

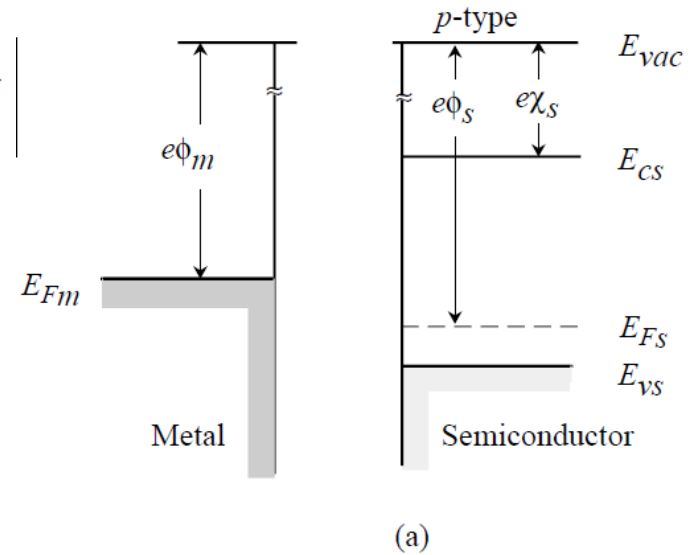
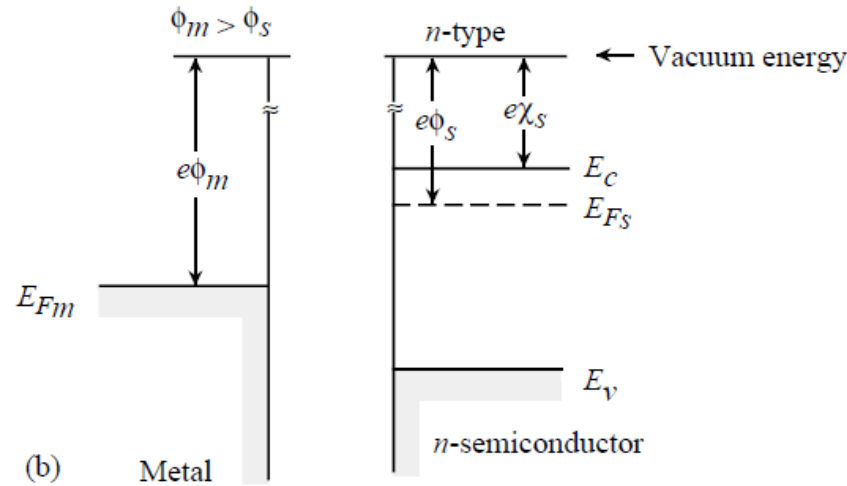
# Φ – 575 Διάλεξη 11

Φυσική διατάξεων δισδιάστατων ημιαγωγών

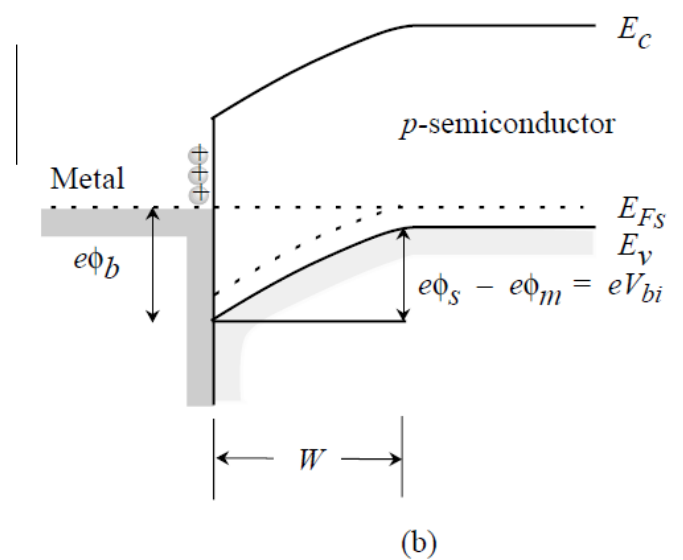
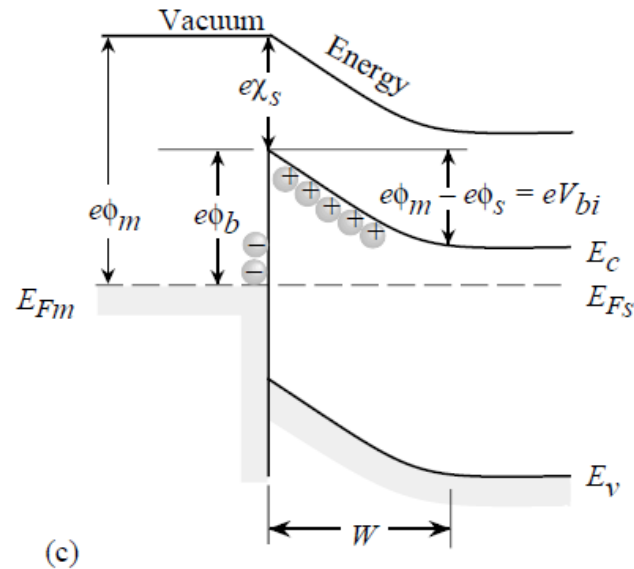
Γιώργος Δεληγεώργης ([deligeo@physics.uoc.gr](mailto:deligeo@physics.uoc.gr))



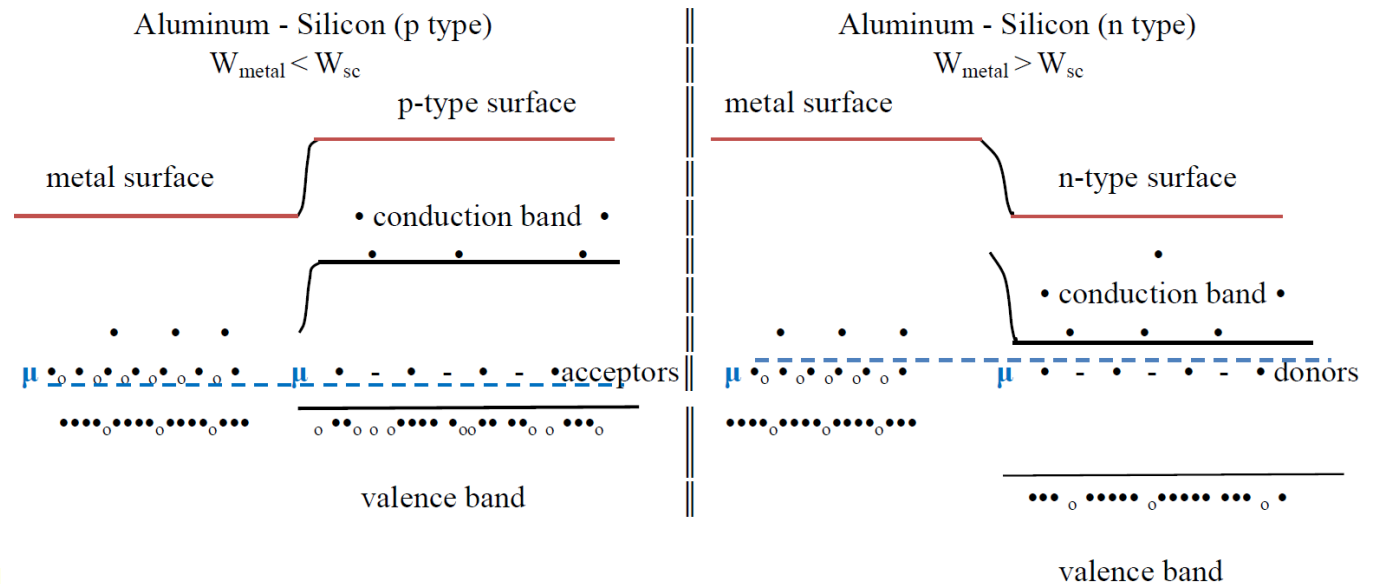
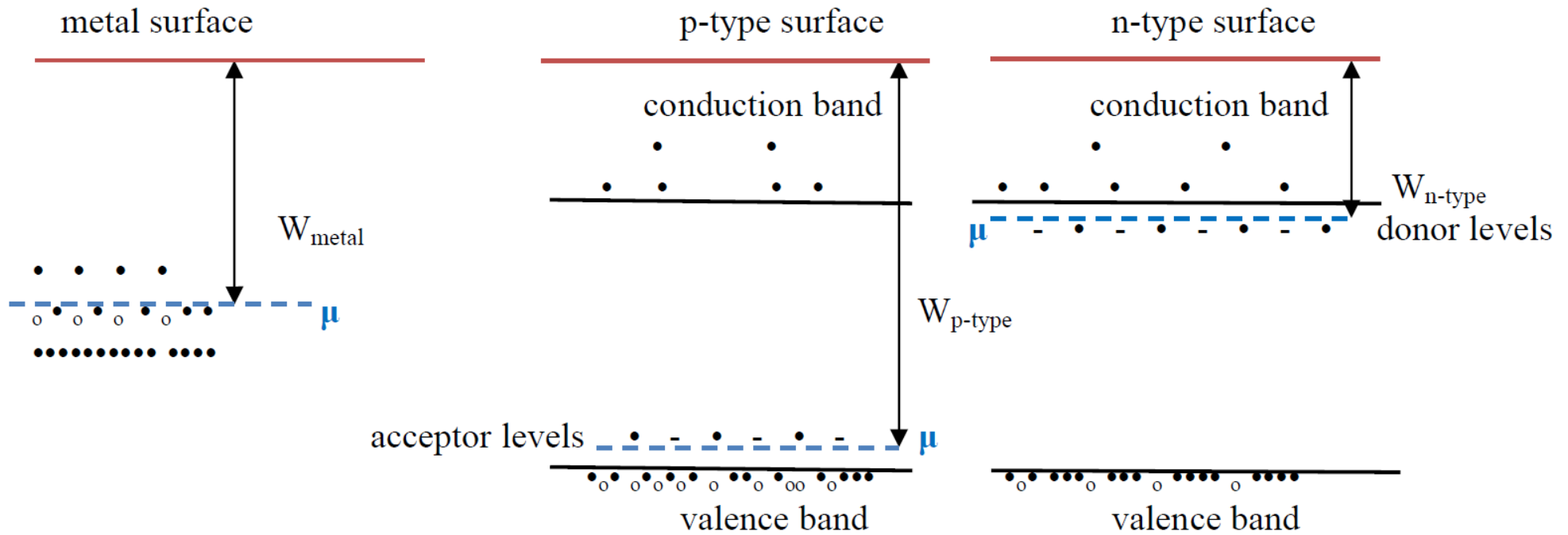
Band profiles of disconnected metal and semiconductor

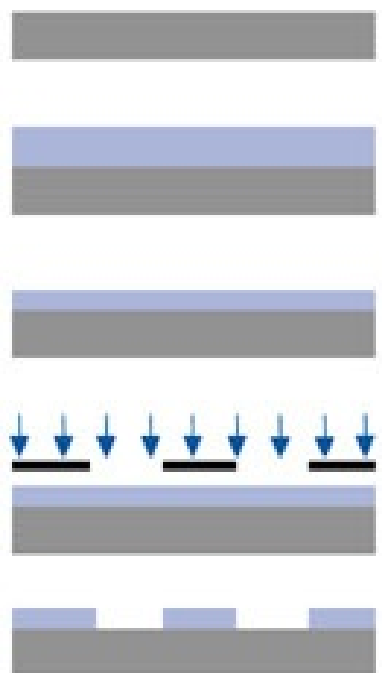


Formation of a Schottky junction



# Ohmic contact





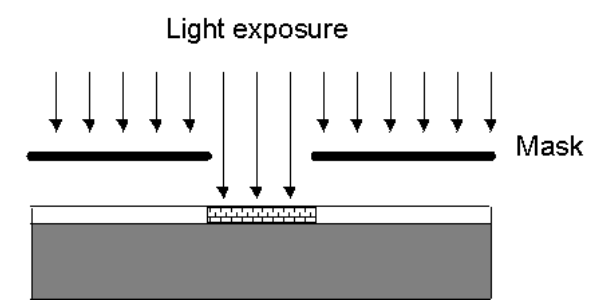
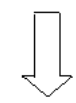
Υπόστρωμα

Τοποθέτηση φώτο-ρητίνης

Ξήρανση

Έκθεση με φως

Εμφάνιση



*Positive development*

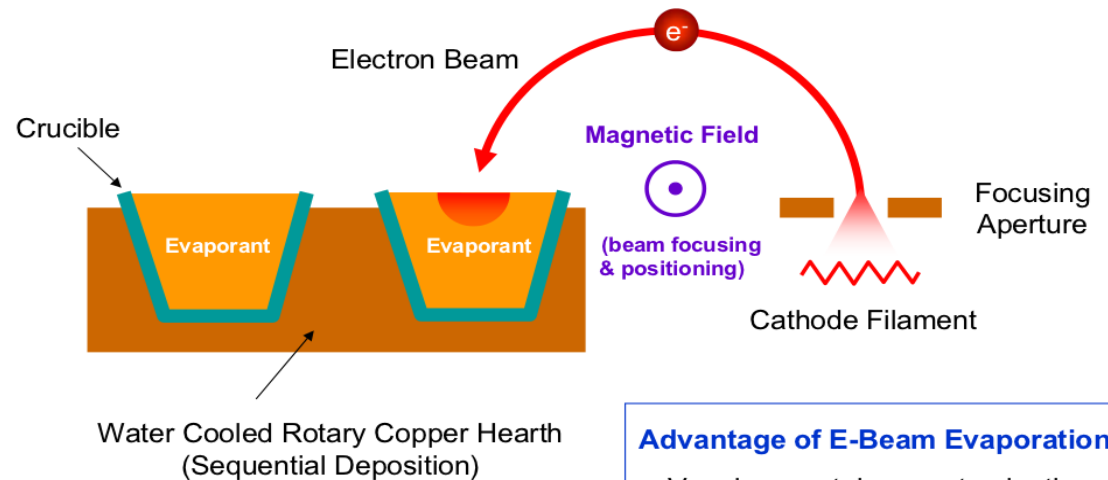
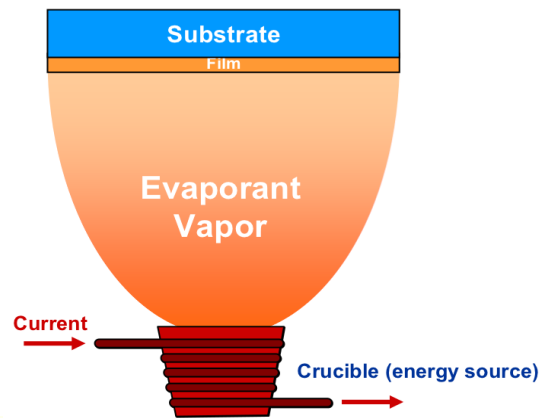
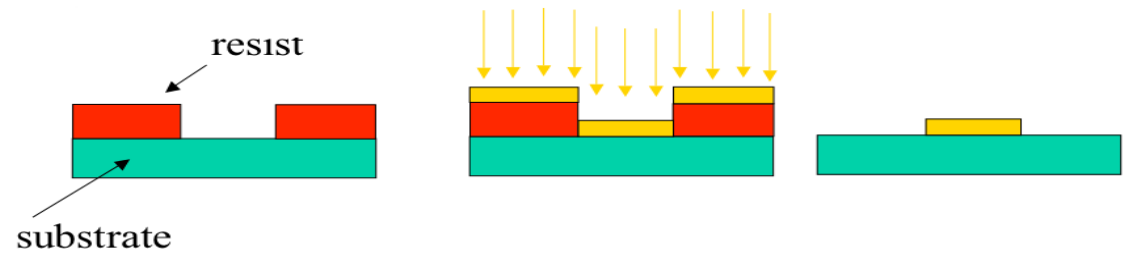
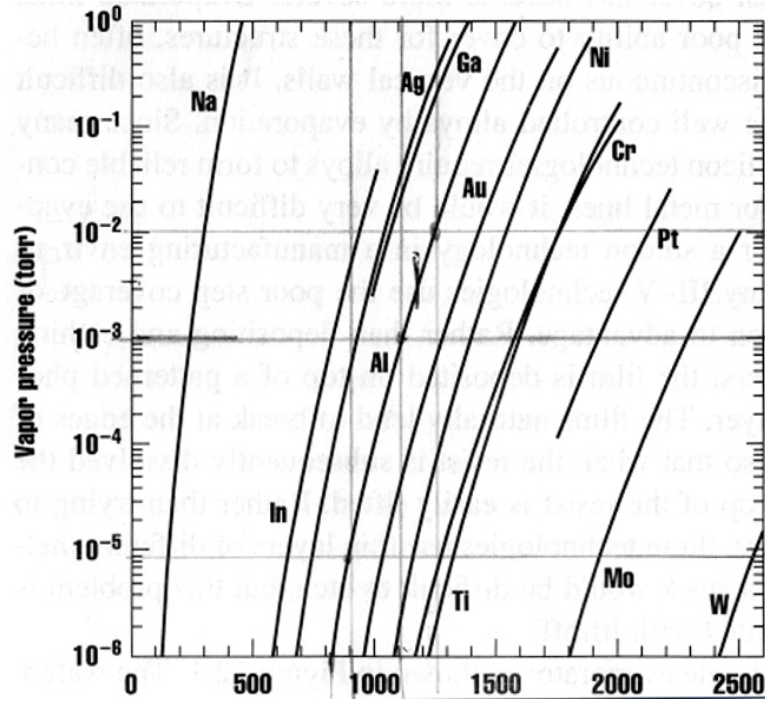
*Negative development*



Polymer is *more* soluble after exposure.



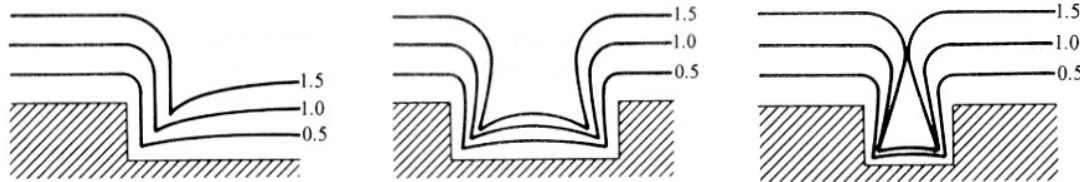
Polymer is *less* soluble after exposure.



**Advantage of E-Beam Evaporation:**  
Very low container contamination

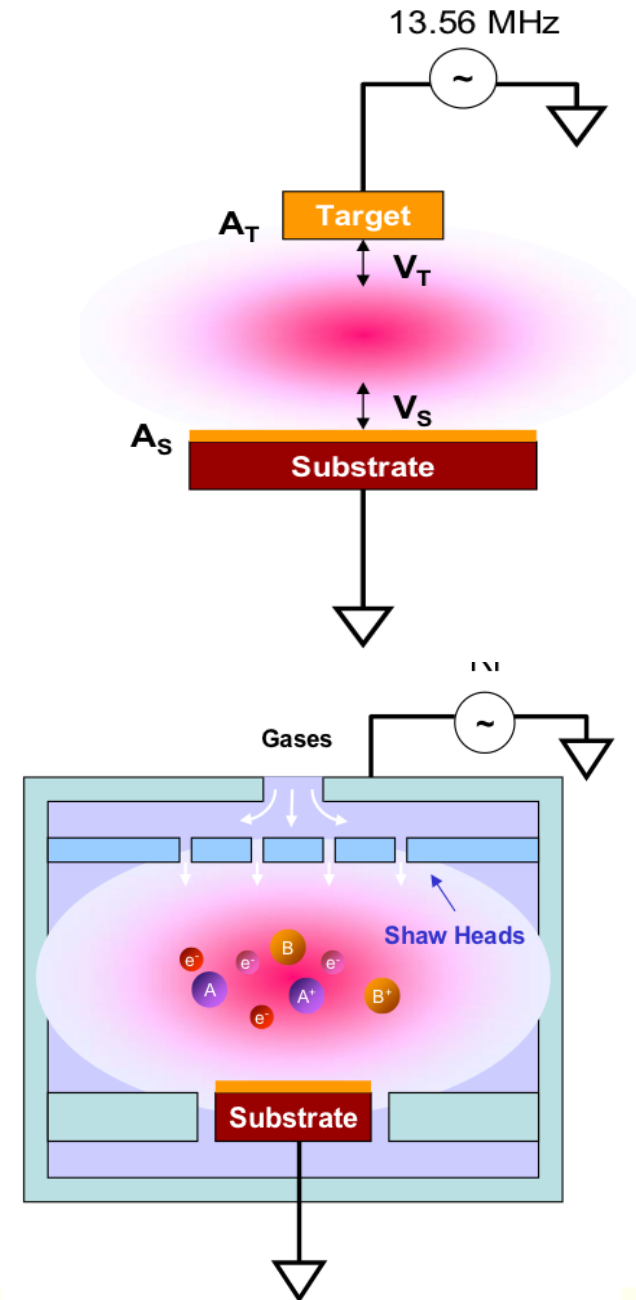
## Sputtering:

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



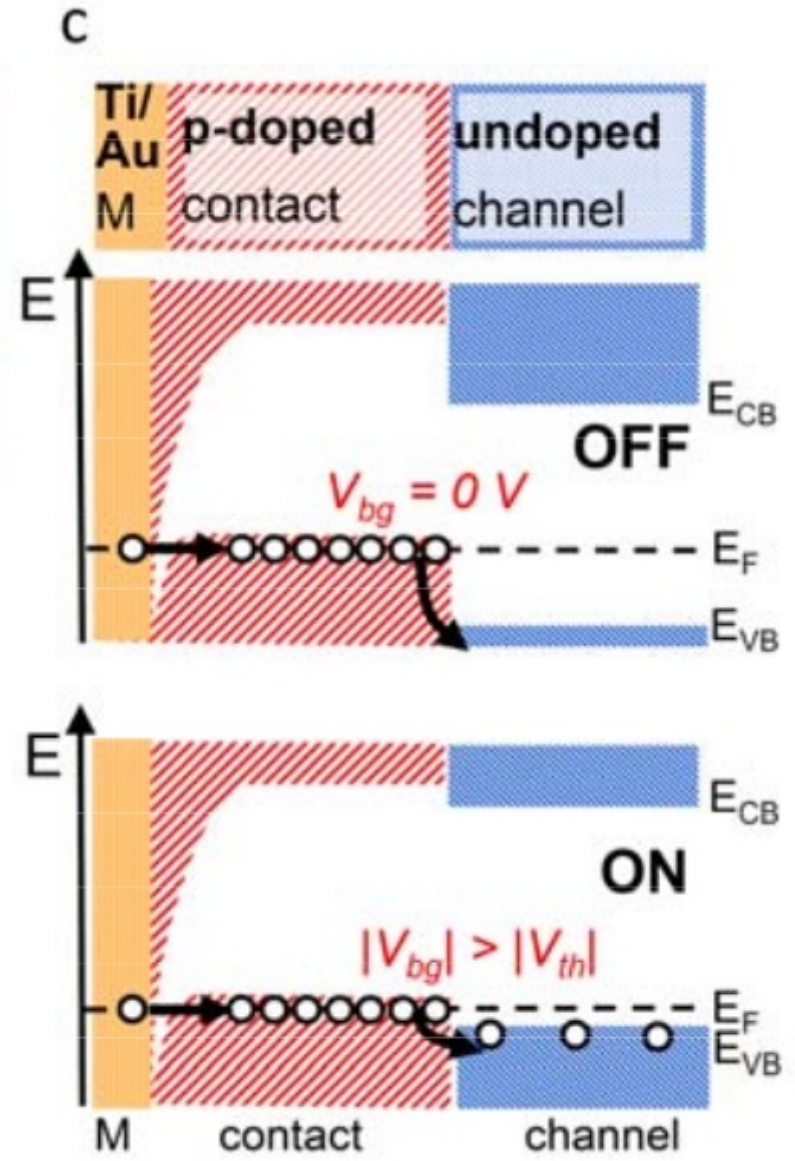
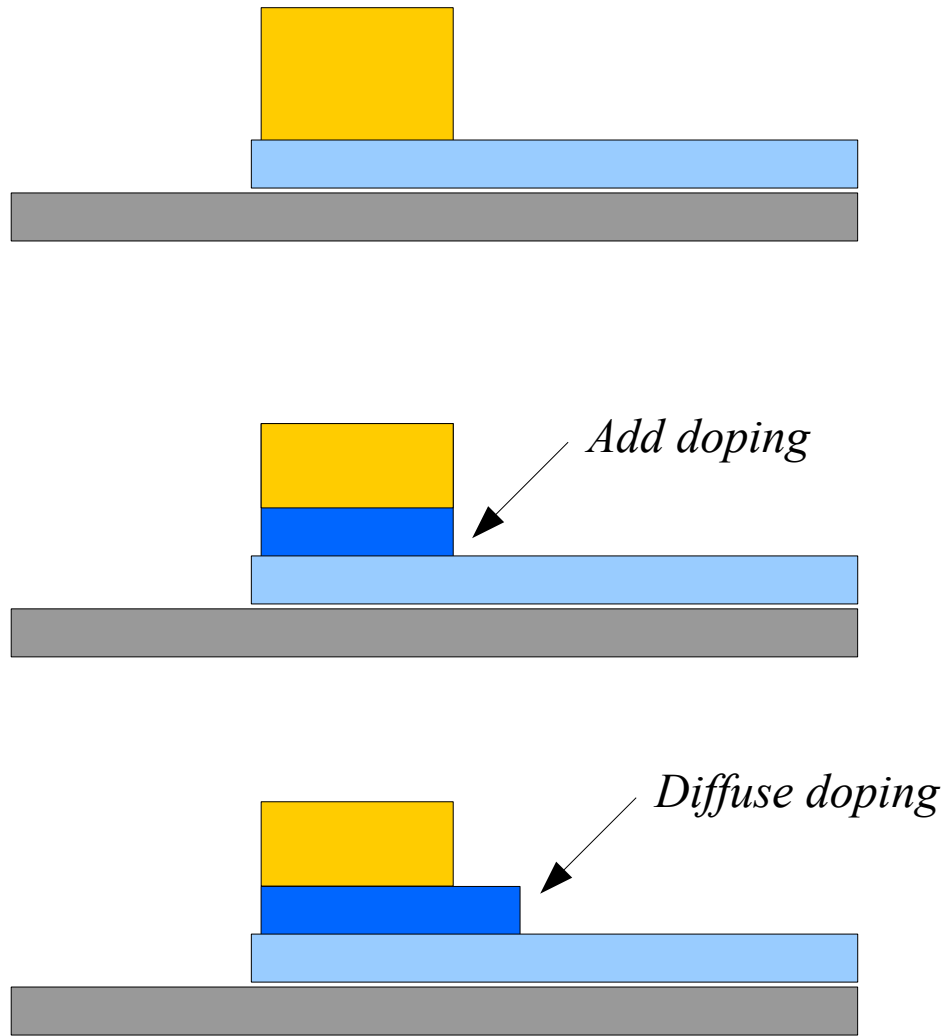
## (PE)CVD:

- Πρόδρομα μόρια υλικών
- Διάσπαση με θερμοκρασία ή πλάσμα
- Δυνατότητας εναπόθεσης μετάλλων διηλεκτρικών

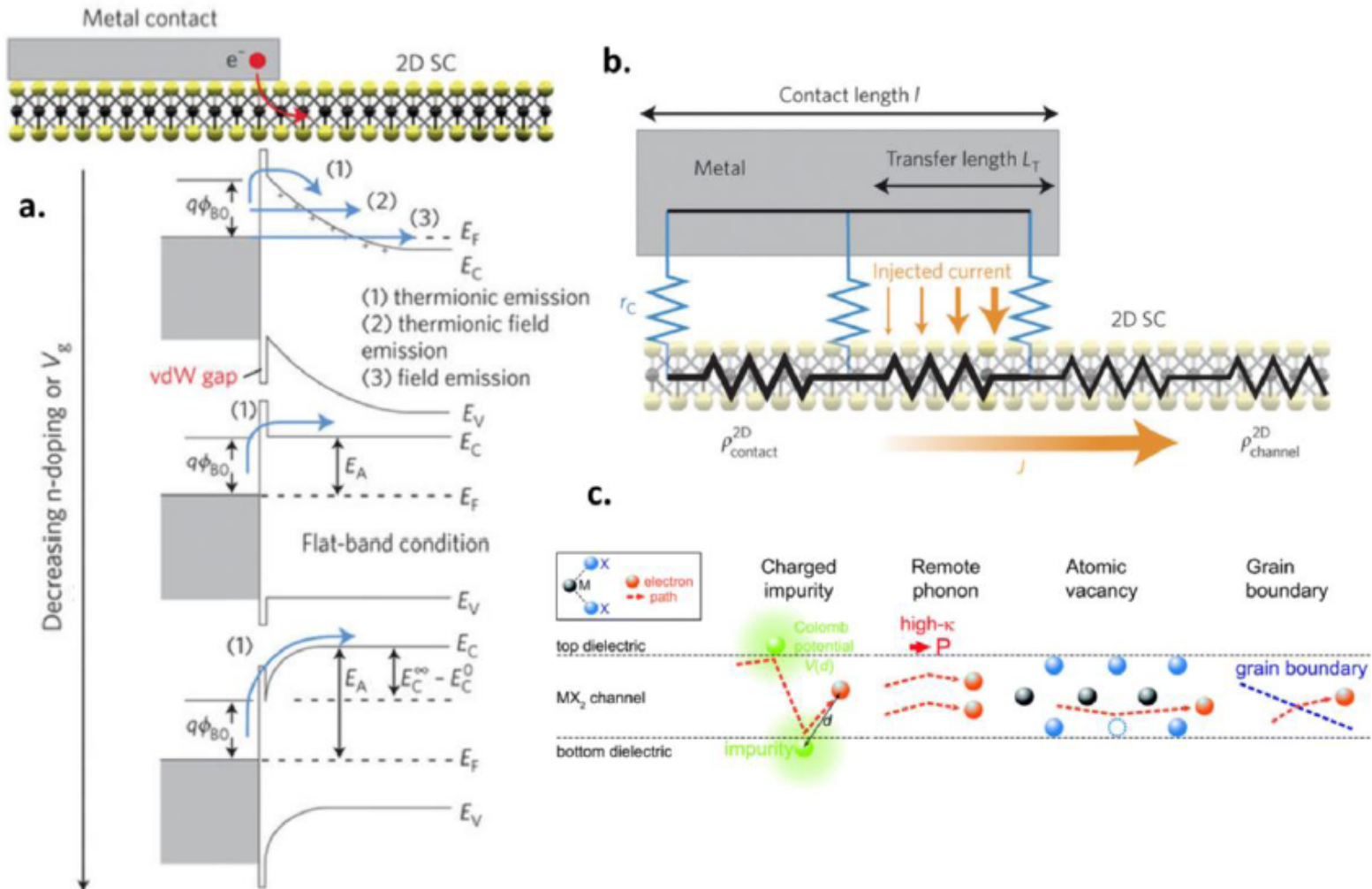




Process	Material	Uniformity	Impurity	Grain Size	Film Density	Deposition Rate	Substrate Temperature	Directional	Cost
Thermal Evaporation	Metal or low melting-point materials	Poor	High	10 ~ 100 nm	Poor	1 ~ 20 A/s	50 ~ 100 °C	Yes	Very low
E-beam Evaporation	Both metal and dielectrics	Poor	Low	10 ~ 100 nm	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







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

- 1) [https://eng.libretexts.org/Bookshelves/Materials\\_Science/Supplemental\\_Modules\\_\(Materials\\_Science\)/Semiconductors/Metal-Semiconductors\\_Contacts](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.