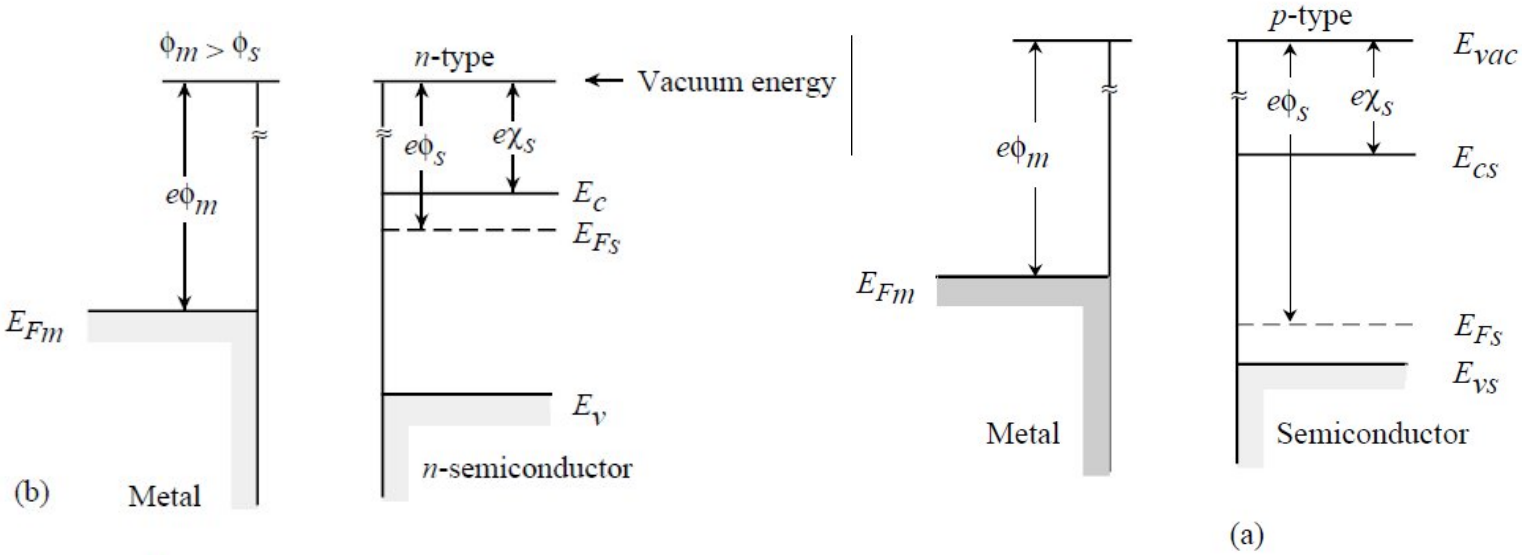
Φ – 575 Διάλεξη 11

Φυσική διατάξεων δισδιάστατων ημιαγωγών

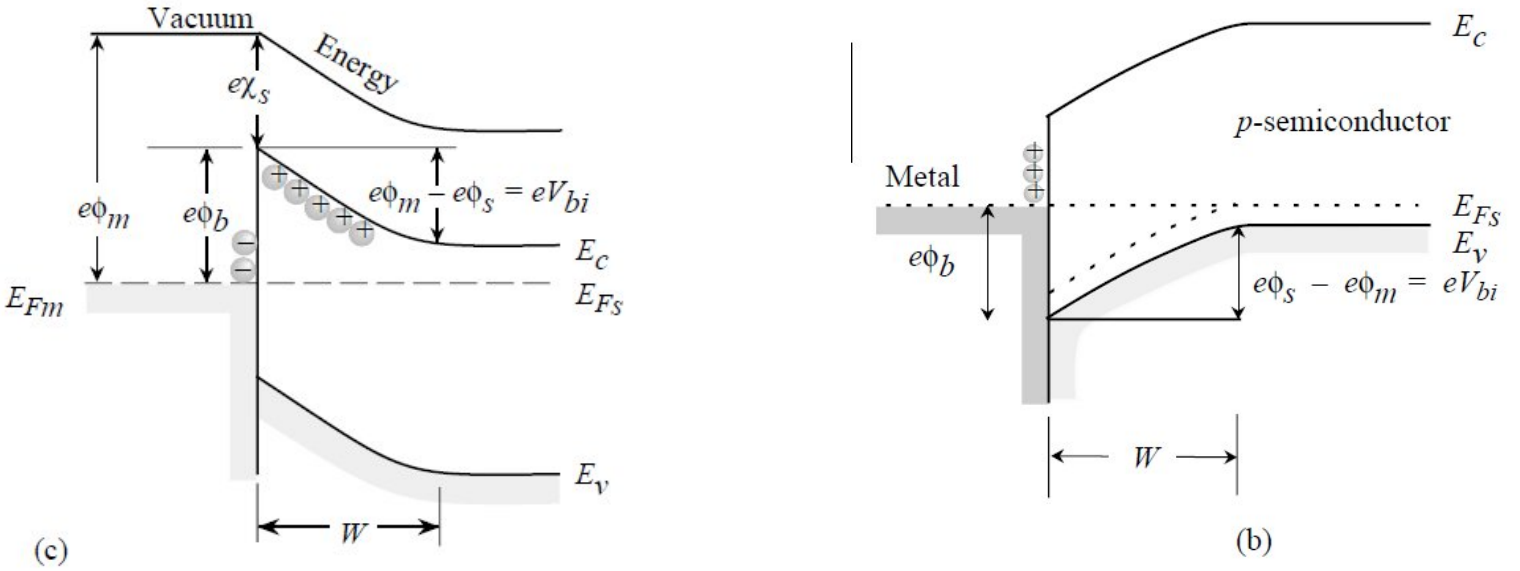
Γιώργος Δεληγεώργης (deligeo@physics.uoc.gr)

Metal – n-type semi $\Phi_m > \Phi_s$ contact

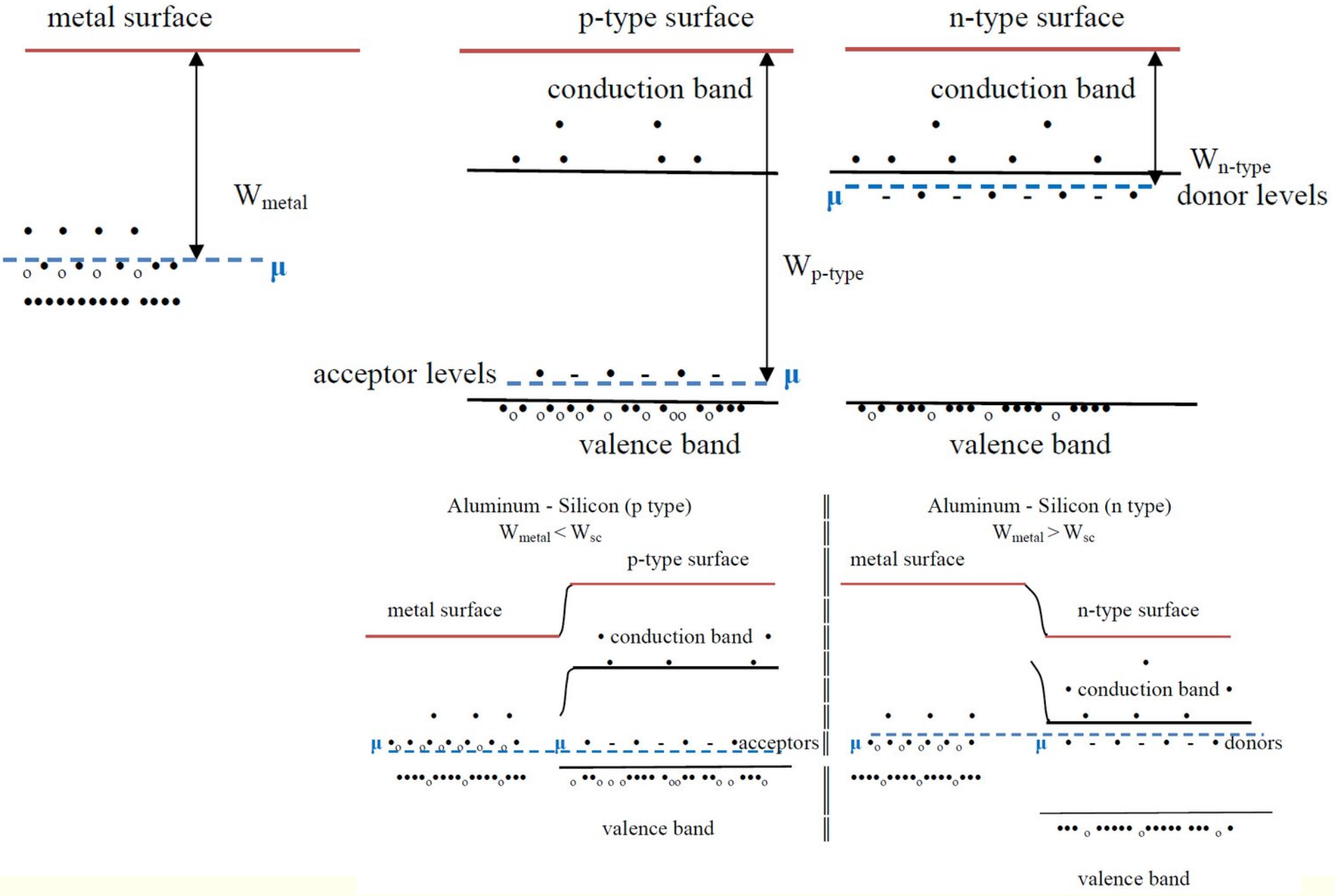
Band profiles of disconnected metal and semiconductor



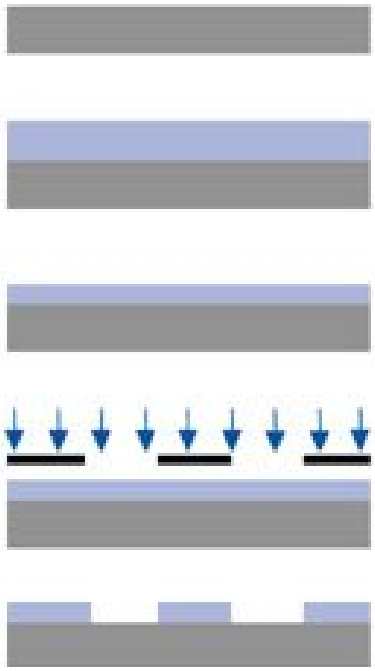
Formation of a Schottky junction



Ohmic contact



Η διαδικασία της λιθογραφίας



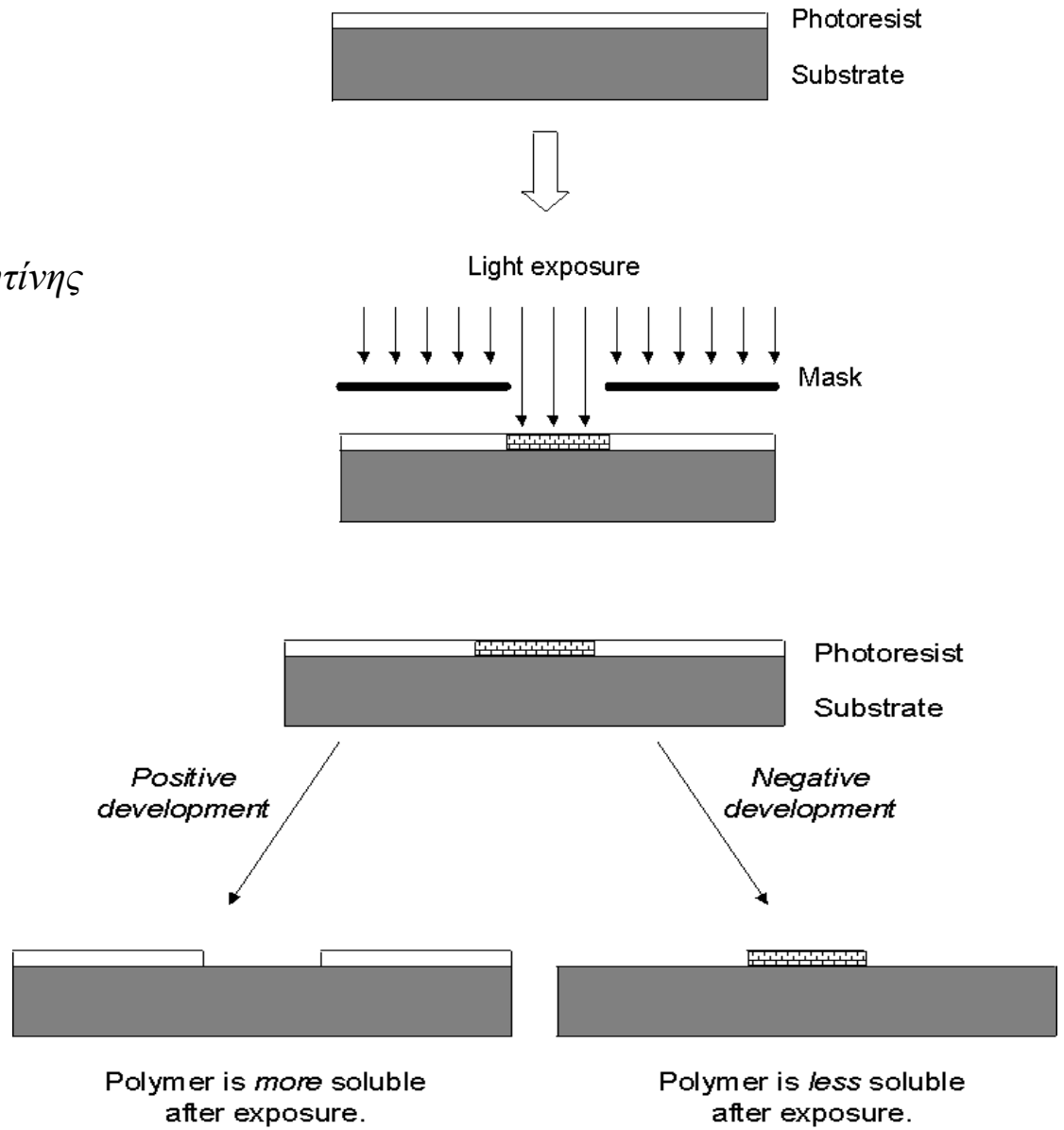
Υπόστρωμα

Τοποθέτηση φώτο-ρητίνης

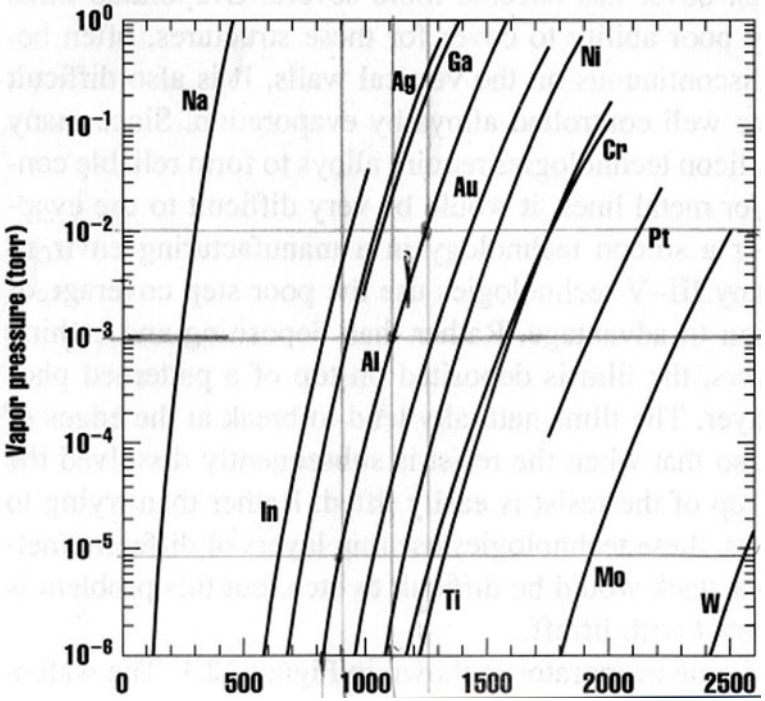
Ξήρανση

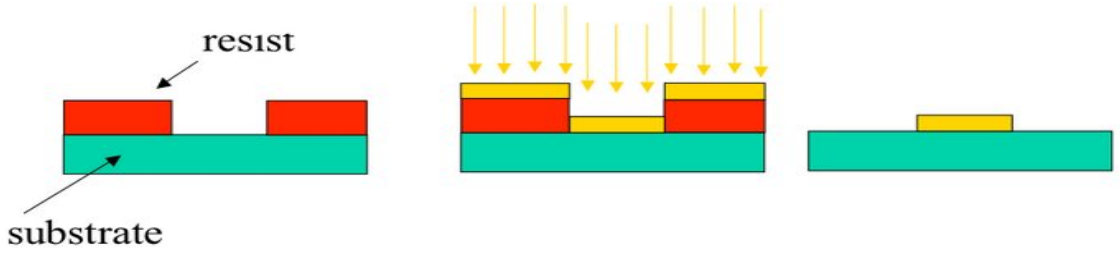
Έκθεση με φως

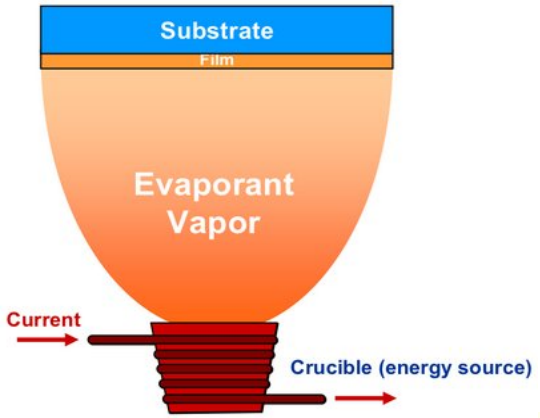
Εμφάνιση

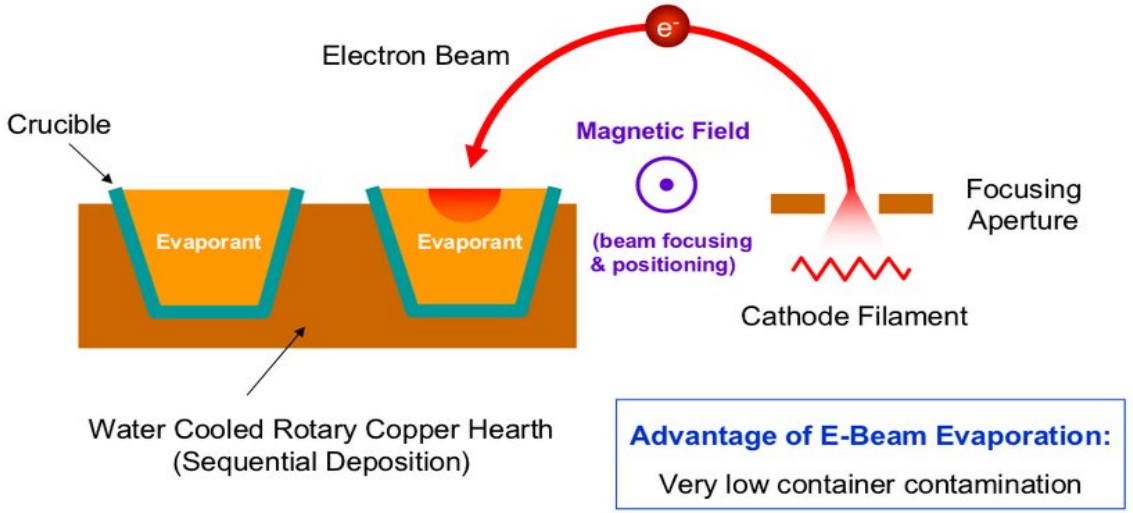


Εναποθέσεις θέρμανση





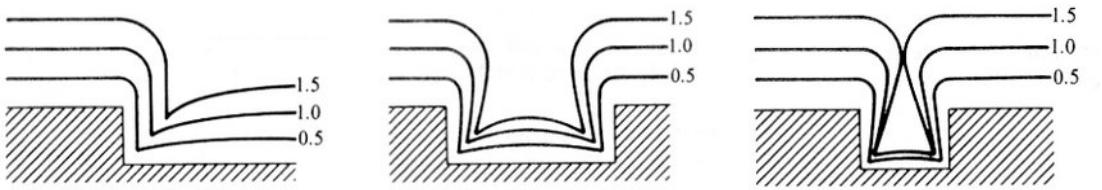




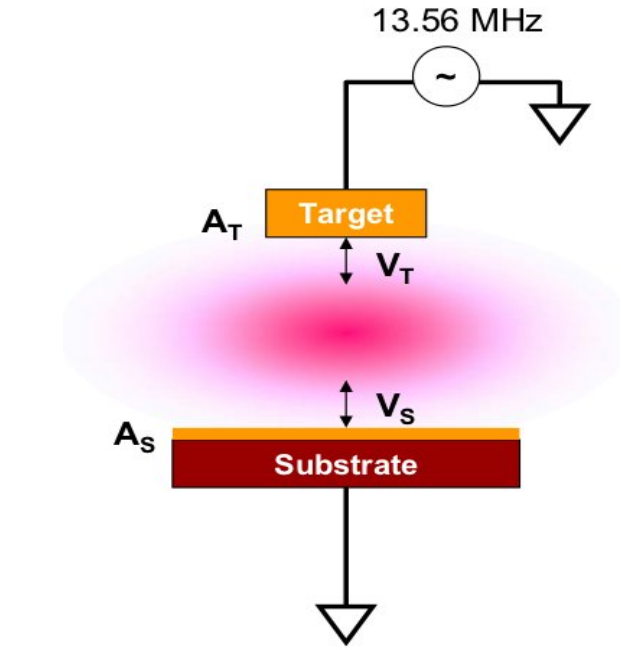
Advantage of E-Beam Evaporation:
Very low container contamination

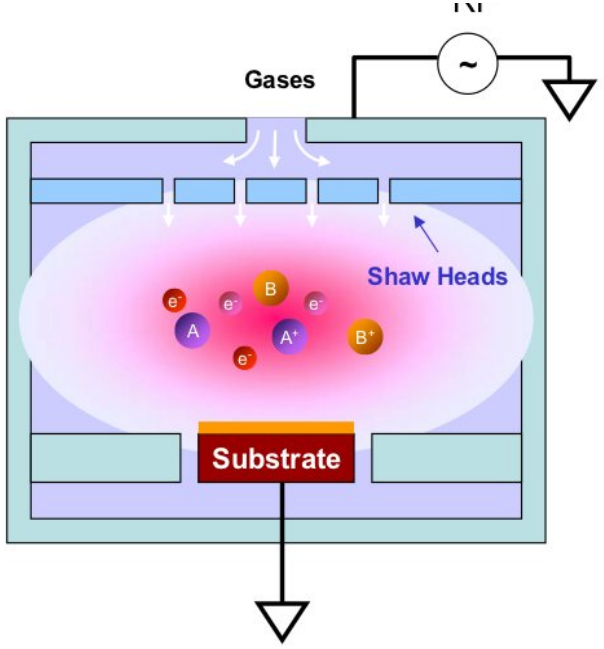
Εναποθέσεις πλάσμα η αποσύνθεση

Sputtering:
- *Ιονισμένο Αέριο (Ar)*
- *Βομβαρδισμός στόχου*
- *Εναπόθεση σωματιδίων στο υπόβαθρο*
- *Δυνατότητα εναπόθεσης Οξειδίων, Νιτριδίων*



(PE)CVD:
- *Πρόδρομα μόρια υλικών*
- *Διάσπαση με θερμοκρασία ή πλάσμα*
- *Δυνατότητας εναπόθεσης μετάλλων διηλεκτρικών*

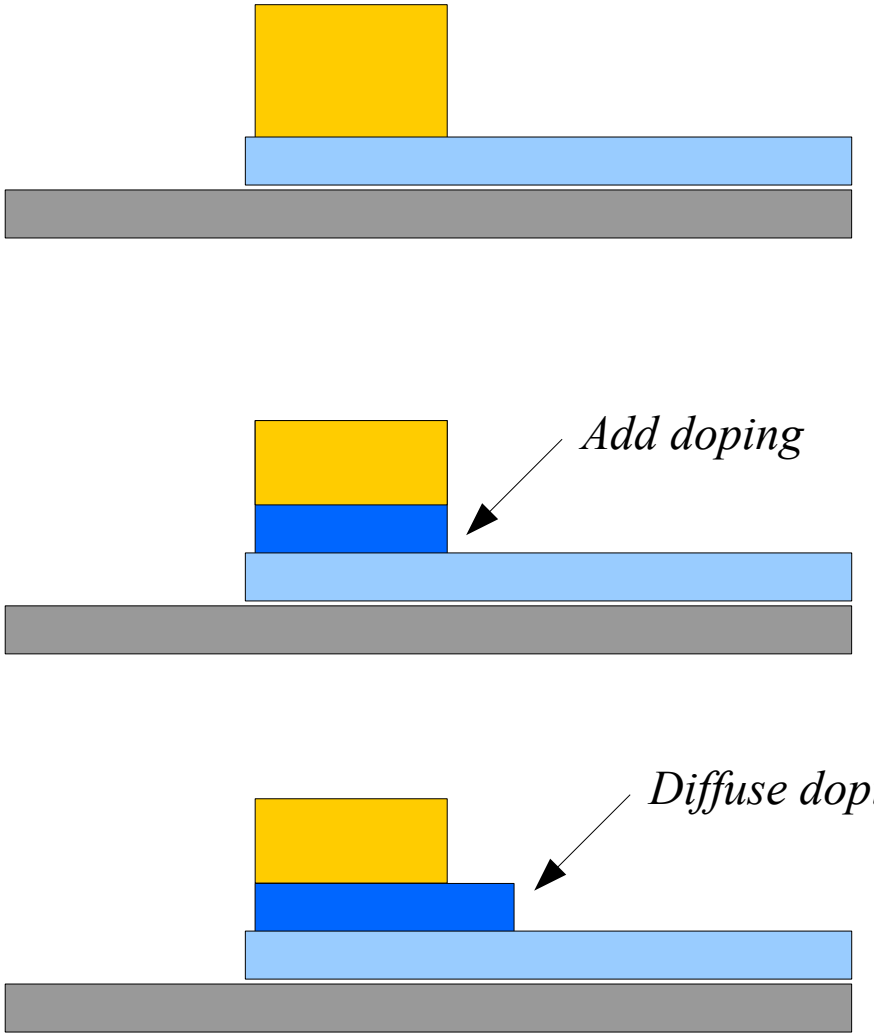


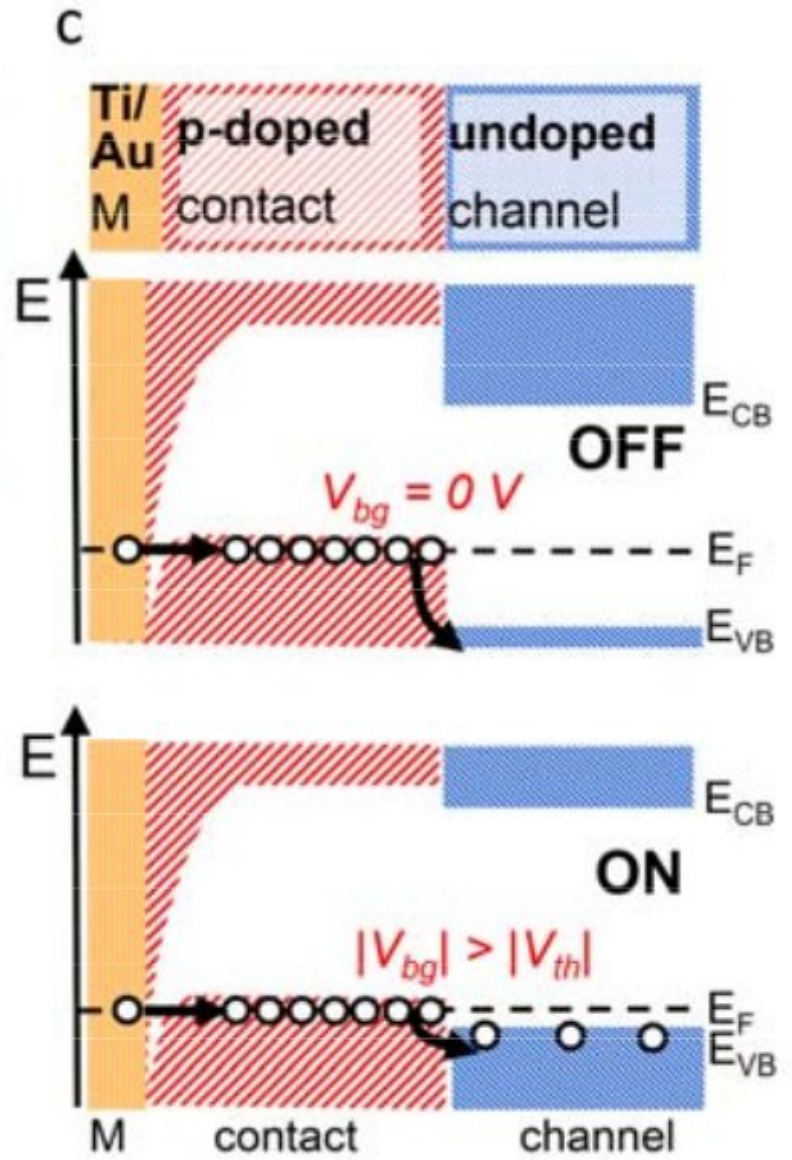


Μέθοδοι εναπόθεσης

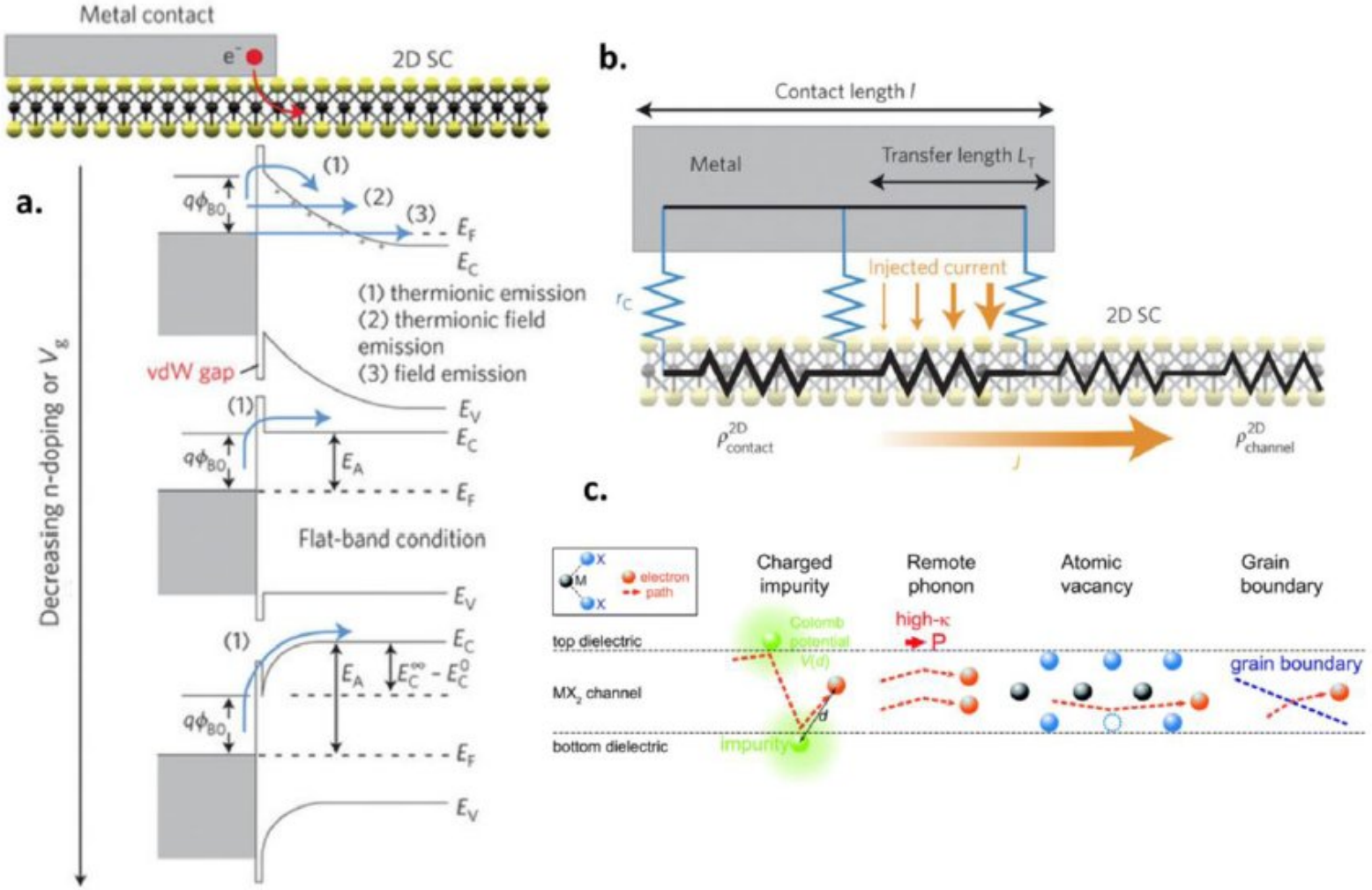
Process	Material	Uniformity	Impurity	Grain Size	Film Density	Deposition Rate	Substrate Temperature	Directional	Cost
Thermal Evaporation	Metal or low melting-point materials	Poor	High	10 ~ 100 nm	Poor	1 ~ 20 A/s	50 ~ 100 °C	Yes	Very low
E-beam Evaporation	Both metal and dielectrics	Poor	Low	10 ~ 100 nm	Poor	10 ~ 100 A/s	50 ~ 100 °C	Yes	High
Sputtering	Both metal and dielectrics	Very good	Low	~ 10 nm	Good	Metal: ~ 100 A/s Dielectric: ~ 1-10 A/s	~ 200 °C	Some degree	High
PECVD	Mainly Dielectrics	Good	Very low	10 ~ 100 nm	Good	10 - 100 A/s	200 ~ 300 °C	Some degree	Very High
LPCVD	Mainly Dielectrics	Very Good	Very low	1 ~ 10 nm	Excellent	10 - 100 A/s	600 ~ 1200 °C	Isotropic	Very High

Doping for better contacts





MoS_2 contacts



A.Rai et al. Crystals 2018, 8, 316; doi:10.3390/cryst8080316

Σχετική βιβλιογραφία

1) https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Semiconductors/Metal-Semiconductors_Contacts

2) "Metal contacts to 2d-materials for device applications," vol. Volume 2, no. Issue 2, Jul. 2018, doi: 10.15406/eetoaj.2018.02.00018.

3) S. Wang, Z. Yu, and X. Wang, "Electrical contacts to two-dimensional transition-metal dichalcogenides," J. Semicond., vol. 39, no. 12, p. 124001, Dec. 2018, doi: 10.1088/1674-4926/39/12/124001.

4) D. S. Schulman, A. J. Arnold, and S. Das, "Contact engineering for 2D materials and devices," Chem. Soc. Rev., vol. 47, no. 9, pp. 3037–3058, May 2018, doi: 10.1039/C7CS00828G.