

METALLO - METALLO

Interfaccia ideale Me - Me

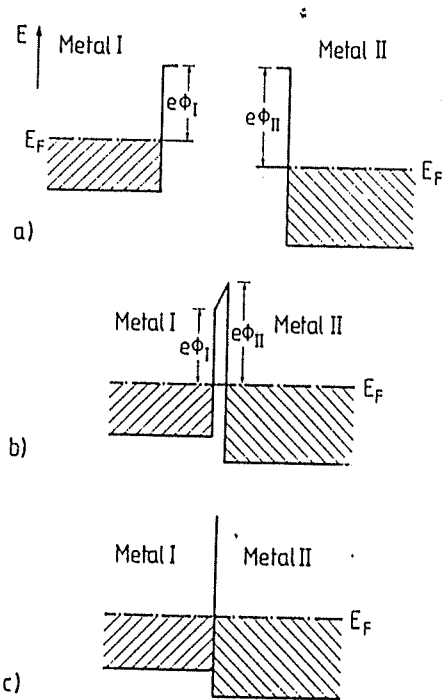
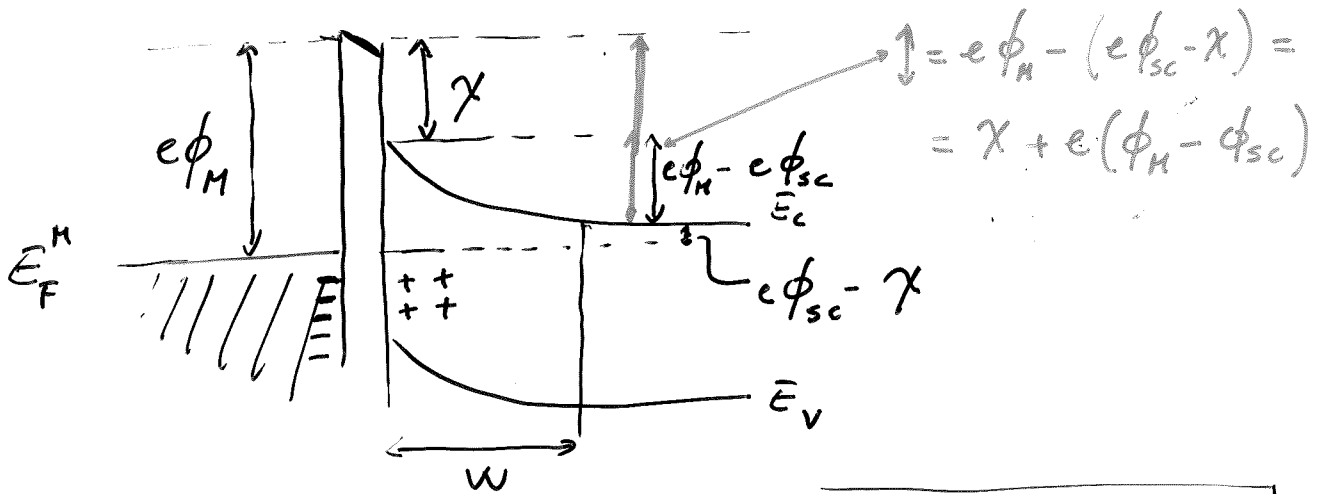
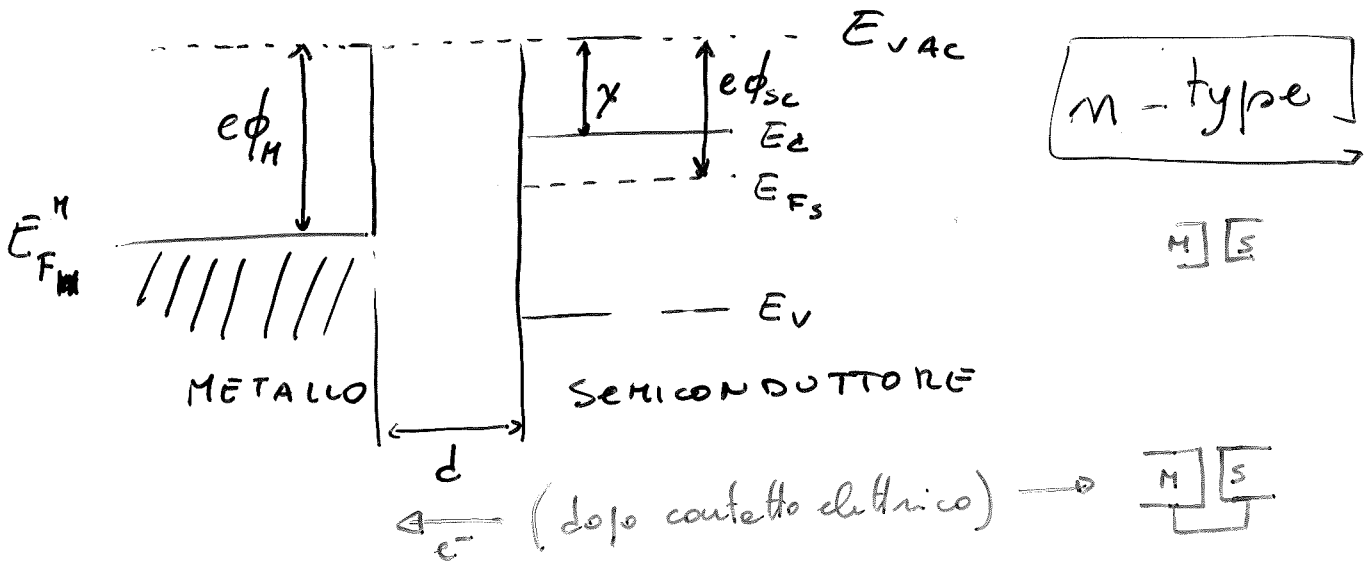


Fig. 8.1a-c. Schematic diagram of the formation of a metal-metal interface. (a) Simplified band schemes of the two metals I and II with work functions $e\phi_I$ and $e\phi_{II}$; the metals are assumed to be not in contact with each other; E_F is the Fermi energy. (b) Band schemes of the conduction bands at the interface for the two metals in contact. (c) Simplified representation of the metal-metal contact; the dipole layer at the interface is not shown

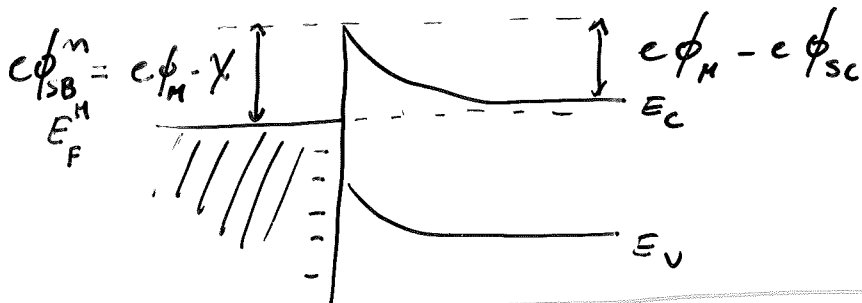
- 1) Metalli con diversa $e\phi_1, e\phi_2 =$ funzione lavoro
- 2) In contatto elettrico $\bar{E}_F(1) = \bar{E}_F(2)$
- 3) Flusso di cariche da $e\phi$ minore $\rightarrow e\phi$ maggiore
- 4) Formazione di un dipolo
cariche positive in I \div cariche negative in II
- 5) Il dipolo, all'interno dei due metalli, \bar{e} schermo degli elettroni di conduzione

MODELLO DI SCHOTTKY

Senza stati di superficie



$$e\phi_{SB}^M = e\phi_M - \chi$$



NOTARE: $e\phi_{SB}^M > e(\phi_M - \phi_{sc})$

\Rightarrow elettroni metallo \rightarrow semiconduttore
 più difficile che semiconduttore \rightarrow metallo

INTERFACCIA METALLO - SEMICONDUCTORE

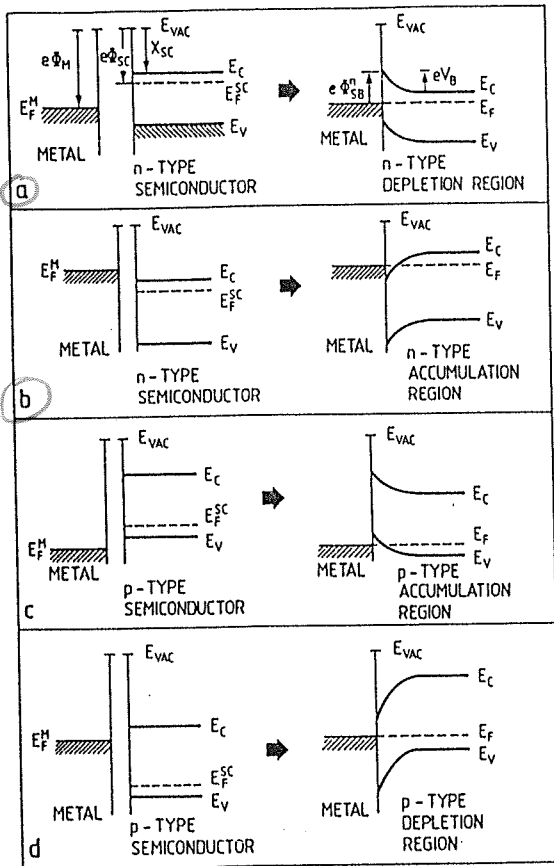


Fig. 8.2a-d. Schematic diagrams of band bending before and after metal-semiconductor contact: (a) High-work-function metal and n-type semiconductor, (b) low-work-function metal and n-type semiconductor, (c) high-work-function metal and p-type semiconductor, and (d) low-work-function metal and p-type semiconductor [8.2]

- a) $e\phi_M > e\phi_{SC}$ (n-type)
- 1) elettroni metallo \rightarrow semiconduttore
 - 2) svuotamento nel semic.
 - 3) densità di carica nel metallo
 - 4) Eq di Poisson \rightarrow band bending.
 - 5) Barriera ($e\phi_{SB}^n$) tra Me - Sem.

- b) $e\phi_M < e\phi_{SC}$ (n-type)
- 1) elettroni metallo \rightarrow semicond.
 - 2) accumulazione nel semicond.
 - 3) bending.
 - 4) barriera NO!

Interfaccia ideale Me - Se

- $e\phi_M$ = FUNZIONE LAVORO METALLO
- $e\phi_{SC}$ = FUNZIONE LAVORO SEMICONDUCTORE
- χ_{SC} = AFFINITÀ ELETTRONICA SEMICONDUCTORE

- 1) QUANDO SONO IN CONTATTO : $E_F^M = E_F^{SC}$
- 2) TRASFERIMENTO DI CARICA
- 3) PRESENZA DI DIPOLLO
- 4) ZONA DI SVUOTAMENTO (ACCUMULAZ.) PROFONDA NEI SEMIC - STRETTA NEI METALLI

PRESENZA DI STATI DI SUPERFICIE

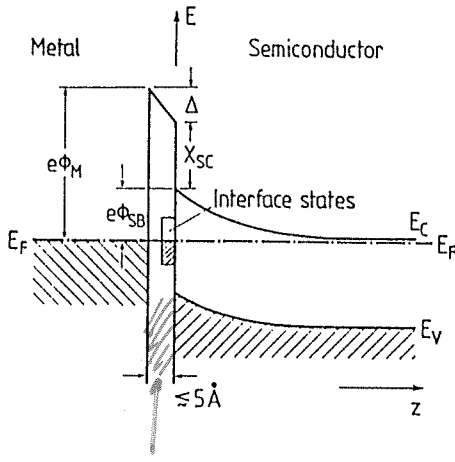
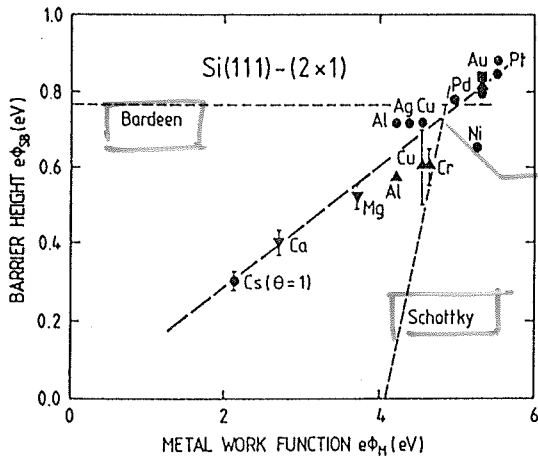


Fig. 8.4. Band diagram of a metal-semiconductor junction in which the interface region (width $\approx 5 \text{ \AA}$) is taken into account explicitly. The formation of new interface states of sufficient density pins the Fermi-level; $e\phi_M$ is the metal work function, χ_{sc} the electron affinity of semiconductor, $e\phi_{SB}$ the Schottky barrier height, and Δ the interface dipole energy

ZONA D'INTERFACCIA

NEL MODELLO NON SONO CONSIDER.

- RICOSTRUZIONE
- DIFFUSIONE
- LEGAMI ME-SE
- STATI DI SUPERFICIE



DATI SPERIMENTALI

Fig. 8.3. Barrier heights $e\phi_{SB}$ of Si-Schottky contacts versus metal work function $e\phi_M$. The data were obtained by different researchers from measurements on the metal-covered Si(111)-(2x1) cleaved surface. For comparison the predictions of the Schottky model (no interface states) and the Bardeen model (high density of interface states) are given [8.4]

Modello di Bardeen

- 1) STATI DI SUPERF. ESISTONO DOPO DEPOSITO DI ME ?
- 2) E_F BLOCCATO DA STATI DI SUPERFICIE
- 3) E_F NON DIPENDE DA $\phi_M \rightarrow$ dal metallo

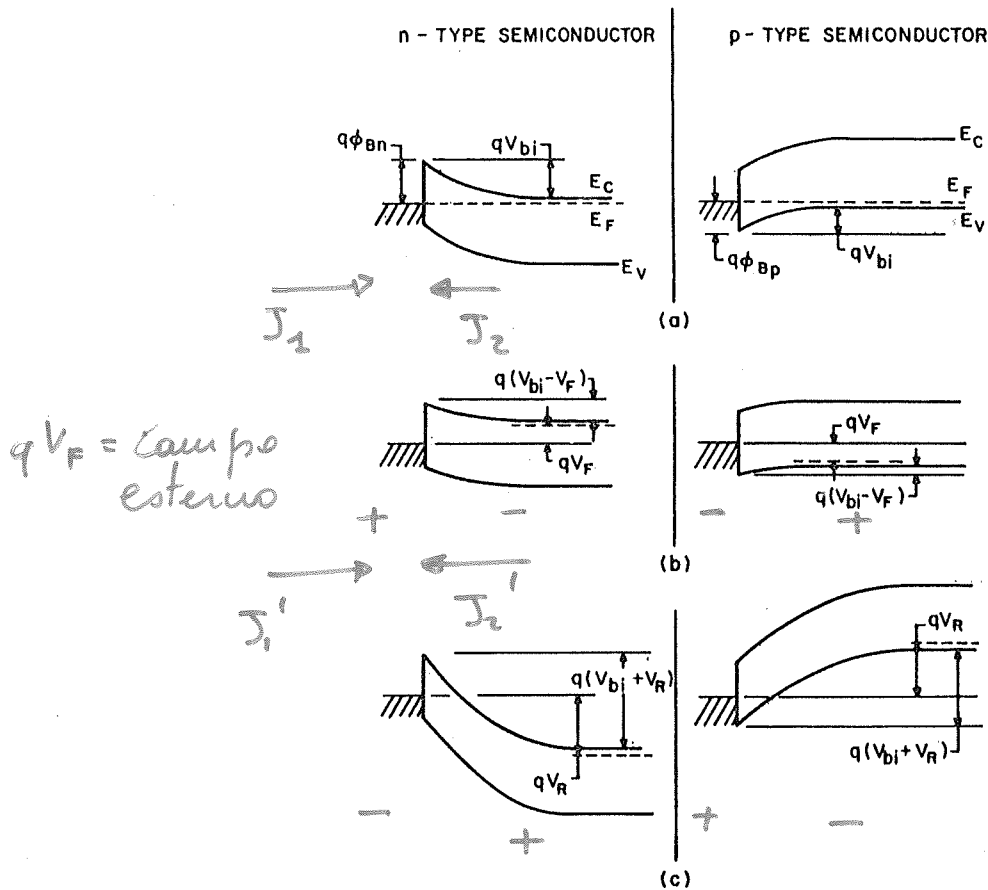


Fig. 2 Energy-band diagram of metal n-type and metal p-type semiconductors under different biasing conditions (a) Thermal equilibrium. (b) Forward bias. (c) Reverse bias.

$$a) J_1 = J_2 \rightarrow J_T = 0$$

$$b) \left. \begin{array}{l} J_1' = J_1 \\ J_2' = J_2 e^{\frac{eV_F}{kT}} \end{array} \right\} J_T = J_2 \left[e^{\frac{eV_F}{kT}} - 1 \right]$$

$$c) \left. \begin{array}{l} J_1' = J_1 \\ J_2' = J_2 e^{-\frac{eV_R}{kT}} \end{array} \right\} J_T = J_1 \left[1 - e^{-\frac{eV_R}{kT}} \right]$$

Comportamento
rettificante!

$\phi_M > \phi_{sc} \rightarrow$ rettificante

$\phi_M < \phi_{sc} \rightarrow$ ohmico