I-V Characteristic of a pn Diode

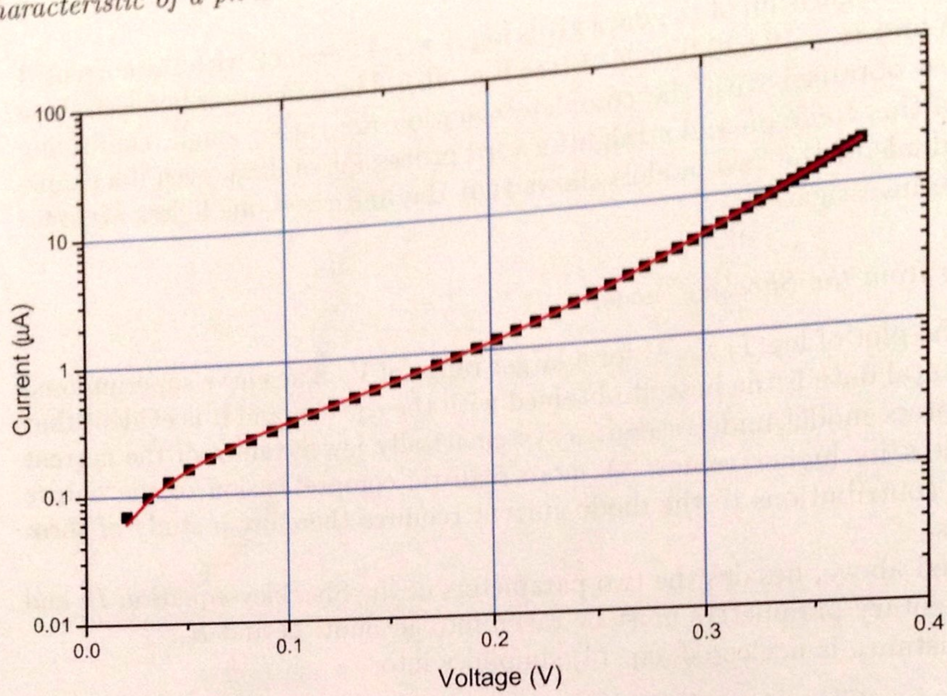

Figure 6. *I–V* data corresponding to the temperature $T = 47.8\,°C$ limited to $I < 20\,\mu A$. The continuous line is the result of the fit of experimental data (black square) with the model of eq. (5). The fitted parameters are $Is = 9.72 \pm 0.17\,nA$ and $B = q/nkT = 20.30 \pm 0.05\,V^{-1}$ and $G = 2.75 \pm 0.01\,\mu S$.

treatment of the reverse biased diode characteristic. Indeed, for $V << nV_T$ the linear approximation of the exponential brings to a linear relation between the current and the voltage:

$$I = (G + BI_S)V \tag{6}$$

which is not useful to calculate G unless I_S and B are known or if the second term of the function of eq. (6) is negligible, as in this case ($BI_S \simeq 0.2\mu S$). As a matter of fact, we find suitable to apply the same least square nonlinear fitting routine using eq. (5) as the model equation. As the first term GV gives an appreciable contribution only at very low values of V we limit the experimental data up to a guess threshold current I_0. The value of the small signal conductance G can be determined executing the corresponding numerical fit with three parameters, I_s, B and G.

The result of the fitting procedure are shown graphically in Fig. (6) and the found values for parameters are reported in the caption. It is worth to note that I_S and B values are not in accordance with those extracted with the minimal model in the central range of the currents. This confirms that the calculated ideality factor n depends on the part of the I–V curve used in its evaluation.

At the higher values of the diode current, the series resistance R_s becomes important, while the admittance G gives a negligible contribution. We may then rewrite eq. (4) as:

$$V(I) = \frac{1}{B}\log\left(\frac{I}{I_S} + 1\right) + R_s I \tag{7}$$