2. Solar Spectrum

Problems

2.1. Assume the spectral photon flux density incident on the surface of a semiconductor has the form:

$$b^{(E)}(E) = \begin{cases} \dfrac{2 \cdot F \cdot E_m{}^2}{h^3 \cdot c^2} \left(\dfrac{E}{E_m} \right), & E \le E_m \\ 0, & E_m < E \end{cases}$$

In this case, the flux drops to zero below a minimum wavelength $\lambda_m = hc/E_m$. Find:

a) an expression for the spectral irradiance $L^{(E)}$ in terms of E and E_m .

b) an expression for the total power density p in terms of E_m .

c) an expression for $b^{(\lambda)}$ in terms of λ and λ_m .

d) an expression for the equivalent current density $j^{(\lambda)}$ in terms of λ and λ_m .

e) an expression for the total photon flux Φ in terms and E_m .

f) Assume $E_m = 3.0$ eV and $F = 1.0 \times 10^{-12}$. Find:

i) the total photon flux available [in $\#/(\mathrm{m}^2 \cdot \mathrm{s})$] in this spectrum;

ii) the total equivalent current density J available in this spectrum;

iii) the total power density available in this spectrum;

iv) Assume a semiconductor with bandgap E_g =1.4 eV absorbs all photons with energy above its bandgap. Find:

A) the total equivalent current density available for conversion;

B) the total power density available for conversion (total for $E > E_g$);

C) the efficiency, assuming perfect quantum efficiency above the bandgap and an operating voltage of $V_a = 1.0$ V .