We're Everywhere It Matters…

Application Brief 8: Infrared Radiation and Radiometry Introduction

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All solid bodies that have temperatures above absolute zero (0 Kelvin, -273°C) emit electromagnetic waves. The thermal radiation portion of this energy is called infrared radiation. Wien's Displacement Law describes the relationship between a solid body's temperature and its emitting peak wavelength by the following equations:

$$\lambda_{max} = 2898/T \qquad \text{Equation 1}$$

or

$$T = 2898/\lambda_{max} \qquad \text{Equation 2}$$

Where T= object temperature is in K (Kelvin) and λ_{max}= peak wavelength is in micrometers (µm). Temperature unit conversions are as follows:

K= °C + 273   °C= K-273   °F= 9/5 °C + 32   °C= (°F – 32)5/9

Using this law we can calculate the specific peak wavelength for an object at a particular temperature. According to Max Planck, the intensity curve of all emitted wavelengths for a solid body is rather broad. For various temperatures of an ideal black body radiator the intensity curves of radiated energy versus wavelength are shown in Figure 1

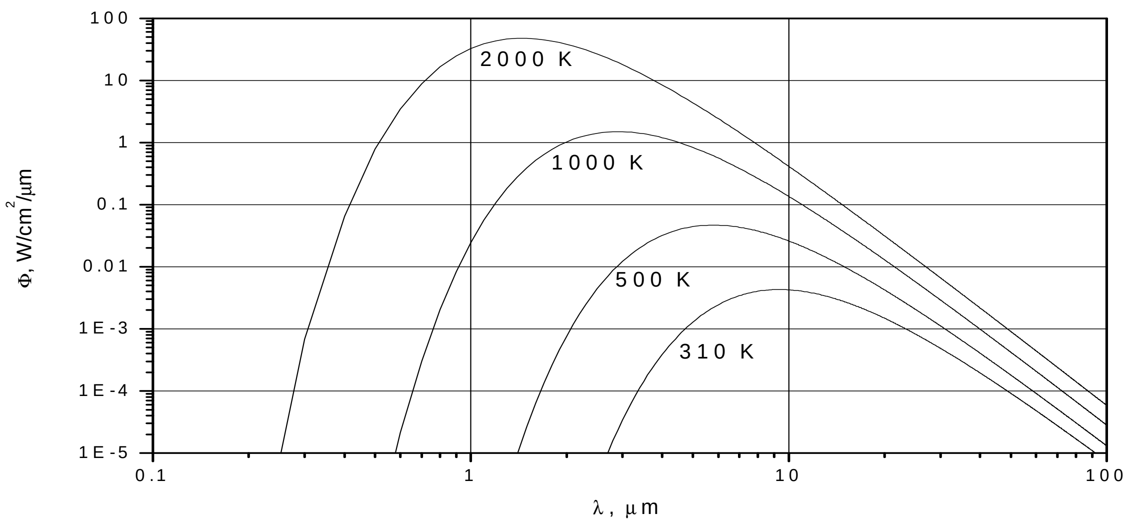

Figure 1: Radiated Energy versus Wavelength

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A hot object of 1000K emits a lot more energy than an object at 500K. For both temperatures, some of the energy is in the visible, the near infrared and infrared regions. For a 1000K object, figure 1 illustrates how the peak radiated energy curve moves to the left toward lower wavelengths and the visible region. This correlates to the fact that an object at 1000K glows and can be felt radiating from the surface. An object at 500K emits most of it's radiation in the infrared region, does not glow, but still can be felt.

Looking at the peak radiated energy vs. target temperature for an 8-14µm band pass window using equation 2, gives the following :

$$T_{8\mu m} = 2898/8 = 362K = 89°C = 192.6°F$$

$$T_{14\mu m} = 2898/14 = 207K = -66°C = -86.9°F$$

From this we can see that an 8-14µm band pass window encompasses peak radiated energy for object temperatures from –86.9°F to 192. 6°F.

Figure 2 shows calculated Peak Radiated Energy (λmax) for select object temperatures using equation 1.

Object Temperature			λ_{max}
2000K	1727°C	3140.6°F	1.45µm
1000K	727°C	1340.6°F	2.90 µm
500K	227°C	440.6°F	5.80 µm
310K	37°C	98.6°F	9.35 µm
300K	27°C	80.6°F	9.66 µm
294.1K	21.1°C	70°F	9.86 µm

Figure 2: Peak Radiated Energy (λ_{max}) for select object temperatures.

When selecting an optical window/filter for thermopile detectors, take into account the object temperature range to insure the peak radiated energy is transmitted. Please see our web site for a list of "Standard Windows and Filters".