COMPOSANTS SEMI-CONDUCTEURS

V) Solutions S5

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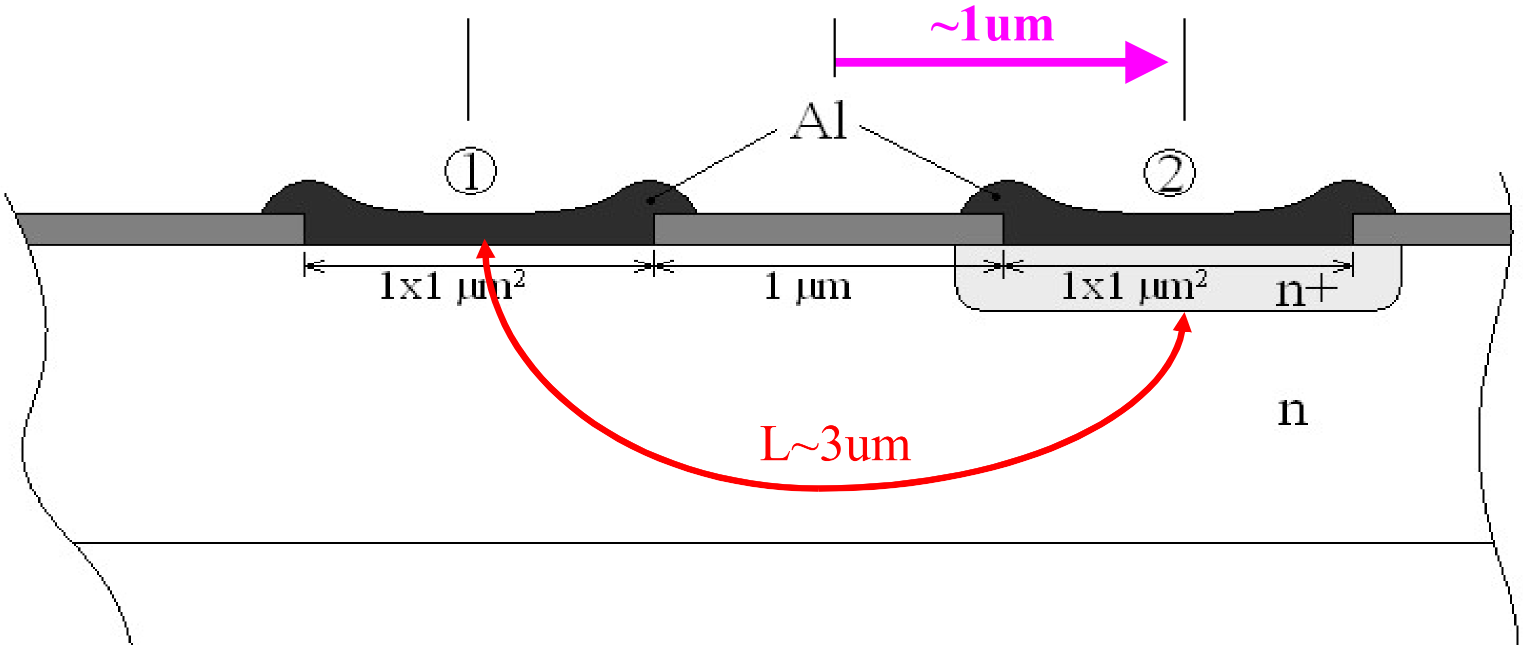
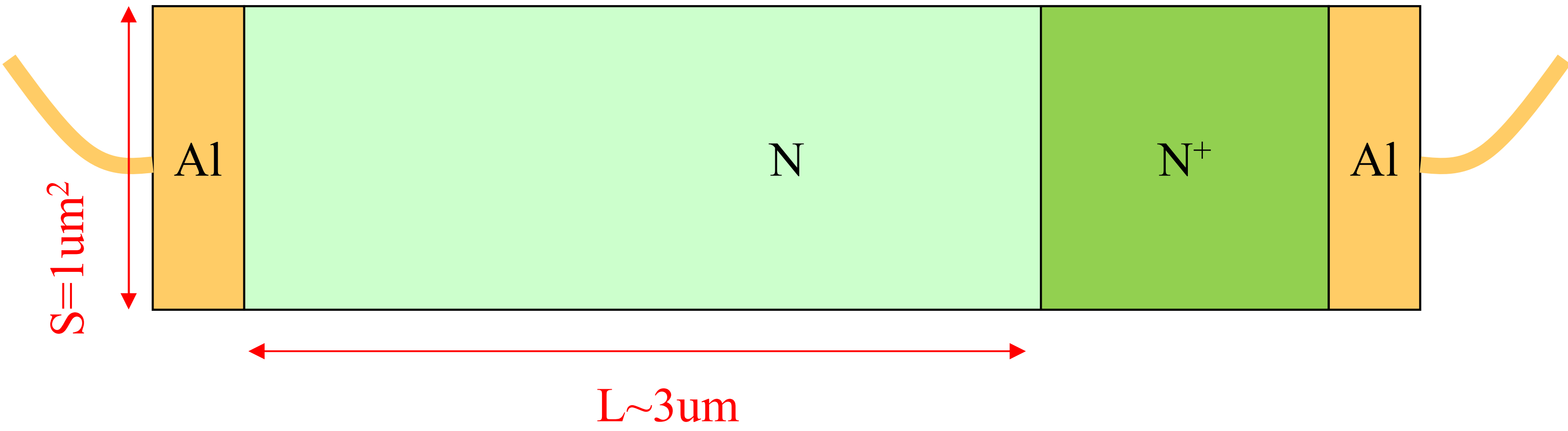
EPFL

Exercice E5.1: diode Schottky





Largeur de la zone de déplétion

Built-in potentital: $q \cdot V_{bi} \cong \frac{E_g}{2}$

Depletion layer: $W = \sqrt{\frac{2\varepsilon_0\varepsilon}{q \cdot N_D} \cdot V_{bi}}$

La jonction Al / N-Si: $N_D = 10^{16}\ cm^{-3}$

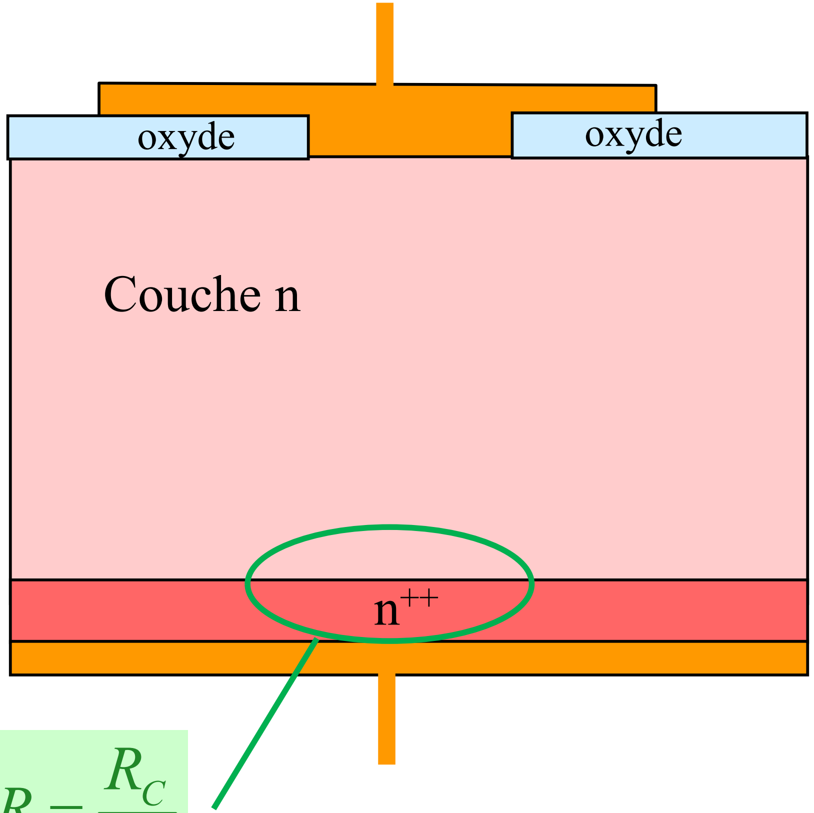
$W_1 \cong 270\ nm$ ⇨ diode Schottky

La jonction Al / N$^+$-Si: $N_D = 10^{20}\ cm^{-3}$

$W_3 \cong 3\ nm$

⇨ La jonction subit l'effet tunnel et devient un contact ohmique

Résistance de contact



$$R = \frac{R_C}{S}$$

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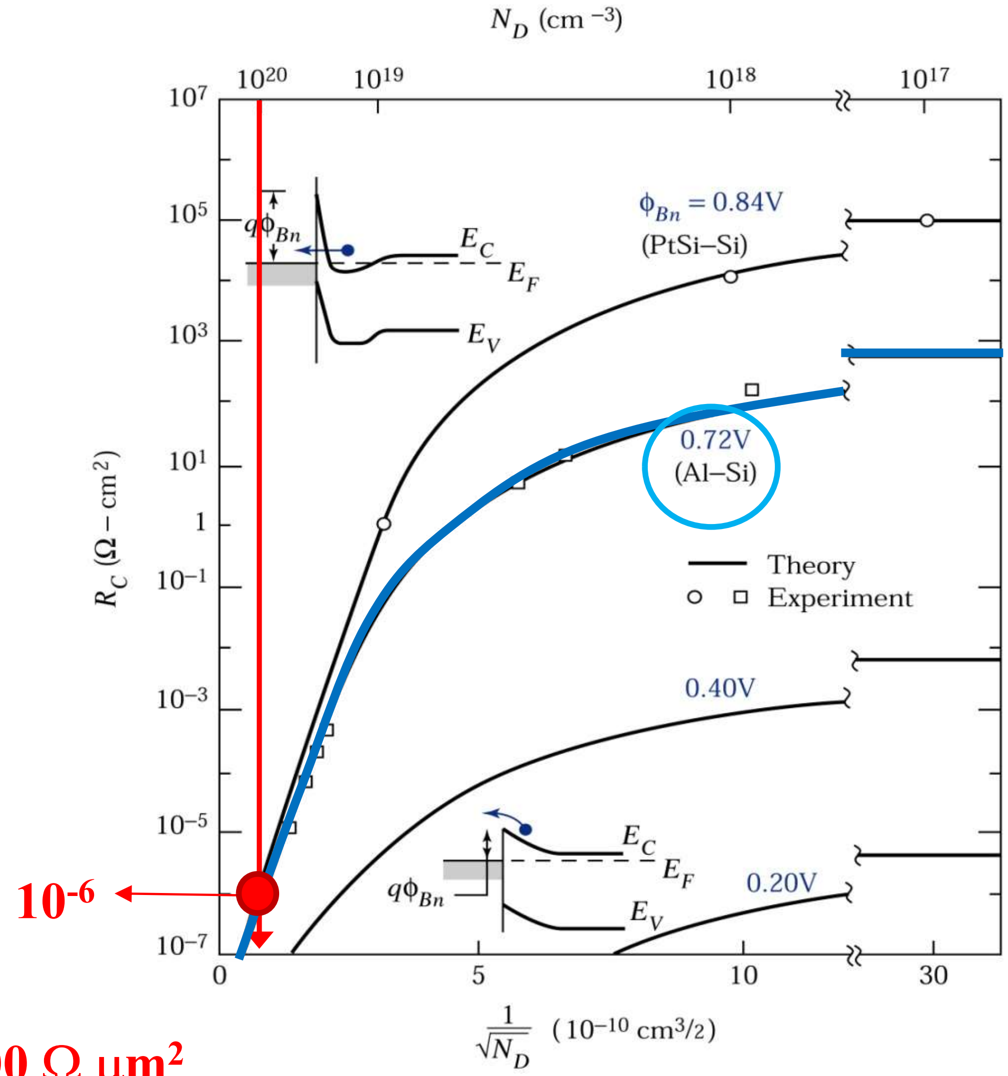
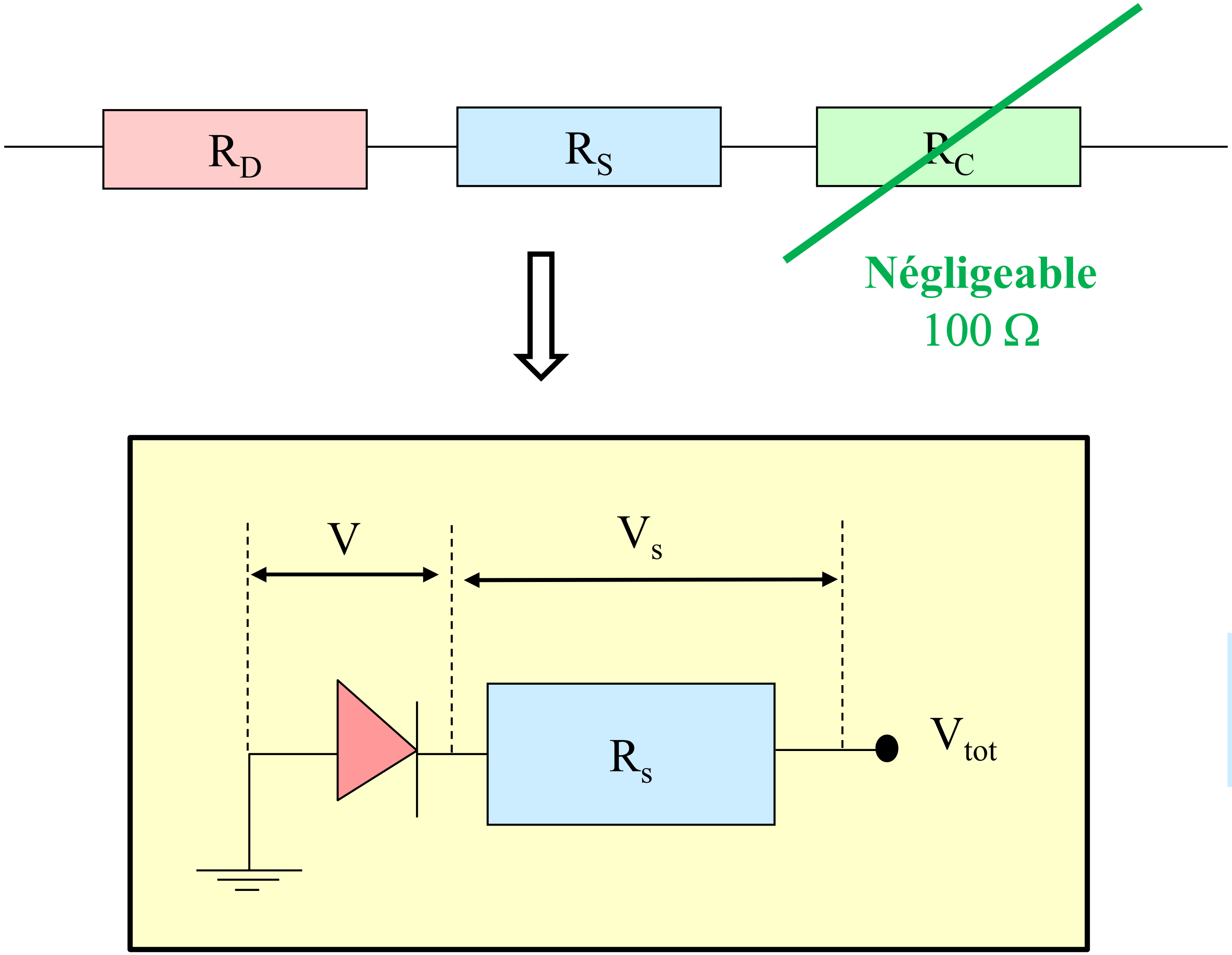


100 Ω µm²

Modèle électrique



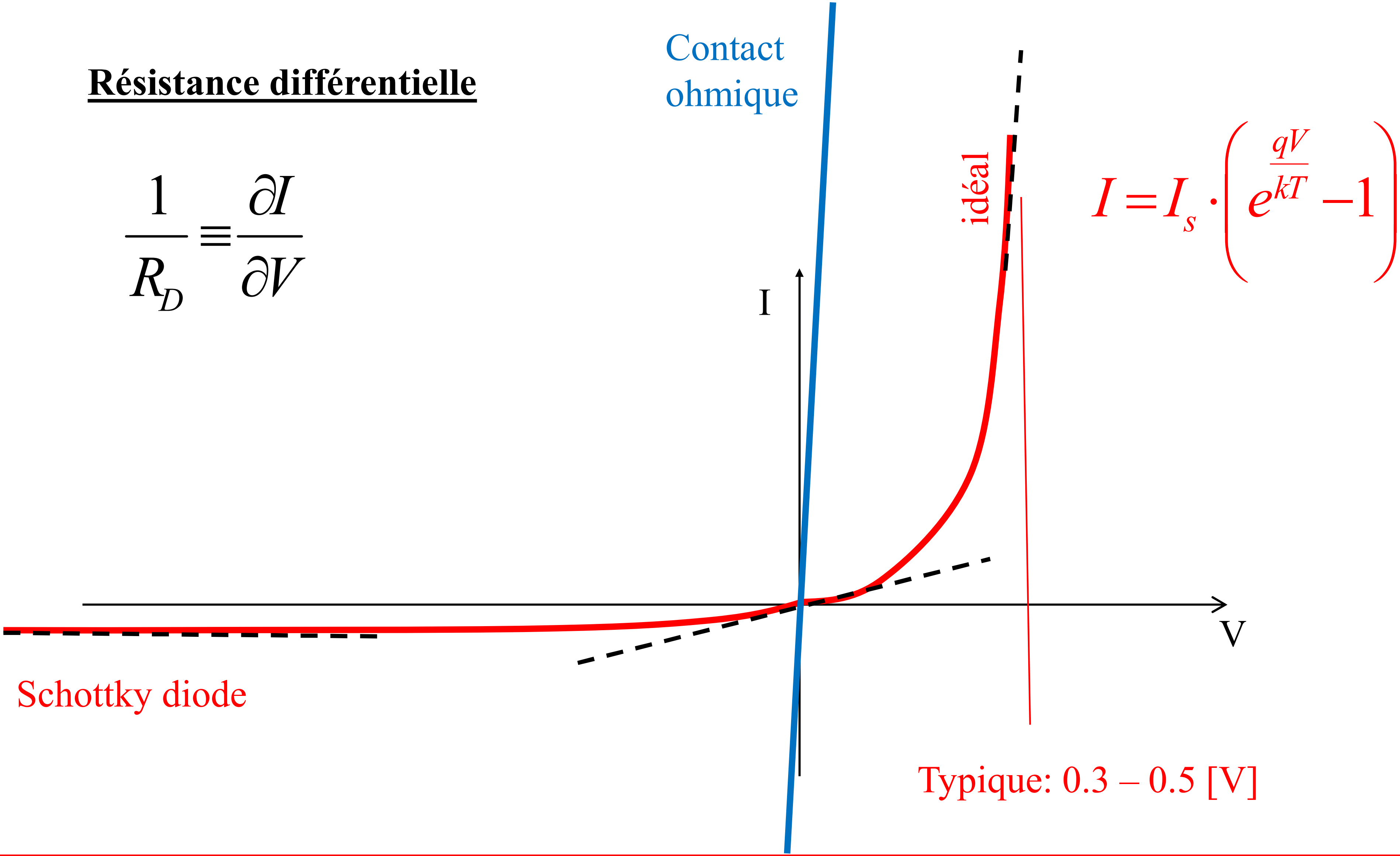
$$R_s = \frac{L}{S}\frac{1}{qn\mu_n} \cong 15\ k\Omega$$

$$\mu_n \cong 1200\,[cm^2 / Vs]$$

Résistance différentielle et contact ohmique

Résistance différentielle

$$\frac{1}{R_D} \equiv \frac{\partial I}{\partial V}$$



Calcul des résistances

Résistance de la diode Schottky:

$$\frac{1}{R_D} = \frac{\partial I}{\partial V} = \frac{qI_S}{kT} e^{qV/kT}$$

$$I_S = S \cdot A_0 \cdot T^2 \cdot e^{-\frac{q\phi_B}{kT}} \cong S \cdot A_0 \cdot T^2 \cdot e^{-\frac{E_g/2}{kT}} \cong 30\ pA$$

$\Rightarrow$

$R_D\big|_{V=-1} \cong \infty$

$R_D\big|_{V=0} \cong 0.8\ G\Omega$

$R_D\big|_{V=0.1} \cong 15\ M\Omega$

$R_D\big|_{V=0.4} \cong 94\ \Omega$

Résistance du substrat

$$R_s = \frac{L}{S}\frac{1}{qn\mu_n}$$

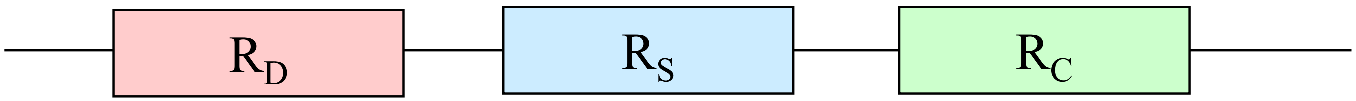
$\mu_n \cong 1200\,[cm^2/Vs]$

$R_S \cong 15\ k\Omega$

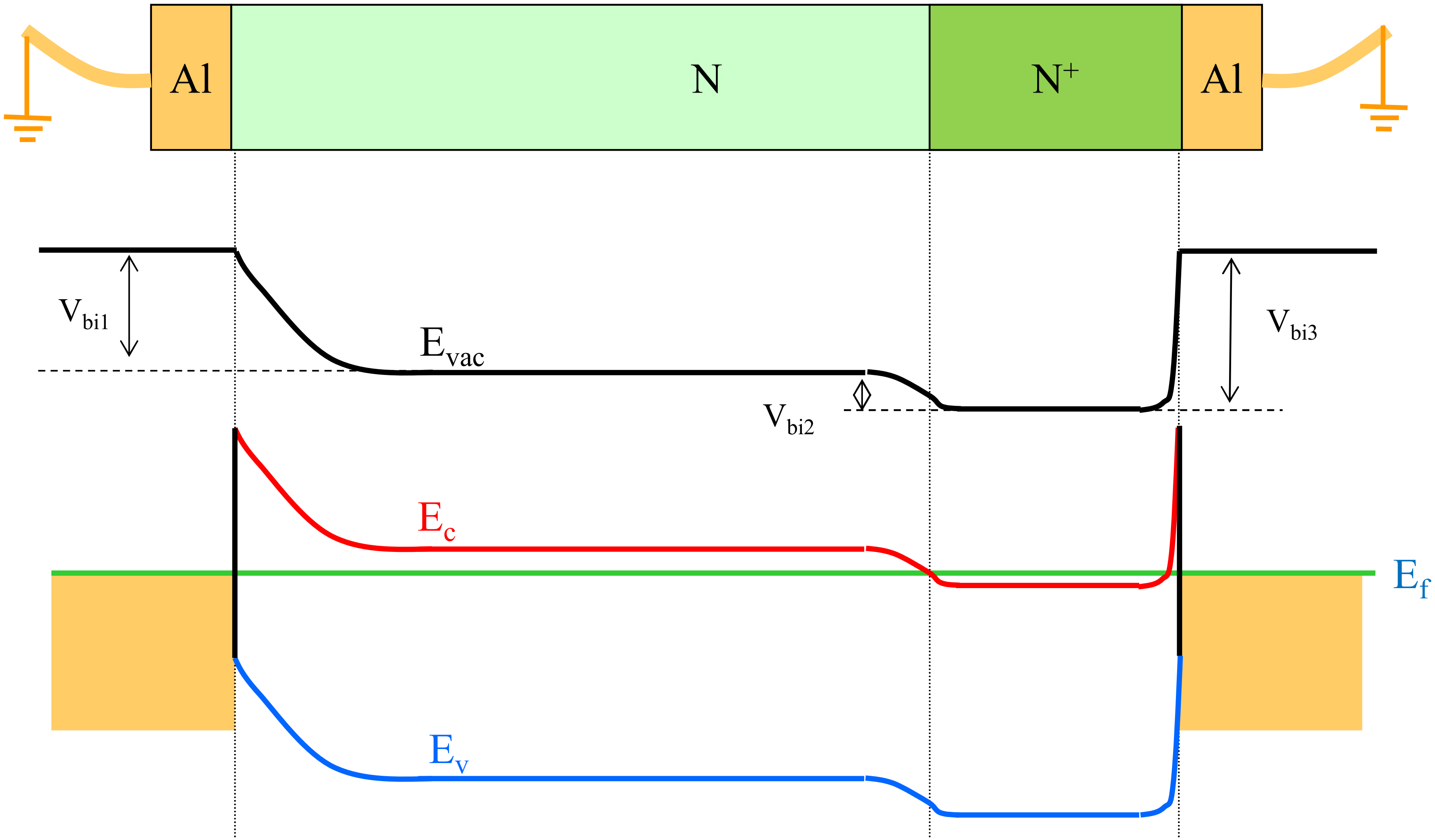
Résistance du contact ohmique:

$$R_C \cong 10^{-6} / S_{[cm^2]}$$

$R_C \cong 100\ \Omega$

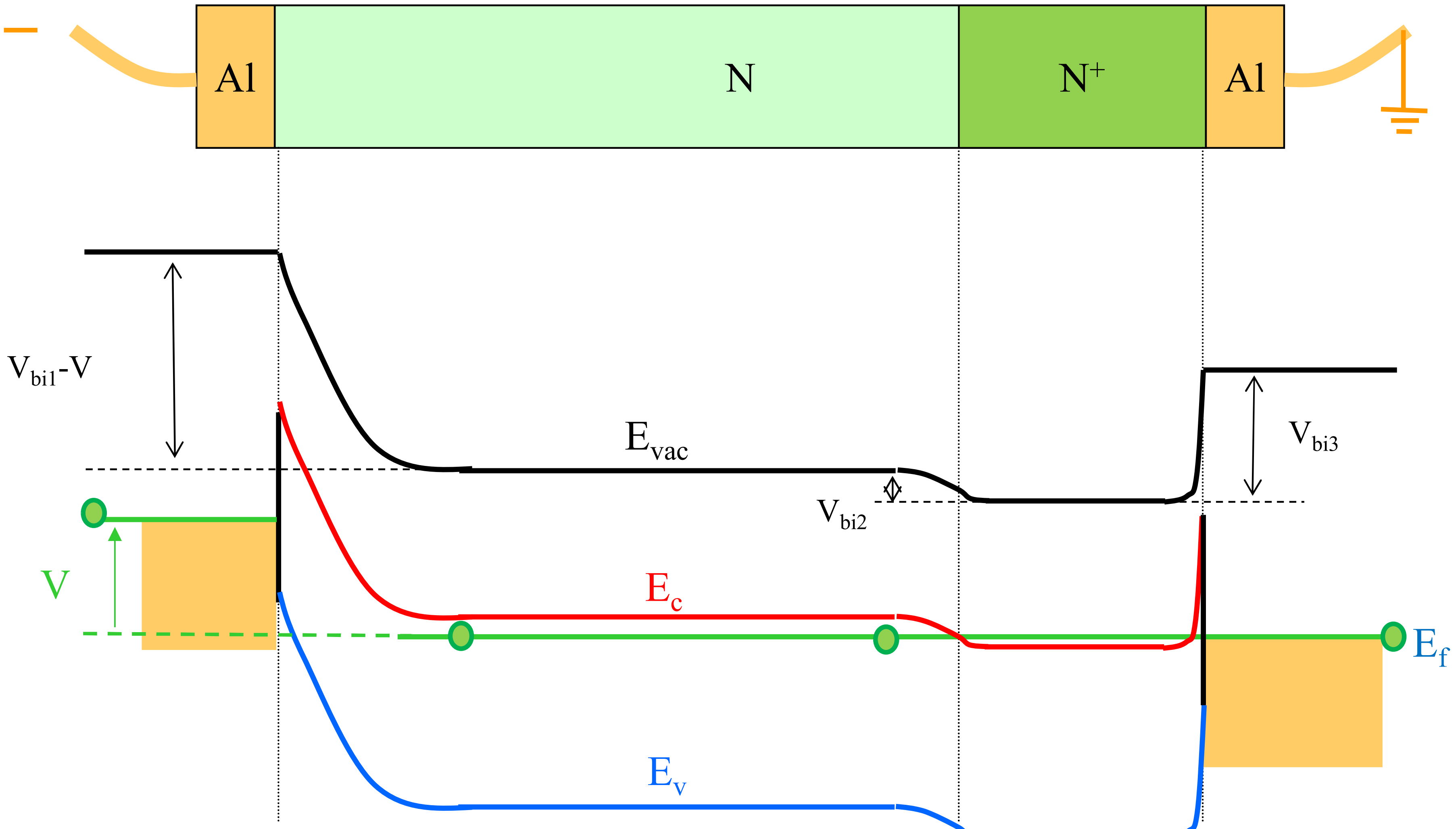


Pas de polarisation



Polarisation inverse de 1V

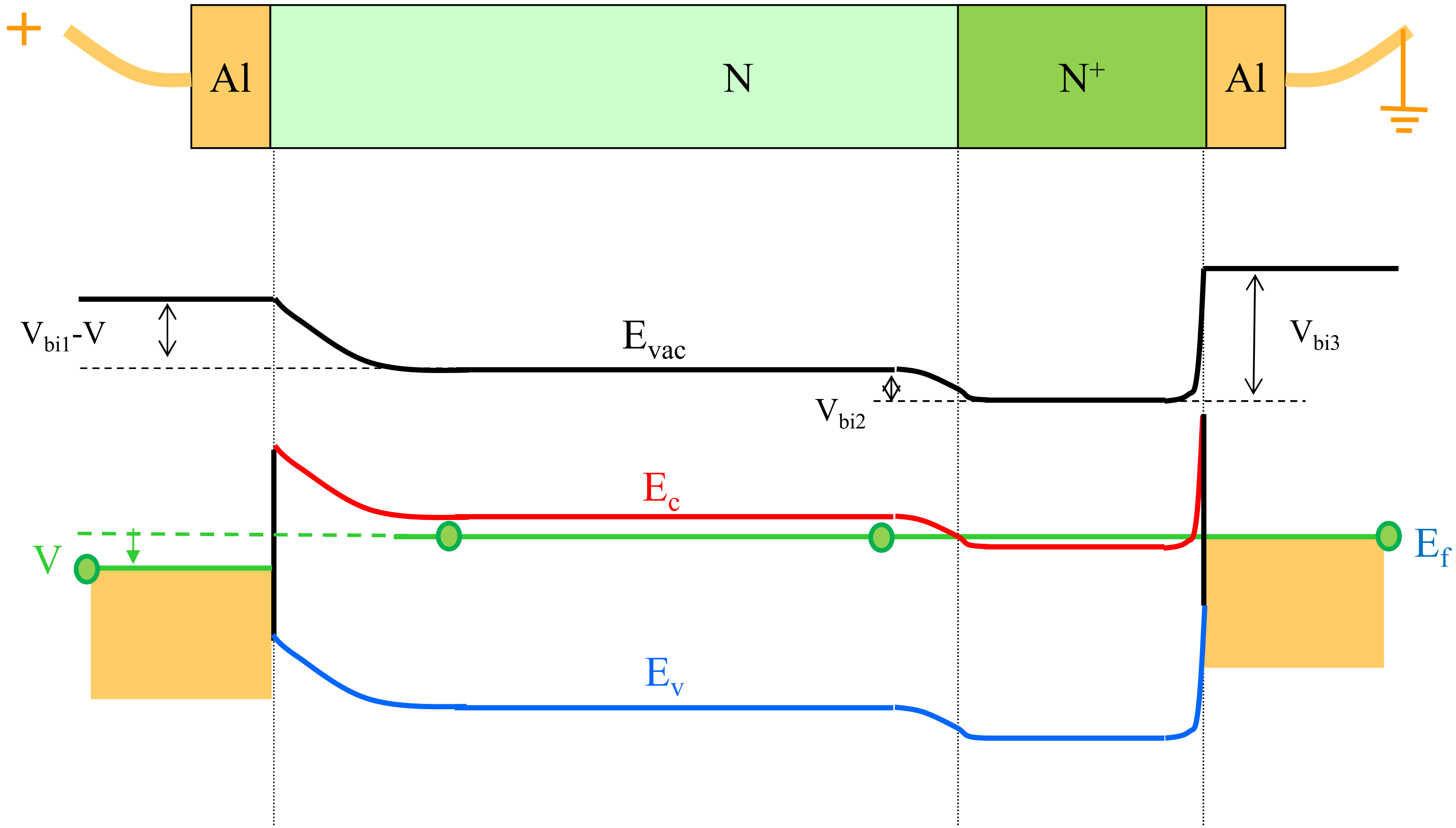
V= -1 [V]: $I = -I_s \cong -30\ pA$ ⟹ $V_s \cong R_S \cdot I \cong -0.45\,[\mu V]$



PAB

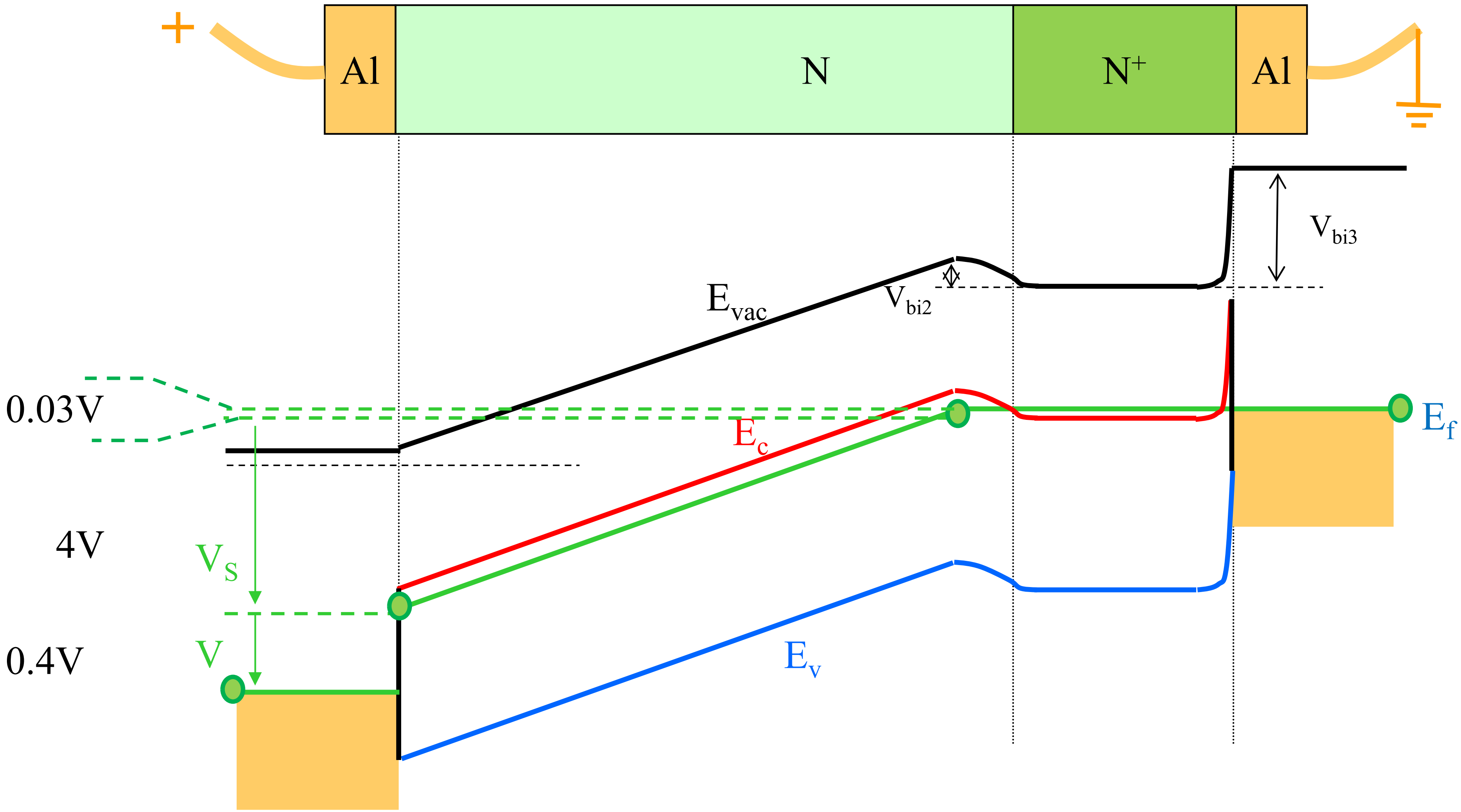
Polarisation directe de 0.1V

V= +0.1 [V]: $I = I_s(e^{\frac{qV}{kT}} - 1) \cong 1.6\, nA$ ⇨ $V_s \cong R_S \cdot I \cong 24\,[\mu V]$

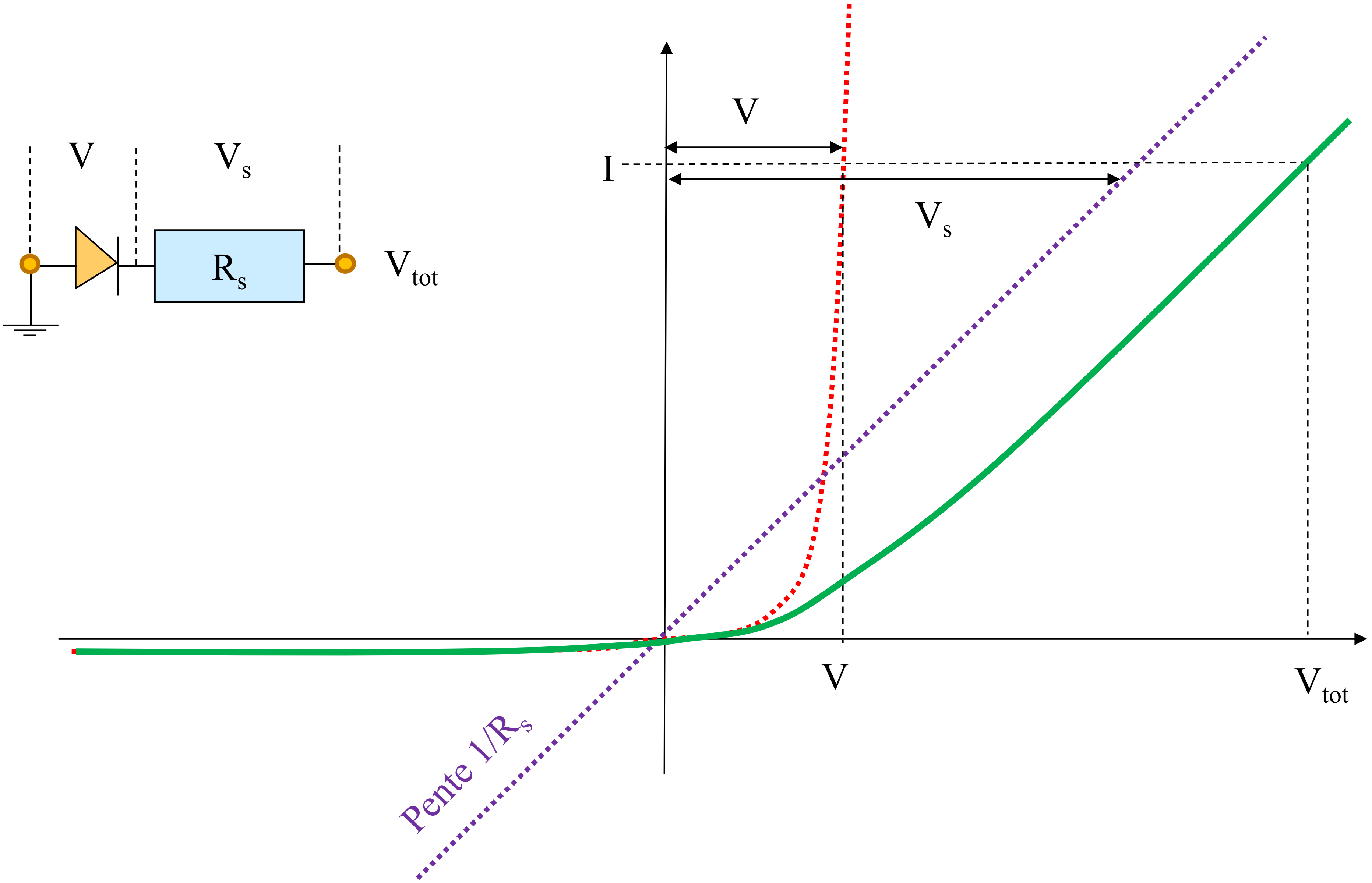


Polarisation directe de 0.4V

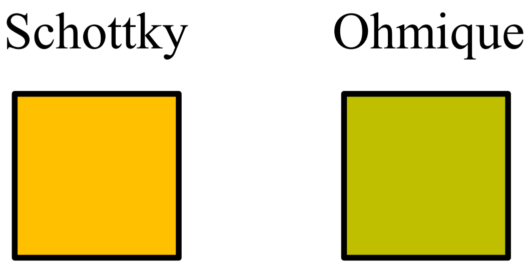
V= +0.4 [V]: $I \cong I_s e^{\frac{qV}{kT}} \cong 0.26\ mA$ ⇨ $V_s \cong R_S \cdot I \cong 4\,[V]$



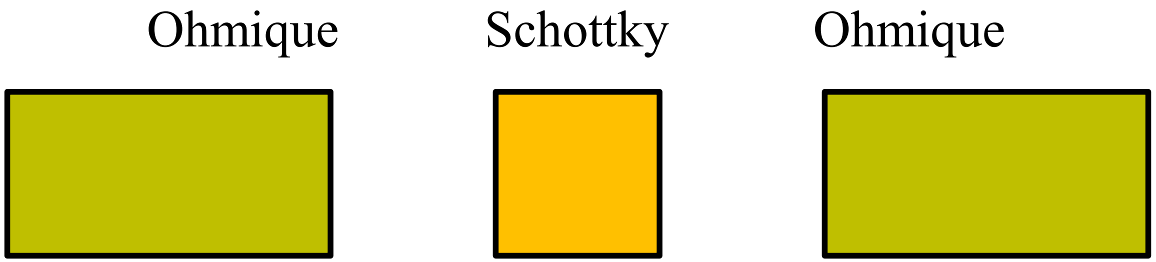
Courbe I-V



Diminuer la résistance en série



Diminuer la résistance en série



Diminuer la résistance en série