Admin
issues, pizza, email, webpage

290G MW 4-5 29G Cory?

HW1

CAD tutorial Wed next week

Simplest accelerant, some numbers

Simplest XL

SOI wafer, 40um Si, 2um SiO, 5um Si

Spin, expose, develop w/ mask STRUCT

DRIE etch "cookie cutter"

Strip resist

5 minute 49% HF etch

Rinse, dry

Design rules

Min line 2um.

Min space 2um.

Min hole 3x3um

49% HF etch rates:

SiO2 1um/min

Si <1/2/min

SCS

etch time

SCS

SCS
Design rules are a contract between designer and manufacturer, "What you get is what you get". Disobeying is unpredictable and not allowed. 

Design rule:
- Make released structures no more than 8 μm wide between etch access points.
- Make fixed structures at least 20 μm wide.

- \( \frac{\sqrt{2}(s-h)}{2} \) < etch distance
- \( s \leq \frac{3}{\sqrt{2}} e + h \)
- \( h = 5.6 + 3 = 8.6 \)

Nothing works exactly as expected. Films are not exactly the right thickness. 2 μm line/space are not exact 2/2. Sidewalls are not exactly vertical and smooth. HF is not exactly isotropic.

Need to start from some semi-ideal model:
- Add corrections as you learn
- Design for manufactureability
- Reuse, hierarchy
\[ F = k y \]

where:

- \( F \) is the force applied
- \( k \) is a proportionality constant
- \( y \) is the deflection

**Deflection**

\[ y = \frac{F}{k} \]

- **Material Stiffness**
  \[ E \text{ material stiffness} = 170 \text{ GPa} \]

- **Young's Modulus**
  \[ K = \frac{Ea^3t}{4L^3} \]

**Film Thickness**

\[ F = K y \]

\[ E = 170 \times 10^9 \text{ N/m}^2 \]

\[ a = 10^{-4} \text{ m} \]

\[ L = 10^{-3} \text{ m} \]

\[ t = 4 \times 10^{-5} \text{ m} \]

\[ y = \frac{F}{K} = \frac{1.7 \times 10^{11} \text{ N/m}^2}{4 \times 10^{-4} \text{ m}^3} \]

\[ y = 1.7 \times 10^{-8} \text{ m} \]

\[ y = 0.6 \times 10^{-4} \text{ m} \]

\[ A = 0.6 \text{ mm} \]

**Capacitor Plates**

\[ m = \rho WL \]

- **Charge in Capacitor**
  \[ Q = CV \]

\[ C = \frac{\varepsilon \varepsilon_0 A}{2d} \]

- **Parallel Plate Capacitor**

\[ C = \frac{\varepsilon \varepsilon_0 A}{2d} \]

\[ \varepsilon = 8.85 \times 10^{-12} \text{ F/m} \]

\[ A = 1 \text{ m}^2 \]

\[ d = 10^{-4} \text{ m} \]

\[ C = \frac{8.85 \times 10^{-12} \times 10^{-12}}{2 \times 10^{-4}} \]

\[ C = 4.425 \times 10^{-15} \text{ F} \]

**Force on Capacitor**

\[ F = \frac{qV}{2d} \]

\[ q = \frac{C}{\varepsilon_0} \]

\[ V = \frac{C}{\varepsilon_0} \]

\[ C = \frac{\varepsilon_0 A}{2d} \]

\[ V = \frac{8.85 \times 10^{-12} \times 10^{-12}}{2 \times 10^{-4}} \]

\[ V = 4.425 \times 10^{-15} \text{ V} \]

\[ q = 4.425 \times 10^{-15} \text{ C} \]

**Electric Field**

\[ E = \frac{F}{q} \]

\[ E = \frac{4.425 \times 10^{-15}}{4.425 \times 10^{-15}} \]

\[ E = 1 \text{ V/m} \]

**Energy Density**

\[ E_D = \frac{1}{2} \varepsilon_0 E^2 \]

\[ E_D = \frac{1}{2} \times 8.85 \times 10^{-12} \times 1 \]

\[ E_D = 4.425 \times 10^{-12} \text{ J/m}^3 \]

**Potential Energy**

\[ U = \frac{1}{2} C V^2 \]

\[ U = \frac{1}{2} \times 4.425 \times 10^{-15} \times 1 \]

\[ U = 2.2125 \times 10^{-14} \text{ J} \]