Lecture 9 Through Mask Plating

Prof. Fan-Gang Tseng

References:

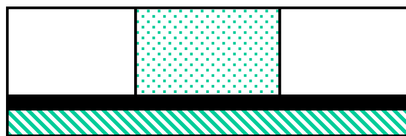
Madou, M., " Fundamentals of Microfabrication", CRC Press, 1998.

Electro-deposition for Micro-devices

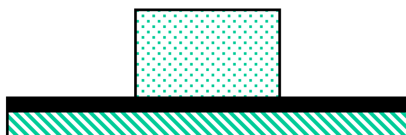
Through Mask Plating

Seed layer deposition and Patterning

Plating



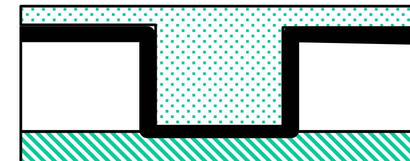
Mask removal
Seed-layer etching



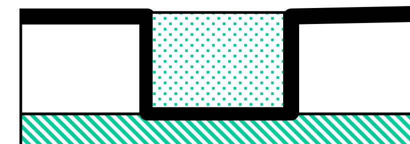
Damascene Plating

Insulator deposition and patterning
Seed-layer deposition

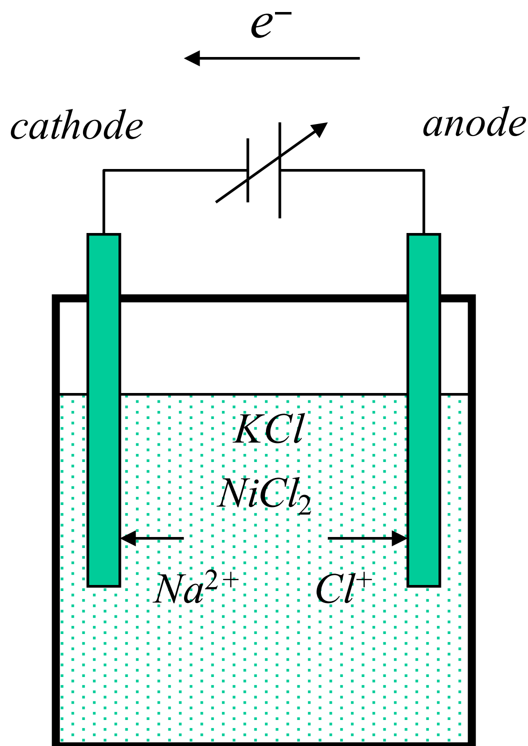
Plating



Planarization



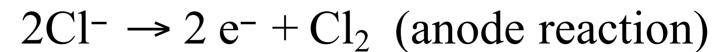
Electroplating

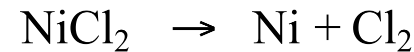


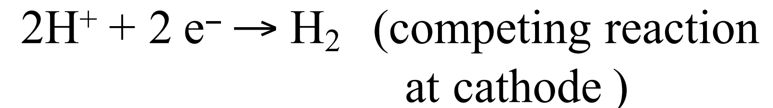
KCl : Supporting electrolyte

$NiCl_2$: Electro-active species

Reactions:







=> PH value important !!

Amount of deposited material :

$$m_{\max} = \frac{I \cdot t \cdot M}{Fz}$$

F: Faraday constant (electricity required to deposit 1 g equivalent of substance)

I : current

t : deposition time

M : molecular weigh of the depositing material

z : ion's charges #

Diffusion Limited Reactions

Diffusion limited cathode current:

current density $$i = i_o\left(1 - e^{nF\eta_c/RT}\right)$$

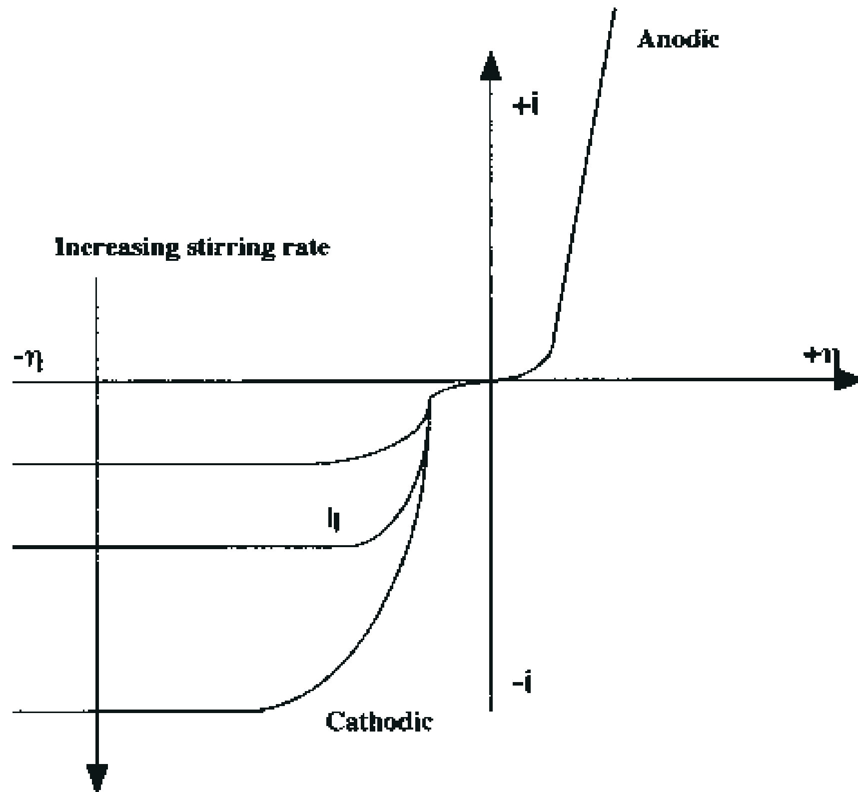


FIGURE 3.30 The cathodic limiting current is indicated for different stirring rates. The cathodic limiting current appears as a horizontal straight line limiting the current that can be achieved at any large negative value of the overpotential.

Nonlinear diffusion effect on microelectrodes

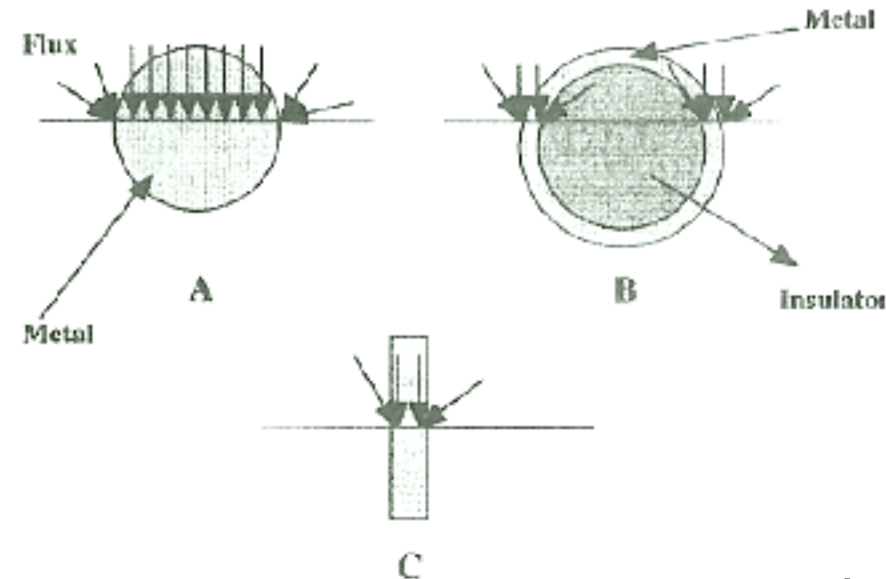


FIGURE 3.31 Convergent flux to small circular (A), ring (B), and band (C) electrodes. Top: side view; bottom: plane view of the electrodes.

Nonlinear diffusion effect on microelectrodes

$$I_{l,m} = ANFD_o \frac{C_\infty^o}{r+L}$$

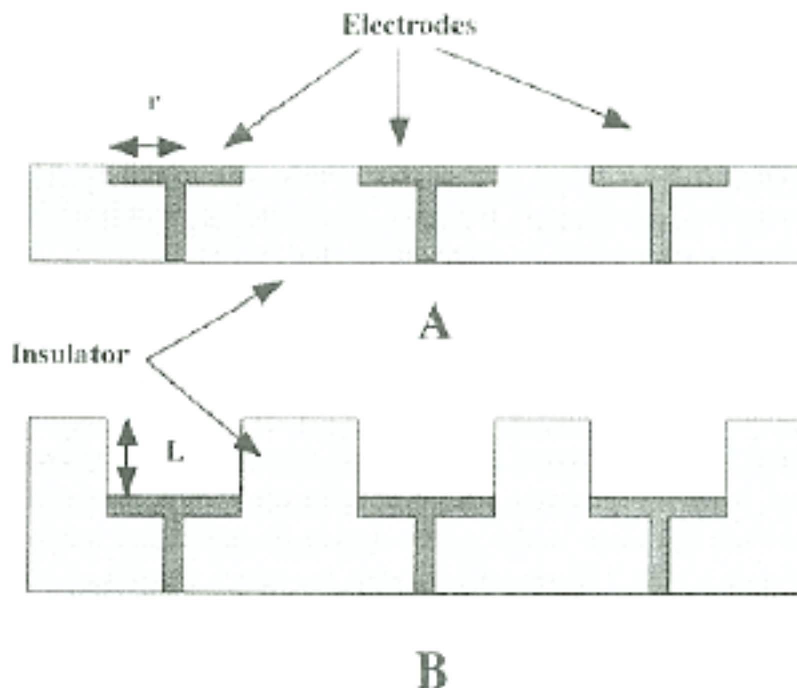


FIGURE 3.32 Nonlinear diffusion on inlaid and recessed electrodes. (A) Inlaid microelectrodes. (B) Recessed microelectrodes.

Effect of current density on stress

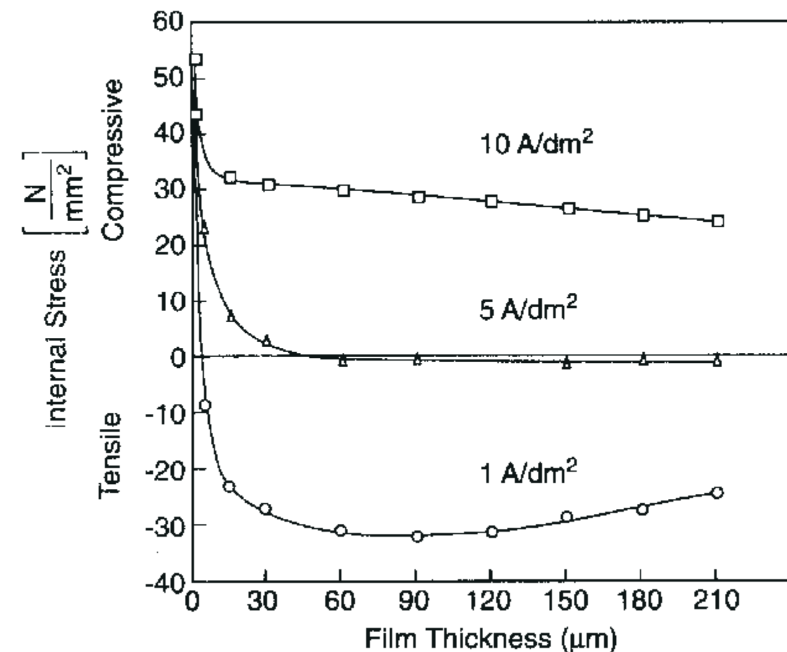


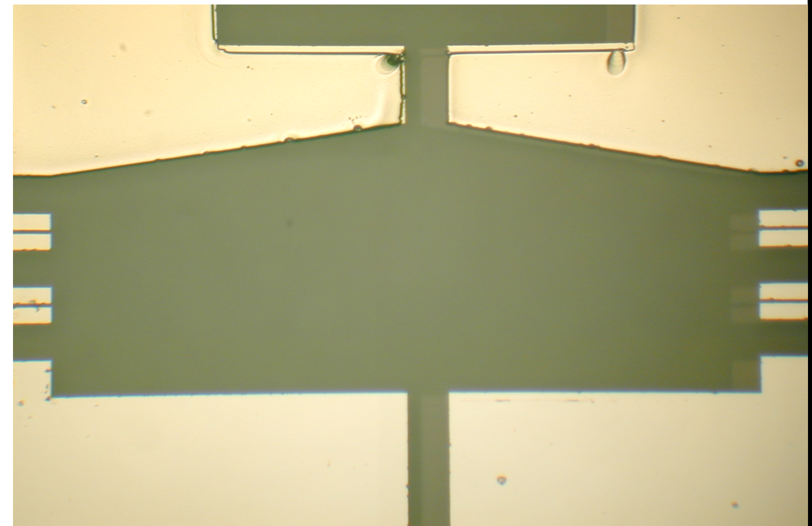
FIGURE 6.19 Influence of the nickel layer thickness on the internal stress. The electrolyte used is described in Table 6.5 (pH = 4; bath temperature = 52°C).[46] (Courtesy of the Karlsruhe Nuclear Research Center.)

Electroplating of Nickel (NTHU ESS Micro-fabrication lab)

Ingredients

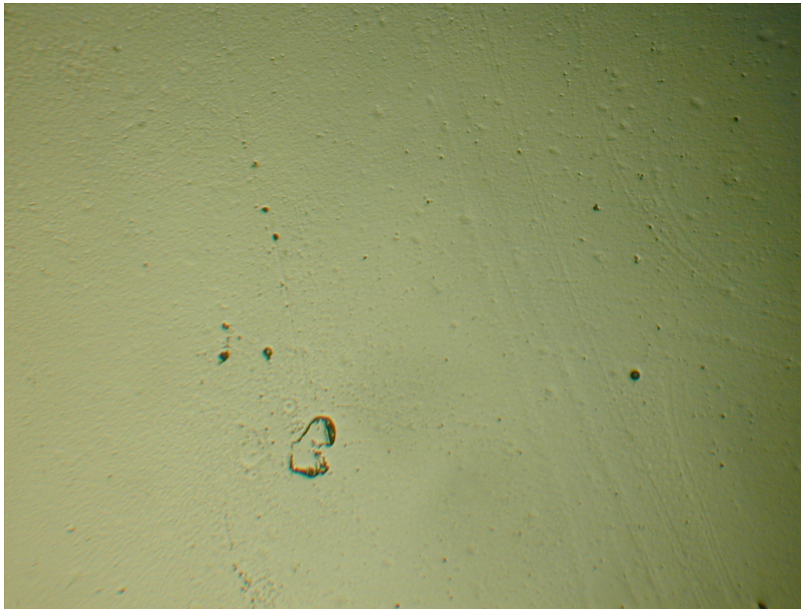
- Nickel Sulfamate 300 g/L
- Nickel Chloride 20 g/L
- Boric Acid 40 g/L
- LN-MU (Stress reduction)
- LN-MA (Surface smooth)
- Pin hole reduction

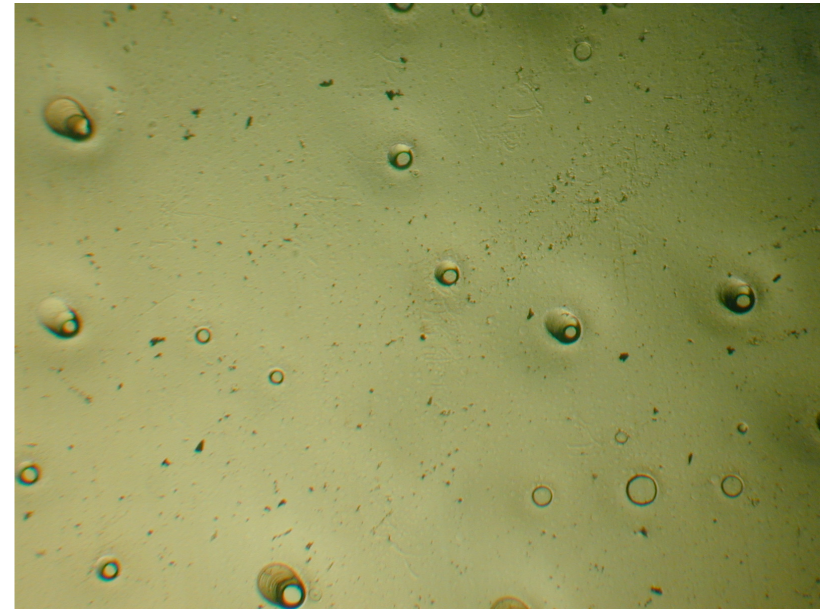
Plating results



Effect of Current Density

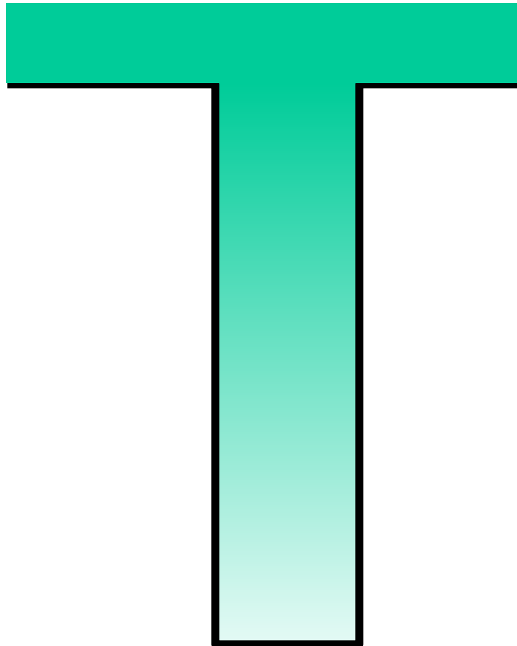
- Current density 15 mA/cm^2
- Current density 40 mA/cm^2





Others important parameters：Ph level, Temperature, Surfactants

High Aspect Ratio Structure Plating



Challenges:

Ni^{2+} current diffusion limited
=> deposition rate ↓

H^+ at bottom depleted
=> PH increase locally
=> form nickel hydroxide
=> deposition stopped