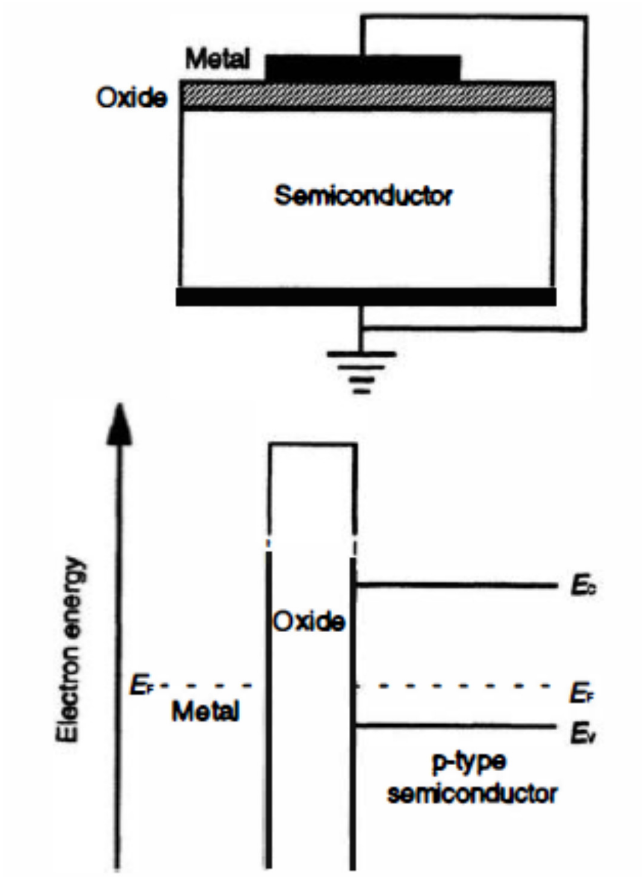
Giunzione Metallo – Ossido (=isolante) – *S*emiconduttore :

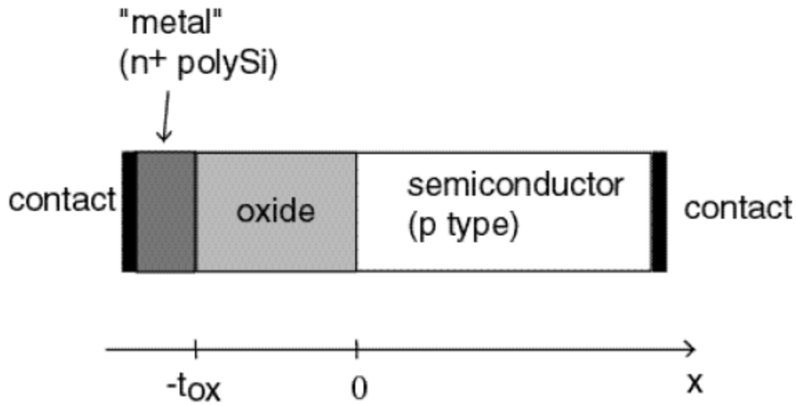
Realizzata sotto forma di *condensatore MOS*

Situazione all'equilibrio:



Gap nell'ossido ~ 10 eV $\gg$ Gap nel semiconduttore

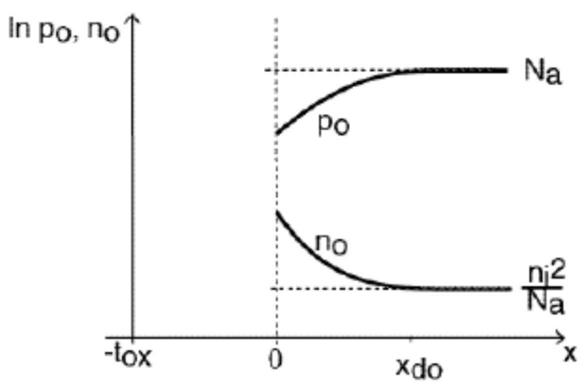
Situazione all'equilibrio:

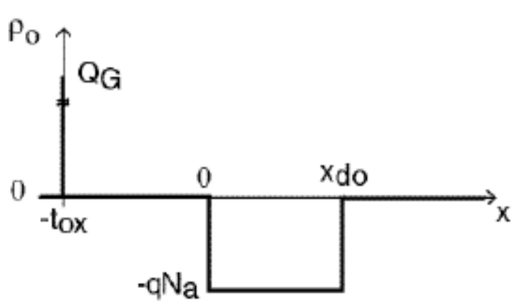


Contatto ohmico fra M e S

$\rightarrow$ Trasferimento di elettroni $M \rightarrow S$, lacune $S \rightarrow M$

$\rightarrow$ Carica spaziale





$\sigma = Q_G \qquad x = -t_{ox}$ carica superficiale sul metallo

$\rho_0(x) = 0 \qquad -t_{ox} < x < 0$

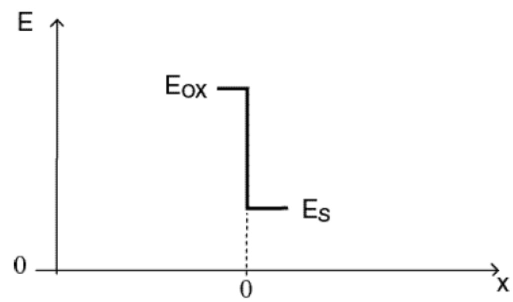
$\rho_0(x) = -qN_A \qquad 0 < x < x_{d0}$

$\rho_0(x) = 0 \qquad x > x_{d0}$

$E_0(x_2) - E_0(x_1) = \frac{1}{\varepsilon} \int_{x1}^{x2} \rho_0(x') dx'$ c. elettrico

$\varepsilon_{ox} E_{ox} = \varepsilon_s E_s$ cons. componente normale di **E** fra due mezzi

$\rightarrow \frac{E_{ox}}{E_s} = \frac{\varepsilon_s}{\varepsilon_{ox}} \approx 3$



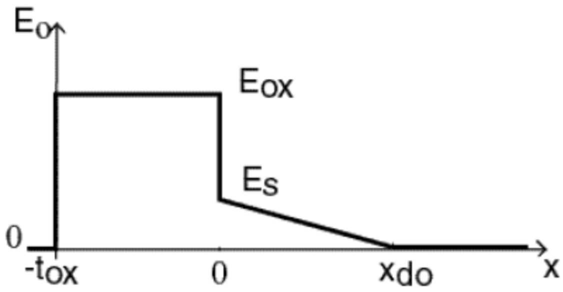
$\rightarrow$ C. elettrico vs x:

$E_0(x) = 0 \qquad x < -t_{ox}$

$E_0(x) = \frac{\varepsilon_s}{\varepsilon_{ox}} E_0(x = 0^+) = \frac{qN_A x_{d0}}{\varepsilon_{ox}} \qquad -t_{ox} < x < 0$

$E_0(x) - E_0(x_{d0}) = \frac{1}{\varepsilon_s} \int_{x_{d0}}^{x} (-qN_A) dx' = -\frac{qN_A}{\varepsilon_s}(x - x_{d0}) \qquad 0 < x < x_{d0}$

$E_0(x) = 0 \qquad x > x_{d0}$



Valori limite del potenziale nel metallo e nel semiconduttore:

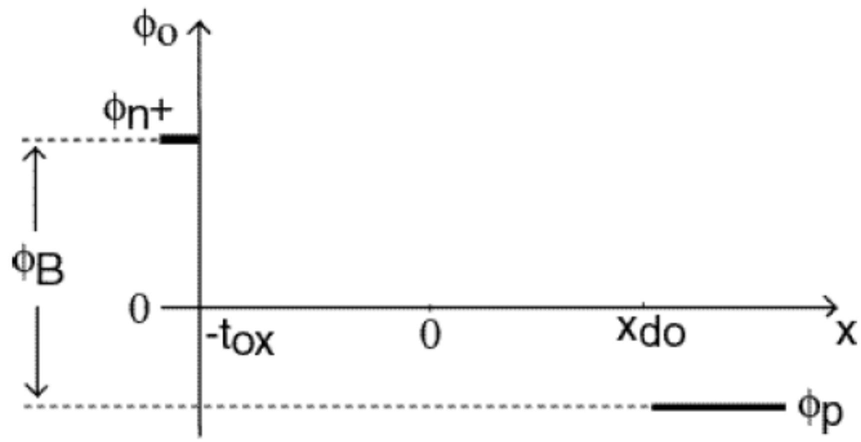
$$\phi = \frac{kT}{q} ln \frac{n_0}{n_i} \quad \text{metallo}$$

$$n_0 = N_D^+ \rightarrow \phi_{n^+} = \phi_G = \frac{kT}{q} ln \frac{N_D^+}{n_i}$$

$$\phi = -\frac{kT}{q} ln \frac{p_0}{n_i} \quad \text{semiconduttore}$$

$$p_0 = N_A \rightarrow \phi_p = -\frac{kT}{q} ln \frac{N_A}{n_i}$$

$$\rightarrow \phi_G - \phi_p = \phi_{n^+} + \frac{kT}{q} ln \frac{N_A}{n_i} \equiv \phi_{bi} \left(\equiv \phi_B \text{ nei grafici} \right)$$



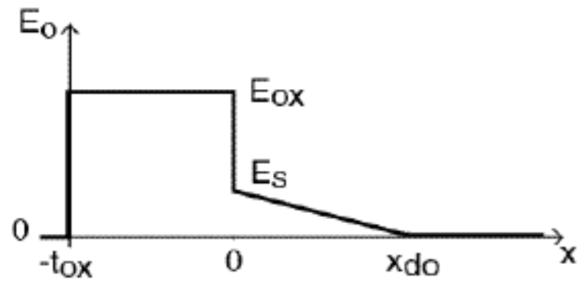
$$\phi_0(x) = \phi_{n^+} \qquad x < -t_{ox}$$

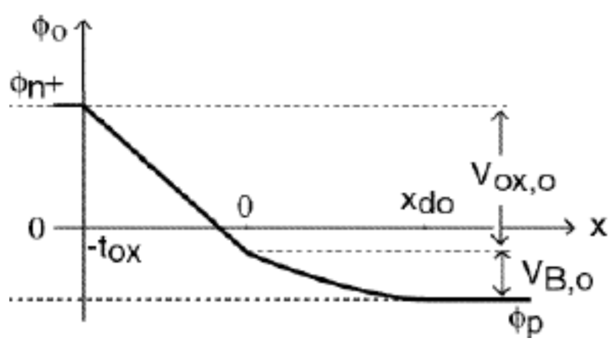
$$\phi_0(x) = \phi_p + \frac{qN_A}{2\varepsilon_s} x_{d0}^2 + \frac{qN_A x_{d0}}{\varepsilon_{ox}}(-x) \qquad -t_{ox} < x < 0$$

$$\phi_0(x) - \phi_0(x_{d0}) = -\int_{x_{d0}}^{x} -\frac{qN_A}{\varepsilon_s}(x' - x_{d0})dx'$$

$$\rightarrow \phi_0(x) = \phi_p + \frac{qN_A}{2\varepsilon_s}(x - x_{d0})^2 \qquad 0 < x < x_{d0}$$

$$\phi_0(x) = \phi_p \qquad x > x_{d0}$$





Per determinare x_{0d}:

$$\rightarrow \phi_B = V_{sc} + V_{ox} = \frac{qN_A x_{0d}^2}{2\varepsilon_s} + \frac{qN_A t_{ox} x_{0d}}{\varepsilon_{ox}}$$

$$\rightarrow x_{0d} = \frac{\varepsilon_s}{\varepsilon_{ox}} t_{ox} \left(\sqrt{1 + \frac{2\varepsilon_{ox}^2 \phi_B}{q\varepsilon_s N_A t_{ox}^2}} - 1 \right)$$

Definendo

$C_{ox} = \frac{\varepsilon_{ox}}{t_{ox}}$ capacita'/unita' di superficie

$$\rightarrow x_{0d} = \frac{\varepsilon_s}{C_{ox}} \left(\sqrt{1 + \frac{2C_{ox}^2 \phi_B}{q\varepsilon_s N_A}} - 1 \right)$$