Detection of Light. Problem Set 2

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1 Mobility of carriers

The mobility of the electrons in a Si photodetector at room temperature is $\mu = 1.35 \times 10^3$ cm^2 V^{-1} s^{-1}. What is its conductivity in AV^{-1} m^{-1} for the amount of charge carriers calculated in Problem set 1? $n_0 = 1.5 \times 10^{10}$ cm^{-3} . The charge of the electron is 1.602×10^{-19}C.

2 Design of an intrinsic photoconductor

Consider an intrinsic silicon photoconductor operating at 1 μm and constructed as shown in the Figure. Let its surface area, wl, be 1 mm^2, and operate it at 300 K. Assume the detector breaks down when the bias voltage, V_{b}, exceeds 60 mV. Determine;

a A reasonable detector thickness for good quantum efficiency in absence of reflection. The refractive index of Si is 3.4. What is the value of η if you take reflectivity into account?

b The responsivity of the detector. The recombination time for Si under the given conditions is $\tau = 1 \times 10^{-4}$ s. The mobility of electrons is $\mu = 1.35 \times 10^3$ cm^2 V^{-1} s^{-1}.

c The dark resistance. Here, use the concentration of carriers calculated in Problem set 1: $n_0 = 1.5 \times 10^{10}$ cm^{-3}.

d The time response. The capacitance of a plane parallel capacitor can be calculated as:

$$C_d = \frac{wd\kappa_0\epsilon_0}{l}$$

where κ_0 is the dielectric constant (11.8 for Si), and $\epsilon_0 = 8.854 \times 10^{-12}$Fm^{-1} is the permittivity of free space.

e The Johnson noise.

f The Noise Equivalent Power (NEP). Assume an integration time of 0.5 s.