discussed in the context of equation (4.15), $\boldsymbol{j}_\omega$ is proportional to T and thus $\boldsymbol{j}_\omega/T$ only depends on $(\varepsilon-\mu)/T$. Note, however, that $\boldsymbol{j}_\omega$ is affected by the specific choice of T.

For simplicity, we shall consider the photons at room temperature and we shall calculate their chemical potential, μ_{ph}, from setting the equality

$$N_{\text{ph}}(\varsigma,\varepsilon)=\frac{\varepsilon^2}{\exp\left[\dfrac{\varepsilon-\mu_{\text{ph}}(\varsigma,\varepsilon)}{kT_a}\right]-1} \tag{4.33}$$

However, we might have chosen to leave $\mu_{\text{ph}}=0$, and then the effect of the absorption of light when passing through the semiconductor could have been described as a cooling down of the photons (if N_{ph} actually decreases with ς).

With the room-temperature luminescent photon description, the production of entropy by photons is given by

$$\sigma_{\text{ph}}=\sum_{i-\text{ph}}\left[\frac{\upsilon_{i-\text{ph}}}{T_a}-\frac{\mu_{i-\text{ph}}g_{i-\text{ph}}}{T_a}-\frac{\boldsymbol{j}_{n,i-\text{ph}}\nabla\mu_{i-\text{ph}}}{T_a}-\frac{\nabla\boldsymbol{j}_{\omega,i-\text{ph}}}{T_a}\right] \tag{4.34}$$

However, using equations (4.15) and (4.3),

$$\nabla\boldsymbol{j}_\omega=\frac{c}{Un_r}\frac{\text{d}\Omega}{\text{d}\mu}\nabla\mu=-\frac{c}{Un_r}f_{\text{BE}}\nabla\mu=-\boldsymbol{j}_n\nabla\mu \tag{4.35}$$

and

$$\sigma_{\text{ph}}=\sum_{i-\text{ph}}\left[-\frac{\upsilon_{i-\text{ph}}}{T_a}+\frac{\mu_{i-\text{ph}}g_{i-\text{ph}}}{T_a}\right] \tag{4.36}$$

where

$$g=(c/Un_r)\alpha f_{\text{BE}}(T_a,qV)\text{e}^{-\alpha\varsigma}-(c/Un_r)\alpha f_{\text{BE}}(T_s,0)\text{e}^{-\alpha\varsigma};\quad \upsilon=\varepsilon g \tag{4.37}$$

The total irreversible entropy production is obtained by adding equations (4.29), (4.30) and (4.36), taking into account equation (4.37). Now, the terms in energy generation, all at the same temperature, must balance out by the first principle of thermodynamics. The net absorption of photons corresponds to an electron transfer (positive and negative generations) between states gaining an electrochemical potential qV, so the terms $\mu g/T$ corresponding to electrons and photons subtract each other. No additional generations are assumed to take place. Thus the total irreversible entropy generation rate can be written as

$$\sigma_{\text{irr}}=\frac{c\alpha}{Un_r}\sum_{i-\text{ph}}\frac{(\mu_{i-\text{ph}}-qV)[f_{\text{BE}}(T_s,0)\text{e}^{-\alpha\varsigma}-f_{\text{BE}}(T_a,qV)\text{e}^{-\alpha\varsigma}]}{T_a} \tag{4.38}$$

For a given mode the second factor balances out when $f_{\text{BE}}(T_s,0)=f_{\text{BE}}(T_a,qV)$, and so does the irreversible entropy generation. In this case, $N_{\text{ph}}=f_{\text{BE}}(T_a,qV)$ is constant along the ray and $\mu_{i-\text{ph}}=qV$ is constant at all points. The irreversible entropy generation rate is