## Haynes-Shockley Experiment

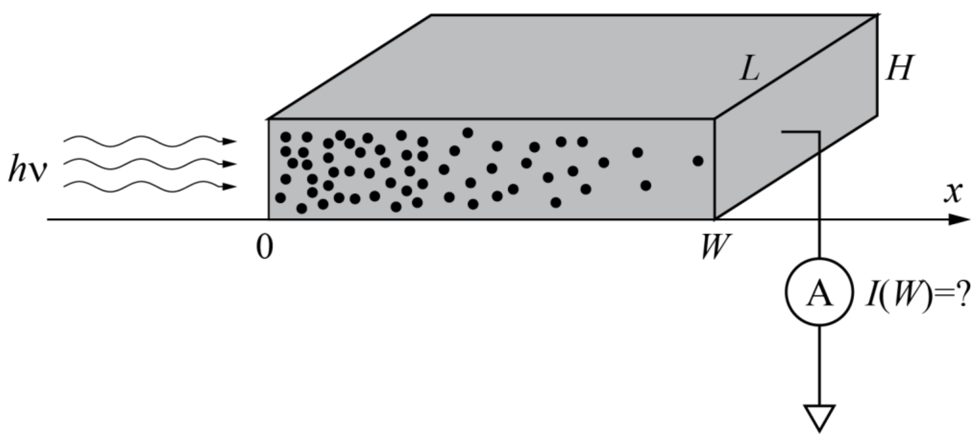
In an experiment similar to the famous Haynes-Shockley experiment to determine minority carrier mobility, excess carriers are injected by optical excitation at one side of a slide of n-type silicon sample. The equilibrium electron concentration in the n-type sample is $n_{n0} = 2 \times 10^{17}$ cm$^{-3}$. The sample length is $W$=0.5 mm. Excess carriers are only generated at $x$=0 with carrier generation rate of $G$=$10^{20}$ cm$^{-3}$/s. The other side of the sample at $x$=$W$ is connected to the ground thereby all excessive carriers are extracted completely. The sample is at room temperature ($T$=300 K). The carrier life time is $\tau$=50 μs, hole mobility is $\mu_p$=250 cm$^2$/V·s. The figure below shows the configuration.

a) (*1 points*) Find the steady-state minority carrier (hole) concentration at $x$=0: $p_n(0)$

b) (*1 points*) Write out the steady-state differential equation of the minority carrier (hole) concentration along the $x$ direction: $p_n(x)$.

c) (*1 points*) Solve the differential equation of $p_n(x)$ using proper boundary conditions.

d) (*1 points*) If the width of the sample is $L$=0.5 mm and the height is $H$=0.2 mm, find the total current measured at the opposite surface of the sample $I(W)$.




Physical constants may be useful:

Elelctron charge: $e = 1.6 \times 10^{-19}$ C

Boltzmann constant: $k = 1.38 \times 10^{-23}$ J/K

Vacuum permitivity: $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m

Planck constant: $h = 6.63 \times 10^{-34}$ J · s