7.3 mm o.d., sintered at 2600°K	Steady state calorimetric method, $7 \times 10^{-5} - 4 \times 10^{-4}$ mm Hg vacuum and argon atm
Petrov, Chekhovskoi, Sheindlin (1969)	1200-3000	TiC, tube	Steady state calorimetric method, $7 \times 10^{-5} - 4 \times 10^{-4}$ mm Hg vacuum and argon atm

Titanium Carbide TiC
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	814-2839	TiC, hot pressed	Separate blackbody comparison method, measured in argon; 10%

Titanium Carbide TiC
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Morgan (1951)	1273-2073	0.655	TiC, coated on Ta sleeves	Integral blackbody hole comparison method, measured in vacuum
Serebryakova, Paderno, Samsonov (1960)	1123-1923	0.65	TiC, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method,
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	TiC, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Petrov, Chekhovskoi, Sheindlin (1968)	1294-2618	0.65	TiC, cold pressed into tube 7.3 mm o.d., sintered at 2600°K	Integral blackbody hole comparison method, 7×10^{-5} - 4×10^{-4} mm Hg vacuum

Titanium Carbide TiC
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Petrov, Chekhovskoi, Sheindlin (1969)	1200-3000	0.65	TiC, cold pressed into tube, 7.3 mm o.d., sintered at 2600°K	Integral blackbody hole comparison method, 7×10^{-5} - 4×10^{-4} mm Hg vacuum
Kirillov, Safonov, Tychina (1972)	1800	0.665	TiC, tablets, 12 mm diam., 2.5 mm thick, hot pressed in vacuum from powder, polished with BC	Integral blackbody hole comparison method, $1 - 2 \times 10^{-6}$ mm Hg vacuum; 2%

Tungsten Carbides
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	792-2911	WC, hot pressed	Separate blackbody comparison method, measured in argon; 10%

Tungsten Carbides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Los Alamos Lab (1961)	1573-2373	0.65	WC, shining and dull surfaces	
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	(a) WC (b) W ₂ C, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Coffman, Kibler, Lyon, Acchione (1963)	1400-1800	0.334-4.98	WC, polished and dried	Integral blackbody hole comparison method, measured in argon
Coffman, Kibler, Lyon Acchione (1963)	1600-2400	0.334-4.98	W ₂ C, polished and dried	Integral blackbody hole comparison method, measured in argon

Uranium Carbides
 Spherical Total Emission

and
 or

12%

Uranium Carbides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Norreys, Wheeler (1963)	1100-2200	0.63	UC rods 0.3 cm diameter	Integral blackbody comparison method
Grossman (1963b)	1150-1890	0.65	UC, arc-cast rod, 0.9 cm diameter, polished	Integral blackbody hole comparison method, 5×10^{-7} mm Hg vacuum; 5%
Grossman (1963c)	1400-2150	0.65	UC ₂ , hot pressed for 15 min. at 1973°K, cleaned and polished	Integral blackbody hole comparison method, 10^{-6} mm Hg vacuum; 5%

Vanadium Carbide VC

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	967-2822	VC, hot pressed	Separate blackbody comparison method, measured in argon; 10%

Yttrium Carbides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2273	0.65	(a) YC, (b) YC ₂ (c) Y ₂ C ₃ , layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison

Zirconium Carbide ZrC
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Grossman (1963a)	1500-2400	ZrC, <20 ppm oxygen, hot pressed, 0.607 cm diameter	Steady state calorimetric method with temp. gradient, 2×10^{-6} mm Hg vacuum;
Grossman (1965)	1530-2390	ZrC, <20 ppm oxygen, hot pressed, 0.607 cm diameter	Steady state calorimetric method with temp. gradient, 2×10^{-6} mm Hg vacuum
Petrov, Chekhovskoi, Sheindlin, Nikolaeva, Fomina (1967)	1211-3401	ZrC, cold pressed into rods, 5.3 mm diameter and sintered at 2773°K in argon atm.	Steady state calorimetric method, measured in vacuum at 2400°K and in argon from 2300-3401°K
Petrov, Chekhovskoi, Sheindlin (1968)	1300-3300	ZrC, cold pressed into rods, 5.3 mm diameter	Steady state calorimetric method, 7×10^{-5} - 4×10^{-4} mm Hg vacuum and argon atm

Zirconium Carbide ZrC
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Petrov, Chekhovskoi, Dymov, Kilin (1969)	1200-2900	Pyrolytic ZrC film (0.2-0.3 mm thick) deposited on graphite tube, 12 mm o.d.	Steady state calorimetric method, measured in vacuum (2×10^{-4} mm Hg) from 1200-2500°K and argon from 2000-2900°K

Zirconium Carbide ZrC

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	1189-2978	ZrC, pressed and sintered	Separate blackbody comparison method, measured in argon; 10%
Piethof, DeSantis (1963)	1930-2500	ZrC, hot pressed at 2273°K into 0.25 cm diameter pellet, sintered, polished, etched and degassed	Calc. from spectral data, measured in argon

Zirconium Carbide ZrC
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Morgan (1951)	1273-2073	0.655	ZrC coated on Ta sleeve	Integral blackbody comparison method, measured in vacuum
Shaffer (1961)	1795-3578	0.65	ZrC, polished	
Samsonov, Fomenko, Paderno (1962)	1073-2273	0.65	ZrC, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Grossman (1963c)	1400	0.65	ZrC, hot pressed, preheated to 2400°K for 1 hr	5 x 10 ⁻⁷ mm Hg vacuum
Riethof, DeSantis (1963)	2100-2670	0.5-4.00	ZrC, hot pressed at 2273°K into 0.25 cm diameter pellet, sintered, polished, etched and degassed	Integral blackbody hole comparison method, measured in vacuum (2100- 2270°K) and argon (2470-2670°K)

Zirconium Carbide ZrC
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Grossman (1965)	1100-2430	0.65	ZrC, <20 ppm O, hot pressed at 2573°K into rods 0.607 cm diameter and polished	Integral blackbody hole comparison method, measured in vacuum
Petrov, Chekhovskoi, Sheindlin, Nikolaeva, Fomina (1967)	1207-3394	0.65	ZrC, cold pressed into rods 5.3 cm diameter and sintered in argon atm. at 2773°K	Integral blackbody hole comparison method, measured in vacuum (1200-2450°K) and argon (2300- 3400°K)
Petrov, Chekhovskoi, Sheindlin (1968)	1300-3300	0.65	ZrC, cold pressed into rods 5.3 cm diameter	Integral blackbody hole comparison method, 7×10^{-5} - 4×10^{-4} mm Hg vacuum (1300-2400°K) and argon (2900- 3300°K)

Zirconium Carbide ZrC
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Kolesnichenko Krasnoshchek- ov, Nezhevenko, Pustagarov (1971)	1600-3500	0.65	ZrC tube, extruded from a die, sintered for 30 min. in argon at 2800°K	Integral blackbody hole comparison method, measured in helium; 20%
Kirillov, Safonov, Tychina (1972)	1800	0.665	ZrC, tablets, 12 mm diam., 2.5 mm thick, hot pressed in vacuum from powder, polished with BC	Integral blackbody hole comparison method, 1 - 2 x 10 ⁻⁶ mm Hg vacuum; 2%

Tantalum Carbide-Hafnium Carbide TaC-HfC

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Deadmore (1964)	1873-3073	0.65	Mixtures of TaC-HfC from 0% TaC to 100% TaC, specimen in shape of ring 5/8 in. diameter, polished surface	Integral blackbody hole comparison method, 10^{-5} - 10^{-6} mm Hg vacuum

Titanium Carbide-Niobium Carbide TiC-NbC

Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Wade, Casey (1959)	589-1644	TiC-NbC strip, varying composition	Integral blackbody hole comparison method

Titanium Carbide-Niobium Carbide TaC-NbC

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Okhremchuk, Podchernyaeva Upadkhaya, Fomenko (1969)	1600	0.655	TiC-NbC cylinder, 20-80% TiC	Integral blackbody hole-in-tube compar- ison method, 15-20%

Titanium Carbide-Zirconium Carbide TiC-ZrC

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Kirillov, Safonov, Tychina (1972)	1800	0.665	TiC-ZrC, composition varying from 0 to 100% TiC, 12 mm diam., 2.5 mm thick tablets, hot pressed in vacuum from powders, polished with BC	Integral blackbody hole comparison method, $1 - 2 \times 10^{-6}$ mm Hg vacuum; 2%

Silicon Carbide-Aluminum Oxide-Silicon Dioxide $\text{SiC-Al}_2\text{O}_3\text{-SiO}_2$

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Sacadura (1971)	1331-1718	Carbolithe, 74% SiC, 11% Al_2O_3 , 15% SiO_2	Calculated from spectral data

Silicon Carbide-Aluminum Oxide-Silicon Dioxide $\text{SiC-Al}_2\text{O}_3\text{-SiO}_2$

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Sacadura (1971)	1331-1718	1.0-15.0	Carbolithe, 74% SiC, 11% Al_2O_3 , 15% SiO_2	Integral blackbody hole comparison method

Potassium Chloride KCl
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Bernstein, Kirk, Stierwalt (1964)	373	2.56-17.0	KCl crystal, 2.1 mm thick, before and after x-ray irradiation	Separate blackbody comparison method

Sodium Chloride NaCl
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schleiger (1966)	74.6-338	NaCl, cleaved crystals, 0.28- 0.81 cm thick	Transient calorimetric method, 10^{-9} mm Hg vacuum; 5%

Sodium Chloride NaCl
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Bernstein, Kirk, Stierwalt (1964)	373	1.95-16.9	NaCl crystal, 6.56 mm thick, before and after x-ray irradiation	Separate blackbody comparison method
Pukhonin, Chaikin (1972)	373-973	2.0-25.0	NaCl crystals	Separate blackbody comparison method

Calcium Flouride CaF_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Fussell, Geist (1967)	773-873	2.0-12.0	CaF_2 single crystal (2.08- 16.11 mm thick), polished, parallel faces, heated to 773°K for 1/2 hr	Separate blackbody comparison method
Hisano, Okamoto, Matumura (1967)	562	6.42-25.0	CaF_2 single crystal, (0.2- 1.5 mm thick), polished	Separate blackbody comparison method
Pukhonin, Chaikin (1972)	373-673	2.0-25.0	CaF_2 crystal	Separate blackbody comparison method

Lithium Flouride LiF
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Pukhonin, Chaikin (1972)	373-673	2.0-25.0	LiF crystal	Separate blackbody comparison method

Magnesium Fluoride MgF_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Stierwalt (1966a)	77-373	15.9-42.6	Irtran 1 (2 mm thick)	Separate blackbody comparison method
Stierwalt (1966b)	77	3.49-44.5	Irtran 1 (2 mm thick), microcrystalline, hot pressed	Separate blackbody comparison method

Aluminum Nitride AlN
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1023	AlN	Calculated from spectral data, measured in argon

Aluminum Nitride AlN
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2273	0.65	AlN layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody comparison method
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	AlN	Reflectance method, heated cavity reflectometer, meas- ured in argon

Boron Nitride BN
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	753-2516	BN, hot pressed	Separate blackbody comparison method, measured in argon; 10%
Walker, Casey (1962)	928-1309	BN, pressed, machined, and polished, dried, 0.71-6.43 mm thick	Separate blackbody comparison method and calculated from spectral data
Schatz, Goldberg, Pearson, Burks (1963)	1023	97% BN, sintered at 2123°K for two hours	Calculated from spectral data, measured in argon
Grenis, Levitt (1965)	1300	97% BN, rough and polished surfaces	Calculated from spectral data, 3.5 x 10 ⁻² mm Hg vacuum

Boron Nitride BN
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Serebryakova, Paderno, Samsonov (1960)	1123-1923	0.65	BN, layer of paste (100 microns thick) on Ta cylinder dried at 313-333°K	Separate blackbody comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	BN, layer of paste (1000 microns thick) on Ta cylinder dried at 313-333°K	Separate blackbody comparison method
Walker, Casey (1962)	1083	0.5-14.9	BN, machine polished, 6.43 mm thick, dried at 373°K	Separate blackbody comparison method
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	97% BN, sintered at 2123°K for 2 hrs, polished	Reflectance method, heated cavity reflectometer, meas- ured in argon
Blau, Jasperse (1964)	873-1353	1.42-15.0	BN, ultrasonically machined	Separate blackbody comparison method, measured in air; 4%

Boron Nitride BN
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Grenis, Levitt (1965)	1300	1.0-10.0	97% BN, polished and rough surfaces	Integral blackbody V-wedge comparison method, 3.5×10^{-2} mm Hg vacuum

Chromium Nitrides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1373-2273	0.65	CrN, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1873	0.65	Cr ₂ N, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody comparison method

Gallium Nitride GaN
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1473	0.65	GaN, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody comparison method

Hafnium Nitride HfN
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	808-2744	HfN, hot pressed	Separate blackbody comparison method, measured in argon; 10%
Riethof, DeSantis (1963)	1605-2195	HfN, hot pressed at 2273°K into 0.25 in. diam. pellet, sintered, polished, etched and degassed	Calculated from spectral data, measured in argon

Hafnium Nitride HfN
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	HfN, layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole comparison method
Riethof, DeSantis (1963)	1617-2192	0.365-4.15	HfN, hot pressed at 2273°K into 0.25 in. pellets, sintered, polished, etched and degassed	Integral blackbody hole comparison method, measured in argon

Niobium Nitrides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	(a) NbN (b) Nb ₂ N, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Scandium Nitride ScN
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	ScN, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Silicon Nitride Si_3N_4
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Wade, Slomp (1962)	589-1255	Pure Si_3N_4 , ground, polished, cleaned and heated in air	Separate blackbody comparison method
Schatz, Goldberg, Pearson, Burks (1963)	1023	Si_3N_4 , sintered at 1673°K for two hours	Calculated from spectral data

Silicon Nitride Si_3N_4
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1873	0.65	Si_3N_4 , layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	Si_3N_4 , sintered at 1673°K for 2 hrs	Reflectance method, heated cavity reflectometer, meas- ured in argon

Tantalum Nitrides
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	830-2672	TaN, hot pressed	Separate blackbody comparison method, measured in argon; 10%
Riethof, DeSantis (1963)	1650-2070	TaN, hot pressed at 2273°K, 0.25 in. diameter, sintered, polished, etched and degassed	Calculated from spectral data, measured in argon
Kibler, Lyon, Linevsky, DeSantis (1964)	1648-2132	TaN	Calculated from spectral data, measured in argon and nitrogen

Tantalum Nitrides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	(a) TaN (b) Ta ₂ N, layer of paste on Ta cylindr, dried at 313-333°K	Integral blackbody hole comparison method
Riethof, DeSantis (1963)	1648-2073	0.4-4.95	TaN, hot pressed at 2273°K, 0.25 in. diameter, sintered, etched and degassed	Integral blackbody hole comparison method, measured in argon
Kibler, Lyon, Linevsky, DeSantis (1964)	1648-2132	0.418-4.44	TaN	Integral blackbody hole comparison method, measured in argon and nitrogen

Titanium Nitride TiN
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Pears (1962a)	811-2994	TiN, hot pressed	Separate blackbody comparison method, measured in argon; 10%

Titanium Nitride TiN
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno, (1962)	1073-1973	0.65	TiN, layer of paste (100 microns) on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Vanadium Nitrides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	VN, layer of paste on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1873	0.65	V ₃ N, layer of paste on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method

Zirconium Nitride ZrN

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Riethof, DeSantis (1963)	1880-2290	ZrN, hot pressed at 2273°K, 0.25 in. diameter, sintered, polished, etched and degassed	Calculated from spectral data, measured in argon

Zirconium Nitride ZrN
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno, (1962)	1073-2073	0.65	ZrN, layer of paste (100 microns thick) on Ta cylinder dried at 313-333°K	Integral blackbody hole comparison method
Riethof, DeSantis (1963)	1895-1968	0.42-2.75	ZrN, hot pressed at 2273°K, 0.25 in. diameter, sintered, polished, etched and degassed	Integral blackbody hole comparison method, measured in argon

Titanium Boronitride $\text{TiB}_2.2\text{TiN}.2\text{BN}$

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Grenis, Levitt (1966)	1300	Cylindrical sample, polished and rough surfaces	Calc. from spectral data

Titanium Boronitride $\text{TiB}_2\cdot 2\text{TiN}\cdot 2\text{BN}$

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Grenis, Levitt (1966)	1300	1.0-10.0	Cylindrical samples, polished and rough surfaces	Integral blackbody wedge comparison method

Boron Phosphide BP
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	BP, layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole comparison method

Gallium Phosphide GaP
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1373	0.65	GaP, layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole comparison method

Titanium Phosphide TiP
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1573	0.65	TiP, layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole comparison method

Zinc Selenide ZnSe
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schleiger, Webb (1968)	44.4-312	Irtran 4, polycrystals 1-3 mm thick	Steady state cryogenic calorimetric method, measured in vacuum

Zinc Selenide ZnSe
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Steirwalt (1966a)	77-373	16.0-43.1	Irtran 4, 2 mm thick	Separate blackbody comparison method
Stierwalt (1966b)	4.2-195	19.0-50.0	Irtran 4, microcrystalline, 0.37 mm thick	Separate blackbody comparison method

Boron Silicides
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1023	B ₄ Si , sintered at 1423°K for two hours	Calculated from spectral data, measured in argon
Schatz, Goldberg, Pearson, Burks (1963)	1023	B ₆ Si, sintered at 1623°K for two hours	Calculated from spectral data, measured in argon

Boron Silicides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	B ₄ Si, sintered at 1423°K for 2 hrs	Reflectance method, heated cavity reflectometer, meas- ured in argon
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	B ₆ Si, sintered at 1623°K for 2 hrs	Reflectance method, heated cavity reflectometer, meas- ured in argon

Chromium Silicides
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1023	Cr ₃ Si, sintered at 1373- 1473°K for two hours	Calculated from spectral data, measured in argon

Chromium Silicides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1873	0.65	CrSi, CrSi , Cr ₃ Si ₂ , layers of paste on Ta cylinder, dried at 313-333°K	Integral blackbody hole comparison method
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	Cr ₃ Si, sintered at 1273- 1473°K for 2 hrs	Reflectance method, heated cavity reflectometer, meas- ured in argon

Cobalt Silicide CoSi
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1573	0.65	CoSi, layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole-in-tube compar- ison method, meas- ured in argon

Gadolinium Disilicide GdSi_2

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1873	0.65	GdSi_2 , layer of paste (100 microns thick) on Ta cylinder, dried at 313-333°K	Integral blackbody hole-in-tube comparison method

Magnesium Silicide Mg_2Si

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1273	0.65	Mg_2Si , layer of paste (100 microns thick) on Ta cylinder, dried at 313-333°K	Integral blackbody hole-in-tube comparison method, measured in argon

Manganese Silicides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1473	0.65	MnSi ₂ , layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole-in-tube compar- ison method, meas- ured in air
Samsonov, Fomenko, Paderno (1962)	1073-1373	0.65	Mn ₃ Si, layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole-in-tube compar- ison method, meas- in argon

Molybdenum Silicides
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Zhorov, Sivakova (1966)	1025-1900	MoSi ₂ coating (75-80 microns thick), thermally coated and plasma coated on Mo alloy	Steady state calorimetric method, measured in vacuum; 4.4%

Molybdenum Silicides
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Anthony, Pearl (1960)	644-1644	MoSi ₂ , wet ball milled, cast, dried, and sintered	Separate blackbody comparison method, measured in dry helium; 20%
Chao, Dormer, Payne, Priest, Zupan (1962)	1123-1923	MoSi ₂ , applied on Mo-0.5Ti alloy	Measured in vacuum
Schatz, Goldberg, Pearson, Burks (1963)	1273	MoSi ₂ , sintered at 1623°K for two hours	Calculated from spectral data
Zhorov, Sivakova (1965)	373-1900	MoSi ₂ coating (75-80 microns thick), thermally coated or plasma coated on Mo alloy	Integral blackbody hole comparison method, measured in vacuum; 5%

Molybdenum Silicides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Byrne, Mancinelli (1954)	1000-1900	0.65	MoSi ₂ , evaporated film (75-81 microns thick) deposited by thermal diffusion on Mo alloy	10 ⁻⁴ -10 ⁻⁵ mm Hg vacuum
Blau, Chaffee, Jasperse, Martin (1960)	1175-1986	0.65	MoSi ₂	Separate blackbody comparison method, measured in 90% argon, 10% helium atmosphere
Samsonov, Fomenko, Paderno (1962)	1073-2273	0.65	MoSi ₂ , layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole comparison method
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	Mo ₃ Si, layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole comparison method
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	Mo ₅ Si ₃ , layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole comparison method

Molybdenum Silicides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1273	1.0-15.0	MoSi ₂ , sintered at 1623°K for 2 hrs	Reflectance method, heated cavity reflectometer, meas- ured in vacuum
Matsno, Homma (1964)	1073-1973	0.65	MoSi ₂	Blackbody compar- ison method
Zhorov, Sivakova (1965)	1000-1900	0.65	MoSi ₂ coating (75-80 microns thick), thermally coated or plasma coated on Mo alloy	Integral blackbody comparison method, measured in vacuum; 15%
Schatz (1966b)	1273	1.0-15.0	MoSi ₂ , sintered at 1423°K for 2 hrs	Reflectance method, heated cavity reflectometer, meas- ured in argon and argon-hydrogen atms.

Nickel Disilicide NiSi_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1473	0.65	NiSi_2 , layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole-in-tube compar- ison method, meas- ured in argon

Niobium Disilicide NbSi_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1973	0.65	NbSi_2 , layer of paste (100 microns thick) on Ta cylinder, dried at 313-333°K	Integral blackbody hole-in-tube comparison method

Rhenium Disilicide ReSi_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1673	0.65	ReSi_2 , layer of paste (100 microns thick) on Ta cylinder, dried at 313-333°K	Integral blackbody hole-in-tube comparison method

Tantalum Silicide TaSi₂

Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1023	TaSi ₂ , sintered at 1723°K for two hours	Calculated from spectral data

Tantalum Silicide TaSi₂
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	TaSi ₂ , layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole comparison method
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	TaSi ₂ , sintered at 1723°K for 2 hrs	Reflectance method, heated cavity reflectometer, meas- ured in argon
Schatz, Alvarez, Counts, Hoppke (1965)	1273	1.0-15.0	TaSi ₂ , sintered at 1523°K for 2 hrs	Reflectance method, heated cavity reflectometer, meas- ured in argon atm.

Titanium Silicides
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schatz, Goldberg, Pearson, Burks (1963)	1023	TiSi ₂ sintered at 1573°K for two hours	Calculated from spectral data

Titanium Silicides
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1873	0.65	(a) TiSi_2 (b) Ti_5Si_3 , layer of paste (100 microns thick) on Ta cylinder, dried at 313-333°K	Integral blackbody comparison method
Schatz, Goldberg, Pearson, Burks (1963)	1023	1.0-15.0	TiSi_2 , sintered at 1573°K for 2 hrs	Reflectance method, heated cavity reflectometer, meas- ured in argon

Tungsten Silicide W_3Si
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2173	0.65	W_3Si , layer of paste (100 microns thick) on Ta cylinder, dried at 313-333°K	Integral blackbody hole-in-tube comparison method

Vanadium Disilicide VSi_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1873	0.65	VSi_2 , layer of paste (100 microns thick) on Ta cylinder, dried at 313-333°K	Integral blackbody hole-in-tube comparison method

Zirconium Silicide ZrSi_2
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	ZrSi_2 , layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole-in-tube compar- ison method

Cadmium Sulphide CdS
Normal Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Stierwalt (1966a)	77-473	CdS, 5.1 mm thick	Calc. from spectral data

Cadmium Sulphide CdS
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Stierwalt (1961)	333-453	3.0-15.0	CdS, (2.15 and 5.1 mm thick) ground and polished	Separate blackbody comparison method, measured in vacuum
Stierwalt, Potter (1962)	323-473	1.97-23.4	CdS, 5.1 mm thick, lapped and polished	Separate blackbody comparison method
Stierwalt (1966a)	77-473	2.0-41.8	CdS, 5.1 mm thick	Separate blackbody comparison method

Cerium Sulphide Ce_2S_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2073	0.65	Ce_2S_3 , layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole-in-tube compar- ison method

Lanthanum Sulphide La_2S_3
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1773	0.65	La_2S_3 , layer of paste (100 microns thick) on Ta cylin- der, dried at 313-333°K	Integral blackbody hole-in-tube compar- ison method

Neodymium Sulphide Nd_2S_3

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-2173	0.65	Nd_2S_3 layer of paste (100 microns thick) on Ta cylinder, dried at 313-333°K	Integral blackbody hole-in-tube comparison method

Praseodymium Sulphide Pr_2S_3

Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Samsonov, Fomenko, Paderno (1962)	1073-1573	0.65	Pr_2S_3 , layer of paste (100 microns thick) on Ta cylinder, dried at 313-333°K	Integral blackbody hole-in-tube comparison method

Zinc Sulphide ZnS
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schleiger, Webb (1968)	74.9-312	ZnS or Irtran 2 polycrystal, 1-3 mm thick	Steady state cryogenic calorimetric method, measured in vacuum

Zinc Sulphide ZnS
Normal Spectral Emittance

Reference	Temp. Range, °K	Wavelength Microns	Sample Specification	Test Method and Reported Error
Stierwalt (1966a)	77-373	3.0-43.6	Irtran 2, 2.0 mm thick	Separate blackbody comparison method
Stierwalt (1966b)	4.2-373	3.01-126.0	Irtran 2, 2.0 mm thick, microcrystalline	Separate blackbody comparison method

Cadmium Telluride CdTe
Hemispherical Total Emittance

Reference	Temperature Range, °K	Sample Specification	Test Method and Reported Error
Schleiger, Webb (1968)	44.5-312	Irtran 6 (CdTe) polycrystal, 1-3 mm thick	Steady state cryogenic calorimetric method

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