Dispositivos Fotovoltaicos: Materiais e Tecnologia

Série 3

2018/2019

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1. a) Using the mobility and diffusivity chart for Si at 300K as a function of impurity concentration, find the room temperature resistivity of an n-type silicon wafer doped with 10^{16} atoms/cm^3 of phosphorus.

b) Repeat for GaAs with the same impurity concentration

2. Find the electron and hole concentrations, mobilities, and resistivities of silicon samples at 300 K, for each of the following impurity concentrations: (a) 5×10^{15} boron atoms/cm^3; (b) 2×10^{16} boron atoms/cm^3 and 1.5×10^{16} arsenic atoms/cm^3

3.A four-point probe (with probe spacing of 0.5 mm) is used to measure the resistivity of a *p*-type silicon sample. Find the resistivity of the sample if its diameter is 200 mm and its thickness is 50 µm. The contact current is 1 mA, and the measured voltage between the inner two probes is 10 mV.

4. Calculate the ideal reverse saturation current in a Si *p*–*n* junction diode with a cross-sectional area of 2×10^{-4} cm^2. The parameters of the diode are
$N_A = 5 \times 10^{16}$ cm^{-3}, $N_D = 10^{16}$ cm^{-3}, $n_i = 9.65 \times 10^9$ cm^{-3}
$D_n = 21$ cm^2/s, $D_p = 10$ cm^2/s, $\tau_p = \tau_n = 5 \times 10^{-7}$ s.

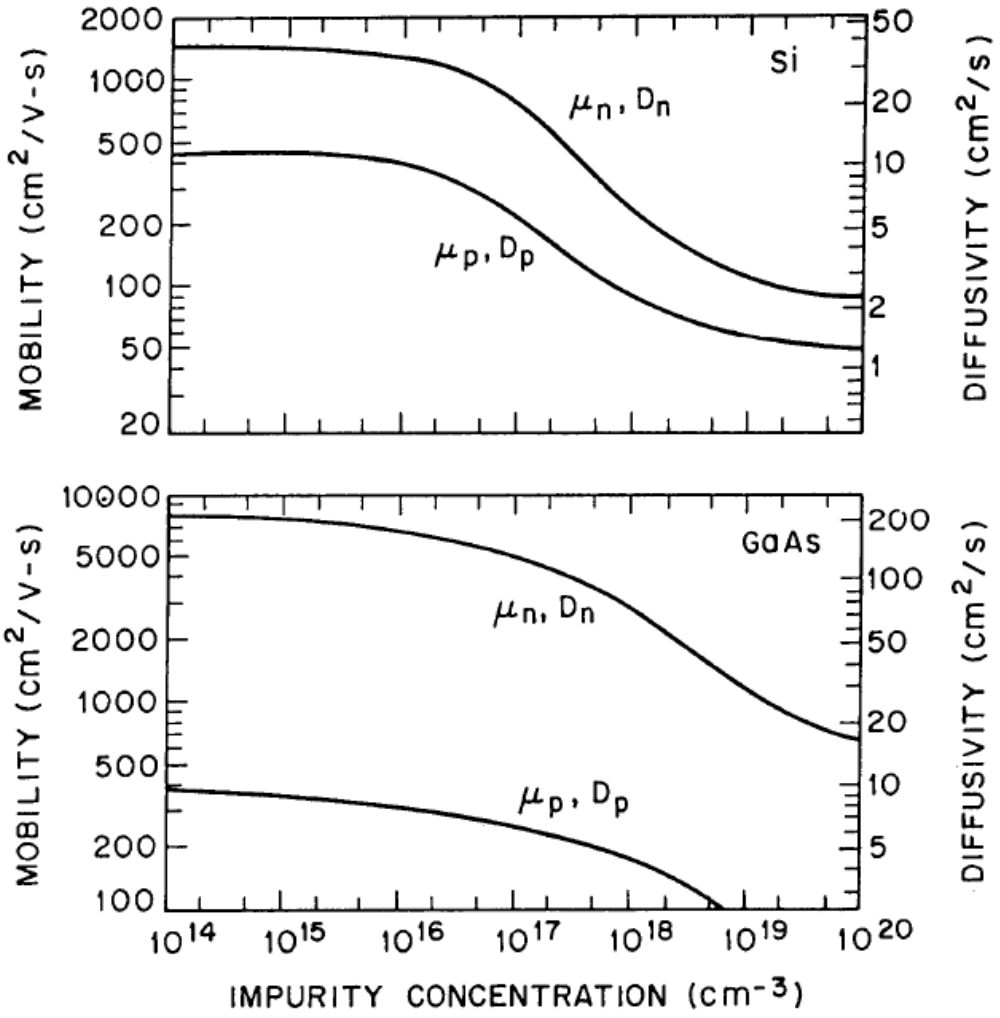
5-For a standard spectra AM1.5 calculate the maximum current in a solar cell using a material with energy gap 1.12 eV, assuming that all absorbed photons will contribute to the current.

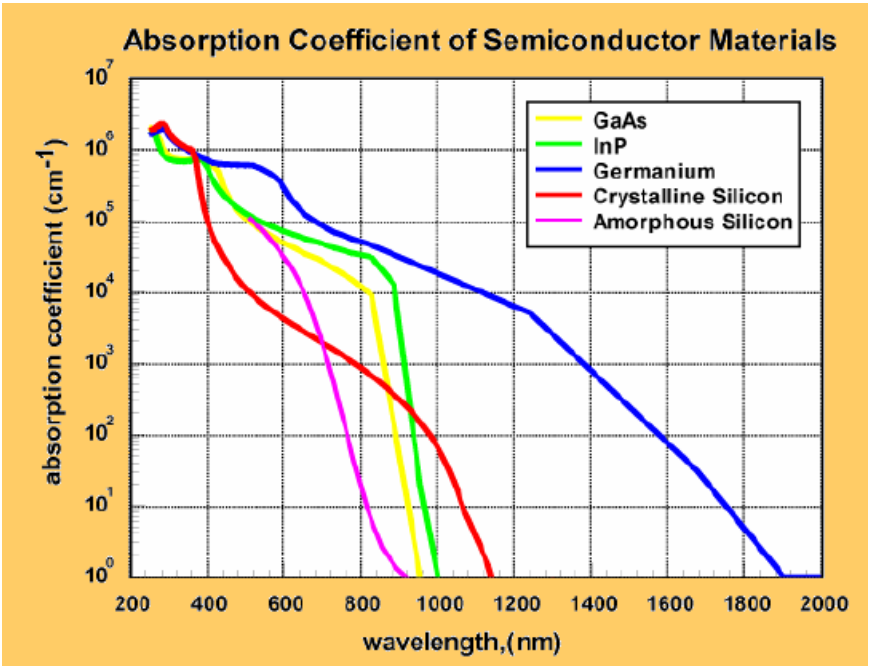
6- What will be the maximum open circuit voltage for a silicon solar cell that has a saturation current of $8x10^{-11}$ A/cm^2?

7-Compare the absorption length (alfa-1) of a radiation with 500 nm and 800 nm in silicon. Calculate the minimum thickness of a solar cell if we want to absorb 90% of the incoming radiation.

8. A 10 W laser beam, 900 nm wavelength is focused on a solar cell with an area of 5 cm^2.
a) Assuming a reflection coefficient of 30% and that all absorbed photons will result in charge collection, calculate the available current produced by this solar cell.

b) How many suns does this represents?

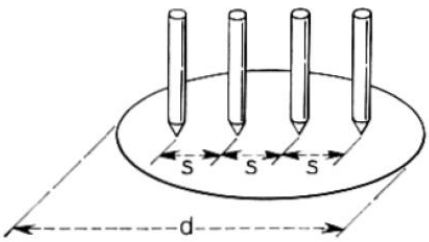

Si
μ_n, D_n
μ_p, D_p
MOBILITY (cm^2/V-s)
DIFFUSIVITY (cm^2/s)
2000
1000
500
200
100
50
20
50
20
10
5
2
1
GaAs
μ_n, D_n
μ_p, D_p
MOBILITY (cm^2/V-s)
DIFFUSIVITY (cm^2/s)
10000
5000
2000
1000
500
200
100
200
100
50
20
10
5
10^{14} 10^{15} 10^{16} 10^{17} 10^{18} 10^{19} 10^{20}
IMPURITY CONCENTRATION (cm^{-3})

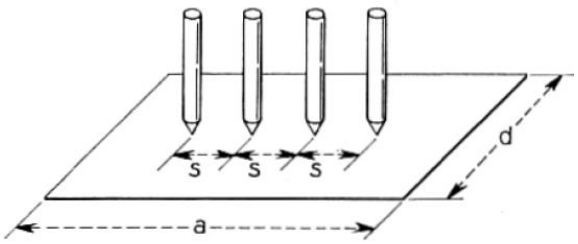

Absorption Coefficient of Semiconductor Materials
absorption coefficient (cm^{-1})
10^7
10^6
10^5
10^4
10^3
10^2
10^1
10^0
GaAs
InP
Germanium
Crystalline Silicon
Amorphous Silicon
200 400 600 800 1000 1200 1400 1600 1800 2000
wavelength,(nm)

4-point resistivity

$$\rho_s = \frac{\rho}{t}$$

Onde t é a espessura da amostra; ρ e resistividade e s a separação entre as pontas de prova





$$\rho_s = \frac{V}{I} C$$

d/s	circle diam d/s	$a/d = 1$	$a/d = 2$	$a/d = 3$	$a/d \geqq 4$
1.0				0.9988	0.9994
1.25				1.2467	1.2248
1.5			1.4788	1.4893	1.4893
1.75			1.7196	1.7238	1.7238
2.0			1.9454	1.9475	1.9475
2.5			2.3532	2.3541	2.3541
3.0	2.2662	2.4575	2.7000	2.7005	2.7005
4.0	2.9289	3.1137	3.2246	3.2248	3.2248
5.0	3.3625	3.5098	3.5749	3.5750	3.5750
7.5	3.9273	4.0095	4.0361	4.0362	4.0362
10.0	4.1716	4.2209	4.2357	4.2357	4.2357
15.0	4.3646	4.3882	4.3947	4.3947	4.3947
20.0	4.4364	4.4516	4.4553	4.4553	4.4553
40.0	4.5076	4.5120	4.5129	4.5129	4.5129
∞	4.5324	4.5324	4.5324	4.5325	4.5324