5.4

$$J_S = \frac{eD_n n_{p0}}{L_n} + \frac{eD_p p_{n0}}{L_p} = en_i^2 \left(\frac{D_n}{L_n N_A} + \frac{D_p}{L_p N_D} \right)$$

$$= en_i^2 \left(\frac{D_n}{\sqrt{L_n D_n} N_A} + \frac{D_p}{\sqrt{L_p D_p} N_D} \right)$$

$$\therefore V_{oc} = \frac{k_B T}{e} \ln\left(\frac{I_L}{I_S} + 1 \right) = \frac{k_B T}{e} \left(\frac{J_L}{J_S} + 1 \right)$$

$$= \frac{k_B T}{e} \ln\left[\frac{J_L}{en_i^2 \left(\frac{D_n}{\sqrt{L_n D_n} N_A} + \frac{D_p}{\sqrt{L_p D_p} N_D} \right)} + 1 \right]$$

∴ 通过 matlab 编程

homework5_1.m

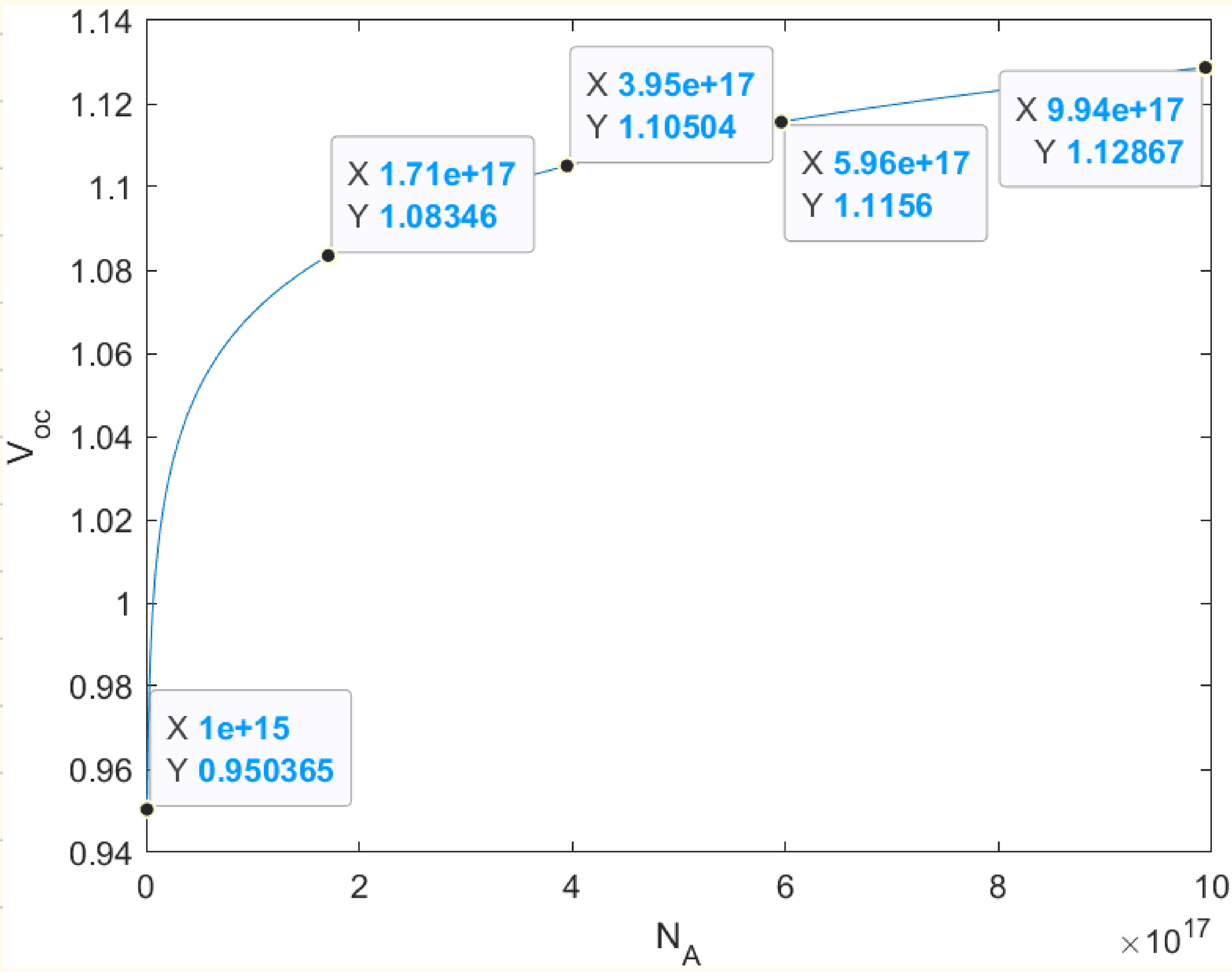
```
NA=1:1:1000;
NA=NA*10^15;

k=0.0259;
Jl=300e-3;
ND=1e19;
Dn=225;
Dp=7;
tn=5e-8;
tp=5e-8;
e=1.6e-19;
ni=1e5;

Ln=sqrt(tn*Dn);
Lp=sqrt(tp*Dp);
Js=e.*ni.^2.*(Dn./(Ln.*NA)+Dp./(Lp.*ND));

Voc=k.*log(Jl./Js+1);

plot(NA, Voc);
```



作业题2：

探测器需要二极管灵敏

$$R = \frac{\eta\lambda}{1.24} = 0.665\ A/W$$

作业题3：

(1) n^+费米能级相对导带底位置：

$\because N_D >> n_i \quad \therefore n_0 = N_D$

$\therefore E_F - E_C = k_B T \ln(n_0/N_C) = k_B T \ln(N_D/N_C)$

$= 0.1233eV$

(2) P^+费米能级相对价带顶位置：

$\because N_A >> n_i \quad \therefore P_0 = N_A$

$\therefore E_V - E_P = k_B T \ln(P_0/N_V) = k_B T \ln(N_A/N_V)$

$= 0.0604eV$

(3) 真空能级差：

$eV_D = eV_T \ln\left(\frac{N_A N_D}{n_i^2}\right) = k_B T \ln\left(\frac{N_A N_D}{n_i^2}\right)$

$= 1.615eV$

(4) 导带底能级差：

$eV_D - eV_F = 0.315eV$

(5) 价带底能级差同导带底能级差一样为 0.315eV

(7)&(8) 冶金结处未发生突变，均为0

(6)与前面重复。

作业题4：

$$W = \left[\frac{2\varepsilon_r \varepsilon_0 (V_D - V_F)(N_A + N_D)}{e N_A N_D} \right]^{\frac{1}{2}} \approx 3.825 \times 10^{-7}\ cm$$

（→单位换为F/cm）

$$\because \begin{cases} W = x_p + x_n \\ N_D \cdot x_n = N_A \cdot x_p \end{cases}$$

$\therefore$ 解得：$x_p = 1.656 \times 10^{-7}\ cm$

$x_n = 2.169 \times 10^{-7}\ cm$

$L_n = \sqrt{D_n \tau_n} = 3.354 \times 10^{-3}\ cm$

$L_p = \sqrt{D_p \tau_p} = 8.916 \times 10^{-4}\ cm$

作业题5：