Spectral Responsivity of Single Layer Anti-Reflection Films
on
Silicon Photo Diodes and Solar Cells

by

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Reference: S.O. Kasap, "Optoelectronics and Photonics, Prentice-Hall, 2001

Air: $n_1 := 1$

Substrate (Silicon): $n_3 := 3.5$

Antireflective film: $n_2 := 1.47$

Thickness: $d := 100$ nm

$r_{12} := \frac{n_1 - n_2}{n_1 + n_2}$ $\quad r_{23} := \frac{n_2 - n_3}{n_2 + n_3}$ $\quad r_1 := r_{12}$ $\quad r_2 := r_{23}$

$R_1 := r_1^{\,2}$ $\quad R_2 := r_2^{\,2}$

$t_{12} := \frac{2 \cdot n_1}{n_1 + n_2}$ $\quad t_{21} := \frac{2 \cdot n_2}{n_1 + n_2}$ $\quad t_{23} := \frac{2 \cdot n_2}{n_2 + n_3}$

$t_1 := t_{12}$ $\quad t_2 := t_{21}$ $\quad t_3 := t_{23}$

$r_1 = -0.19$ $\quad r_2 = -0.408$ $\quad R_1 = 0.036$ $\quad R_2 = 0.167$

$t_1 = 0.81$ $\quad t_2 = 1.19$ $\quad t_3 = 0.592$

$x := \frac{t_1 \cdot t_2}{1 - r_1 \cdot r_2}$ $\quad x^2 = 1.092$

$y := \frac{t_1 \cdot t_2}{1 + r_1 \cdot r_2}$ $\quad y^2 = 0.8$

$\Phi(\lambda_n) := \frac{2 \cdot \pi}{\lambda_n}$ where λ where λn is normalized wavelength wrt (n2).(d)

Transmission:

$$t(\lambda_n) := \frac{t_1 \cdot t_3 \cdot \exp(-i \cdot \Phi(\lambda_n))}{1 + r_1 \cdot r_2 \cdot \exp(-2i \cdot \Phi(\lambda_n))}$$

$$T(\lambda_n) := \left(\left|t(\lambda_n)\right|\right)^2 \cdot n_3$$

$$\lambda_n := 0.25, 0.255 .. 8$$

Reflection:

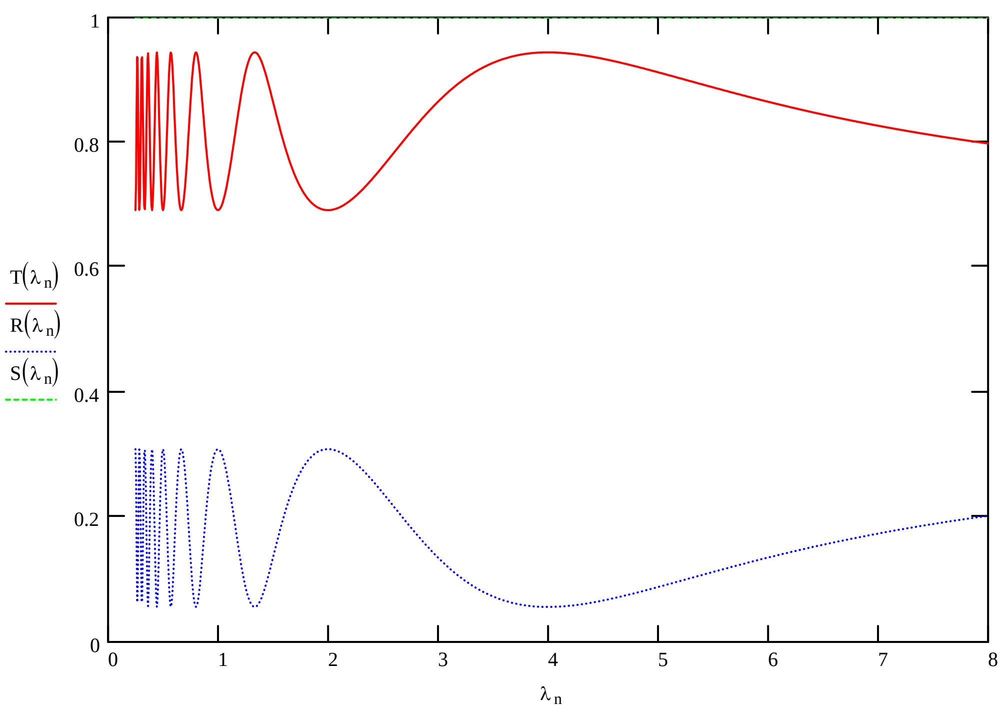
$$r(\lambda_n) := \frac{r_1 + r_2 \cdot \exp(-2i \cdot \Phi(\lambda_n))}{1 + r_1 \cdot r_2 \cdot \exp(-2i \cdot \Phi(\lambda_n))}$$

$$R(\lambda_n) := \left(\left|r(\lambda_n)\right|\right)^2$$

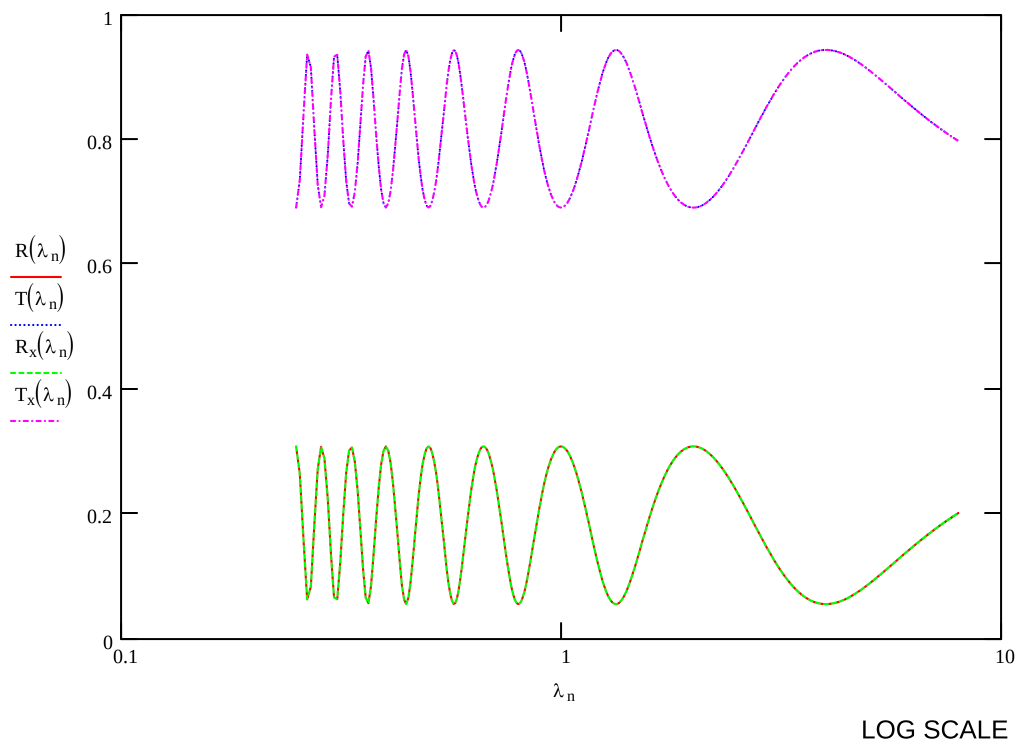
$$T_x(\lambda_n) := 1 - R(\lambda_n)$$

$$R_x(\lambda_n) := 1 - T(\lambda_n)$$

$S(\lambda_n) := R(\lambda_n) + T(\lambda_n)$ Sum of R & T



$T(2) = 0.691$	$R(2) = 0.309$	$S(2) = 1$
$T(4) = 0.944$	$R(4) = 0.056$	$S(4) = 1$


1
0.8
0.6
0.4
0.2
0
0.1
1
10
λ_n
$R(\lambda_n)$
$T(\lambda_n)$
$R_x(\lambda_n)$
$T_x(\lambda_n)$
LOG SCALE