Solution 8

Exercise 1:

a)

$$R(\Theta_i = 0) = \left(\frac{n_1 - n_2}{n_1 + n_2}\right)^2$$
$$= 4\% \quad (air - glass)$$

with

$$n_1 = n_{air} = 1$$
$$n_2 = n_{glass} = 1.5$$

b)

$$R(\Theta_i = 0) = 31\% \quad (air - silicon)$$

with

$$n_{Si} = 3.5$$

c)

$$d = \frac{\lambda}{4n}$$
$$\lambda = 600\,\text{nm},$$
$$n = extracted\ from\ PV\ Lighthouse$$

(a) Highly doped ITO: $n(600\,\text{nm}) = 1.755 => d = 85.5\,\text{nm}$
(b) Lowly doped ITO: $n(600\,\text{nm}) = 2.109 => d = 71.1\,\text{nm}$
(c) MgF2: $n(600\,\text{nm}) = 1.362 => d = 110.1\,\text{nm}$

d)

$$n_{arc} = \sqrt{n_{air} n_{Si}}$$
$$= 1.87$$

Exercise 2: With $j_z = j_{mpp}$ the increment of the current flowing to the fingers is given by

$$dI(y) = j_{mpp} \cdot l \cdot dy$$

and therefore

$$I(y) = j_{mpp} \cdot l \cdot y$$

The incremental power-loss in dy is

$$dP = I(y)dV = I^2(y)dR$$

with

$$dR = \frac{\rho_{TCO}}{d_{TCO} \cdot l} dy$$

Integration over the area between two fingers results in

$$\begin{aligned} P &= 2\frac{j_{mpp}^2 \cdot l \cdot \rho_{TCO}}{d_{TCO}} \int_0^{s/2} y^2 dy \\ &= \frac{\rho_{TCO} \cdot l \cdot s^3 \cdot j_{mpp}^2}{12 d_{TCO}} \end{aligned}$$

Using $P_{el} = j_{mpp} \cdot s \cdot l \cdot V_{mpp}$ leads to

$$\begin{aligned} P_{TCO} &= \frac{P_{TCO}}{P_{el}} = \frac{s^2}{12} \frac{\rho_{TCO}}{d_{TCO}} \frac{j_{mpp}}{V_{mpp}} \\ &= \frac{s^2}{12} \cdot R_{SH,TCO} \cdot \frac{j_{mpp}}{V_{mpp}} \end{aligned}$$