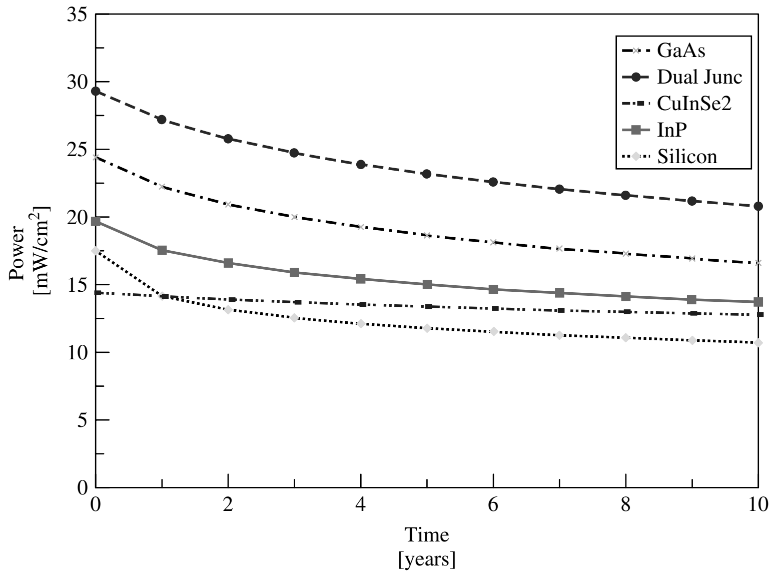

Figure 10.5 Solar cell power density as a function of time in a 1853-km altitude, 103° sun-synchronous orbit for the same cells as in Figure 10.6. (Graph courtesy of Tom Morton, Ohio Aerospace Institute)

that at Earth. The solar intensity in the orbit around the Earth will vary seasonally because of the ellipticity of the Earth's orbit around the sun. Orbital characteristics are also a major source of thermal variation. Most spacecraft experience some amount of eclipse that will vary as the orbit precesses. This can result in very large and rapid temperature changes as shown above for the space station cell. The temperature of a solar cell in space is also affected by the fraction of incident solar radiation returned from a planet or albedo. The average albedo from the Earth is 0.34, but can range anywhere from 0.03 (over forests) to 0.8 (over clouds) [7]. Typically, the range of temperatures experienced by solar cells in orbit about the Earth is from about 20°C to as high as 85°C.

An increase in solar cell temperature will cause a slight increase in the short-circuit current but a significant decrease in the open-circuit voltage (see Figure 10.6). Therefore, the overall effect is a reduction in power of a solar cell with an increase in temperature. It is typically less than 0.1%/°C, but can vary dramatically depending on cell type. This change coupled with rapid changes in temperature associated with eclipses can result in power surges that may be problematic.

The degradation of solar cell performance as a function of temperature is expressed in terms of temperature coefficients. There are several different temperature coefficients used to describe the thermal behavior of solar cells. These coefficients are generally expressed as the difference in a device parameter (i.e. I_{SC}, V_{OC}, I_{mp}, V_{mp}, or η) measured at a desired temperature and at a reference temperature [traditionally 28°C, although the new International Space Organization (ISO) standard is 25°C] divided by the difference in the two temperatures. Solar cell response to temperature is fairly linear for most cells over the range of -100 to 100°C. Unfortunately, for cells of amorphous silicon or low