Making movable structures
- different 3-mask process, with masks
  2um LPCVD oxide
  2um LPCVD poly → Poly1
  1um LPCVD oxide → Anchor2
  2um LPCVD poly → Poly2
  HF release
Motor

Poly2
Poly1

$C_1 = \frac{\varepsilon_0 t \cdot R (\theta + \theta_0)}{g}$

$C_2 = \frac{\varepsilon_0 t \cdot R (-\theta + \theta_0)}{g}$

$\text{Force} = \frac{dU}{dx} \quad U = \frac{1}{2} CV^2$

$\text{Torque}_1 = \frac{dU}{d\theta} = \frac{d}{d\theta} \left( \frac{1}{2} CV^2 \right)$

$= \frac{d}{d\theta} \left( \frac{\varepsilon_0 V^2}{2} \cdot \frac{R \cdot t}{g} \right) = \frac{\varepsilon_0 V^2}{2} \cdot \frac{R \cdot t}{g}$

@15V \Rightarrow 1 \text{ N}\cdot\text{m} \times 1 \text{ mm} = 10^{-12} \text{ N}\cdot\text{m}

R = 1 \text{ mm}
Very small torque
No spring! Only need to overcome friction!
  Flat surface
  "Stiction"
  van der Waals force

⇒ Motor will not move! (stuck)

Solution:
Reduce contact area

⇒ Add a dimple mask to etch oxide before depositing Poly!
To make a real motor, need a few more masks.
Poly O for bias
SiN for insulation

After Release

Mismatch
in height

Sliding contact
Another cool thing you can do:
3D structures by folding ("origami")

Layout

Cross Section

After Release
"Pister" Hinge