

The background of the slide is an aerial photograph of the EPFL campus in Lausanne, Switzerland. The image shows the university's modern buildings, green spaces, and surrounding urban area, with Lake Geneva and the Alps visible in the distance.

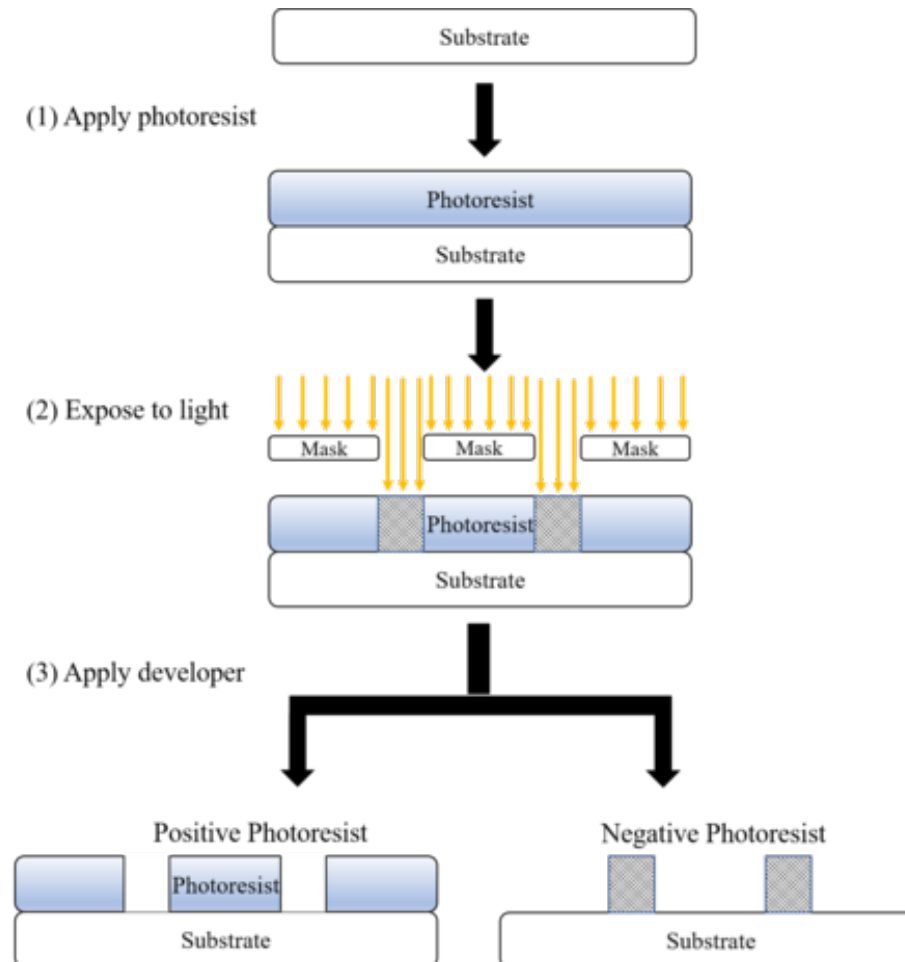
Neural Interfaces

Problem Set No 2

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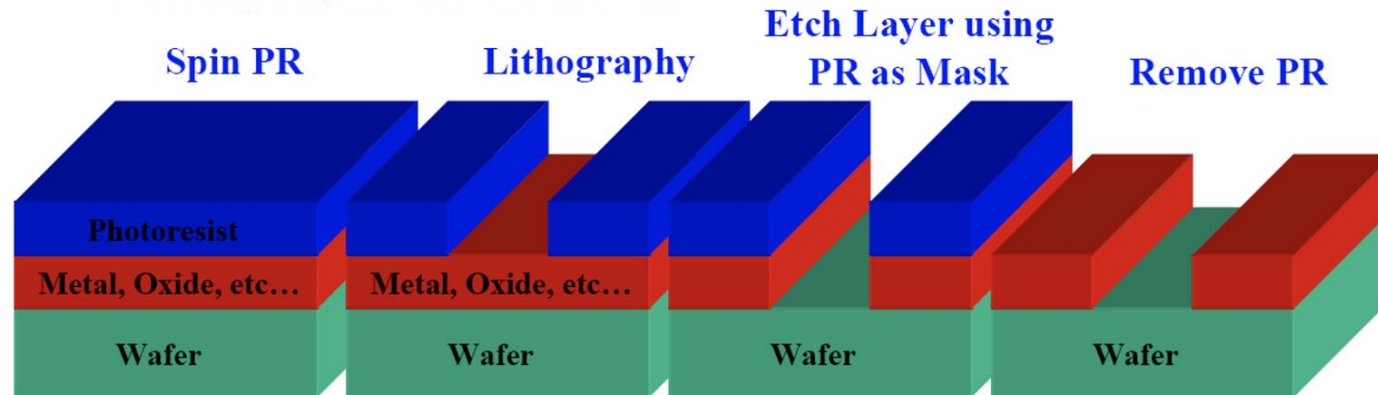
Fall 2024

Photolithography

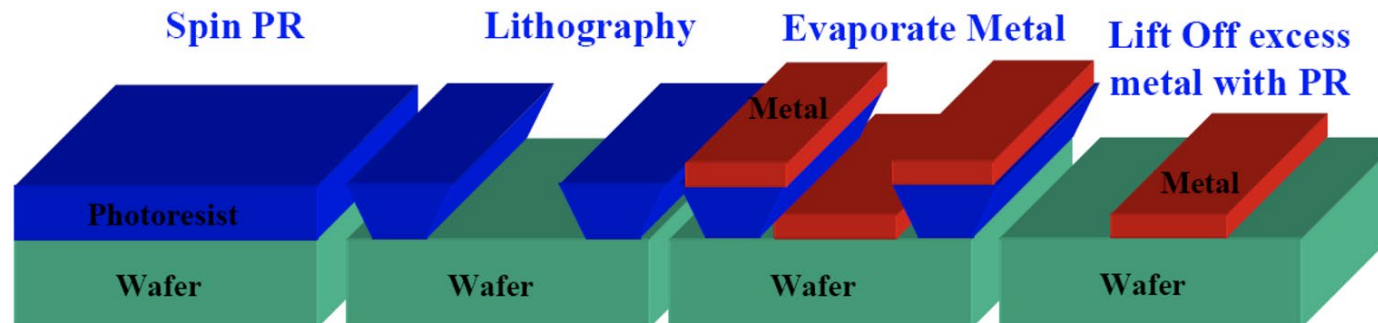


Etching vs Lift-Off

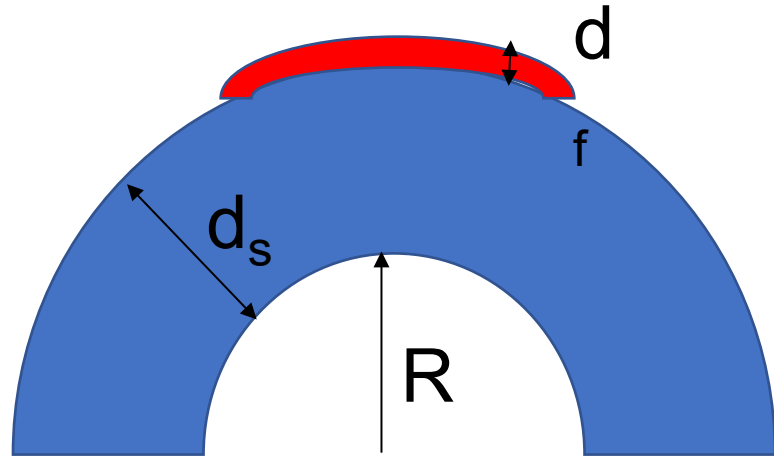
1.) Etching Processes:



2.) Lift off Processes:



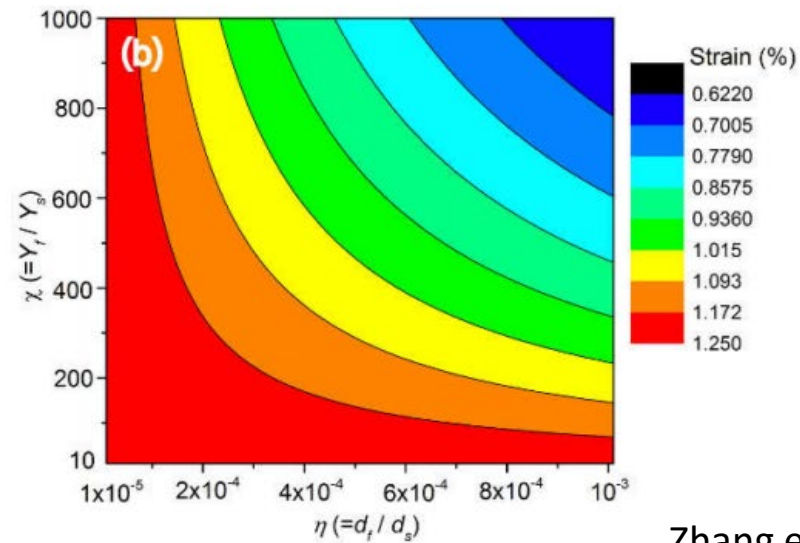
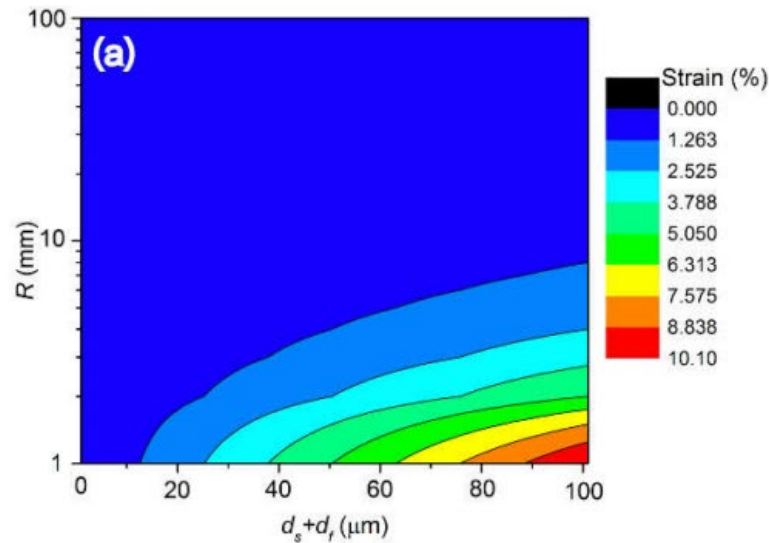
Bending of plastic foils



$$\varepsilon = \frac{d_s + d_f}{2R}$$

For thin films
 $d_s \gg d_f$

$$\varepsilon = \frac{d_s}{2R}$$

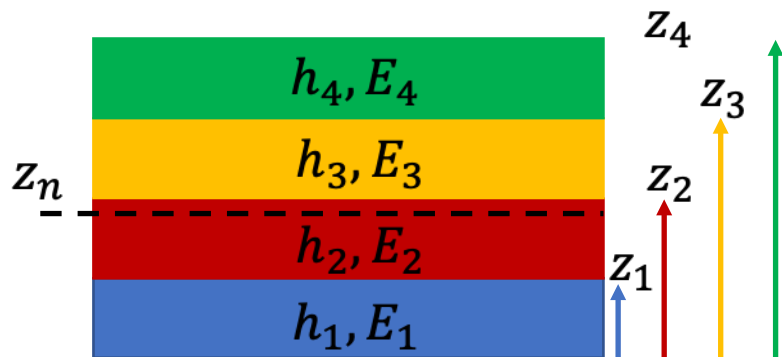
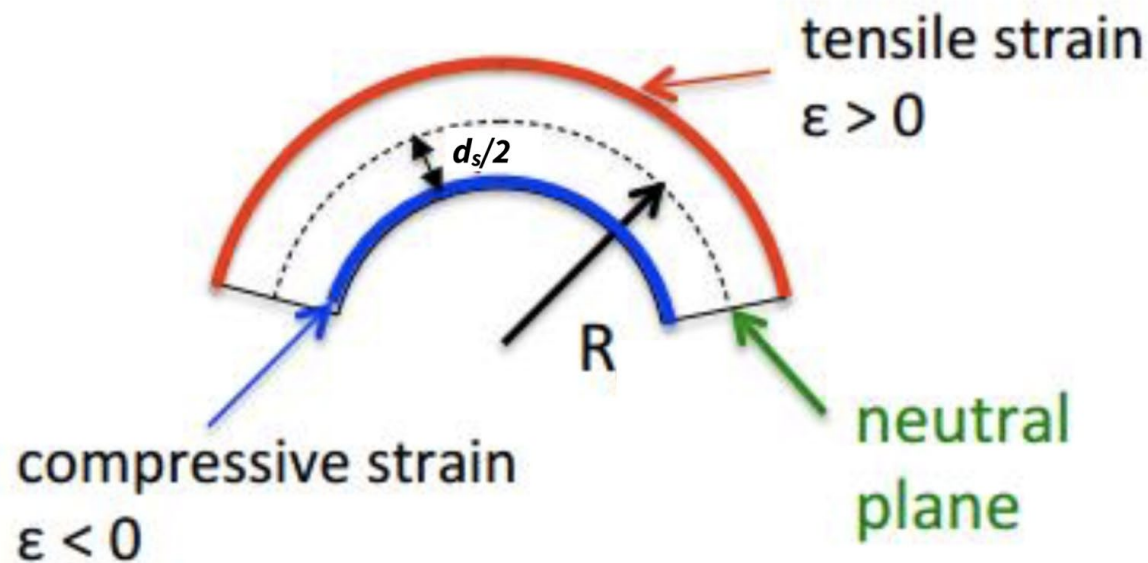


Y_f = film Young's modulus
 Y_s = substrate Young's modulus
 d_f = film thickness
 d_s = substrate thickness

Zhang et al. 2017

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Neutral plane and bending in multilayers



$$\epsilon_i = \frac{z_i - z_n}{R}$$

$$\sigma_i = E_i \epsilon_i$$

$$z_n = \frac{\sum_{i=1}^N \bar{E}_i h_i \bar{z}_i}{\sum_{i=1}^N \bar{E}_i h_i}$$

$$\bar{E}_i = \frac{E_i}{(1 - \nu^2)}$$

E_i = Young's modulus

h_i = layer thickness

ν_i = Poisson ratio

$\bar{E}$ = plane-strain modulus

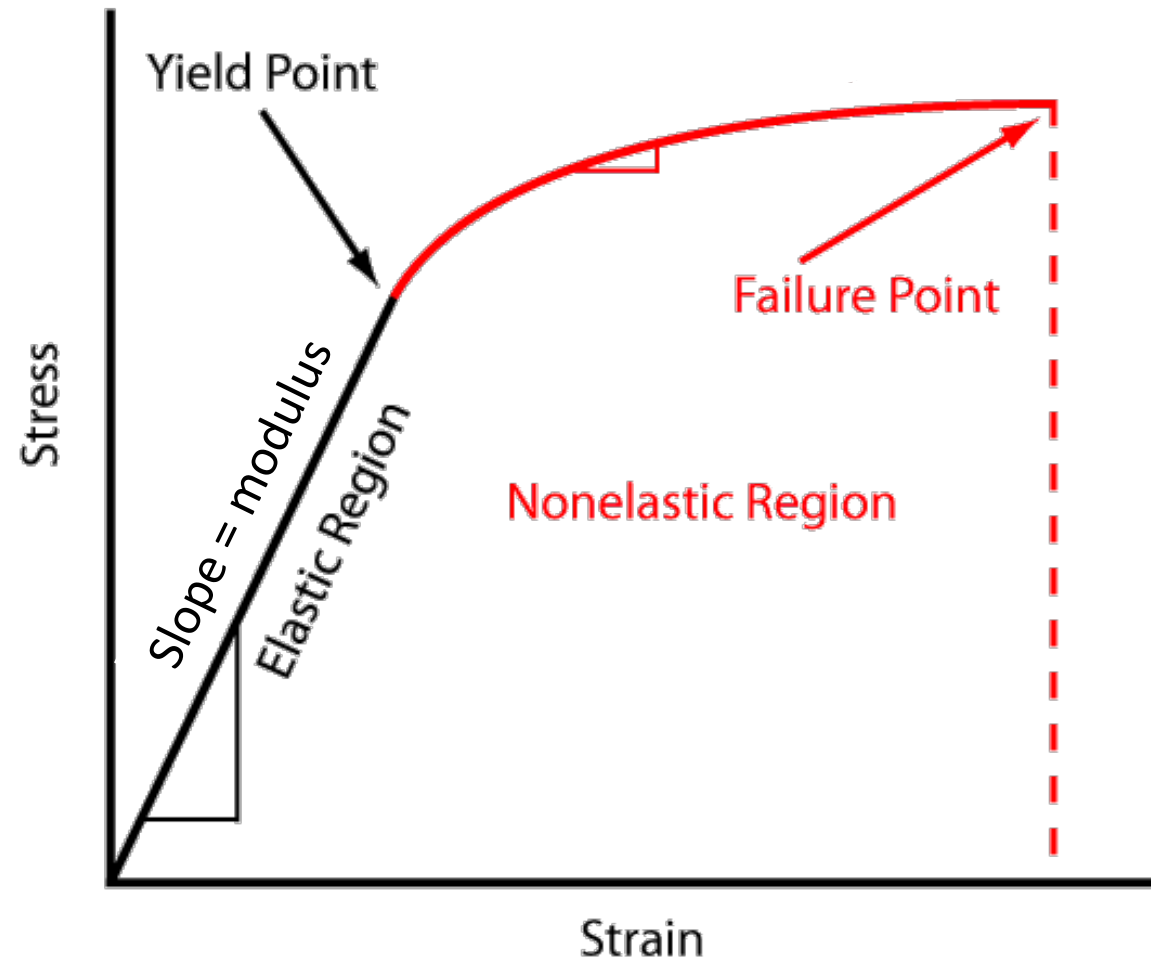
$\bar{z}_i$ = position of middle of layer i

z_i = position of top of layer i

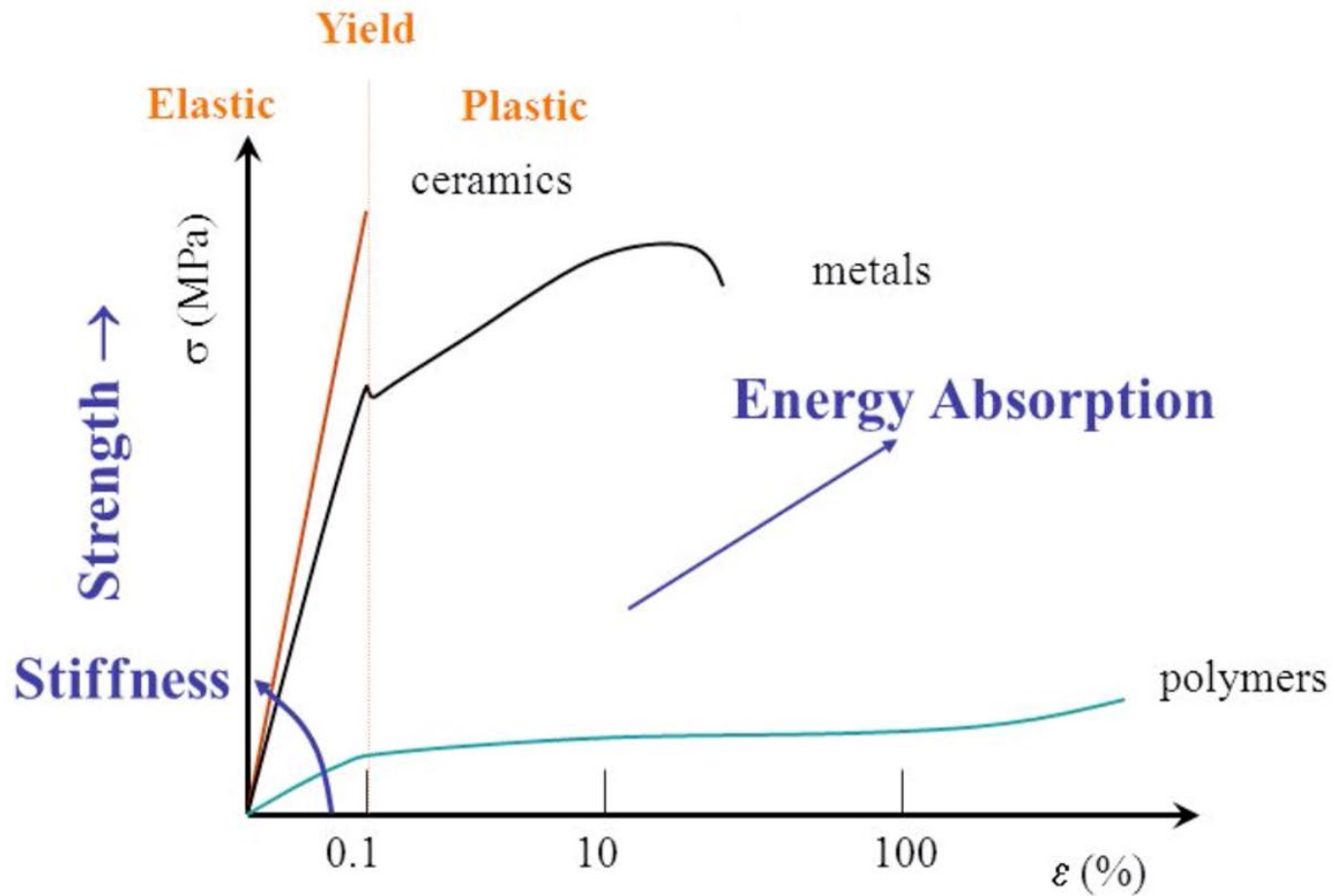
ϵ_i = strain in layer i

σ_i = stress in layer i

Tensile test on materials



Tensile test on materials



Slope:

Stiff $\longleftrightarrow$ Soft

Ultimate strength:

Strong $\longleftrightarrow$ Weak

Plastic deformation:

Brittle $\longleftrightarrow$ Ductile