

**8.39** A parallel-polarized beam of light with an electric field amplitude of 10 (V/m) is incident in air on polystyrene with  $\mu_r = 1$  and  $\epsilon_r = 2.6$ . If the incidence angle at the air–polystyrene planar boundary is  $50^\circ$ , determine the following:

- (a) The reflectivity and transmissivity.
- (b) The power carried by the incident, reflected, and transmitted beams if the spot on the boundary illuminated by the incident beam is  $1 \text{ m}^2$  in area.

**Solution:**

- (a) From Eq. (8.68),

$$\begin{aligned}\Gamma_{\parallel} &= \frac{-(\epsilon_2/\epsilon_1) \cos \theta_i + \sqrt{(\epsilon_2/\epsilon_1) - \sin^2 \theta_i}}{(\epsilon_2/\epsilon_1) \cos \theta_i + \sqrt{(\epsilon_2/\epsilon_1) - \sin^2 \theta_i}} \\ &= \frac{-2.6 \cos 50^\circ + \sqrt{2.6 - \sin^2 50^\circ}}{2.6 \cos 50^\circ + \sqrt{2.6 - \sin^2 50^\circ}} = -0.08, \\ R_{\parallel} &= |\Gamma_{\parallel}|^2 = (0.08)^2 = 6.4 \times 10^{-3}, \\ T_{\parallel} &= 1 - R_{\parallel} = 0.9936.\end{aligned}$$

- (b)

$$\begin{aligned}P_{\parallel}^i &= \frac{|E_{\parallel 0}^i|^2}{2\eta_1} A \cos \theta_i = \frac{(10)^2}{2 \times 120\pi} \times \cos 50^\circ = 85 \text{ mW}, \\ P_{\parallel}^r &= R_{\parallel} P_{\parallel}^i = (6.4 \times 10^{-3}) \times 0.085 = 0.55 \text{ mW}, \\ P_{\parallel}^t &= T_{\parallel} P_{\parallel}^i = 0.9936 \times 0.085 = 84.45 \text{ mW}.\end{aligned}$$


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