

1. Thin Film Deposition (continued)

Plasma-Enhanced Chemical Vapor Deposition (PECVD)

- reaction energy supplied by plasma
- lower temperature than LPCVD: $\sim 300^\circ\text{C}$ to 400°C
 - * can deposit on substrates possessing deposited metal features
 - * lower intrinsic stress in deposited films than LPCVD
- Typically 500 mTorr to 2000 mTorr
- can deposit a variety of insulators: SiO_2 , Si_3N_4 , etc.
- Negative: deposited insulators generally have poorer dielectric and processing (i.e. masking) properties than LPCVD deposited films

④ Thermal Oxidation

- growing thin layers ($\sim \leq 1\mu\text{m}$) of SiO_2 on Si wafers
- conformal process
- "Dry Oxidation" $\rightarrow \text{Si} + \text{O}_2 \rightarrow \text{SiO}_2$: in oxygen ambient
- "Wet Oxidation" $\rightarrow \text{Si} + 2\text{H}_2\text{O} \rightarrow \text{SiO}_2 + \text{H}_2$: in steam ambient
- SiO_2 growth rate exponentially decreases with SiO_2 thickness

⑤ Electro- and Electroless Plating

- thin or thick films, ex: Au, Ni, Cu, Sn ...

⑥ Spin-On-Materials

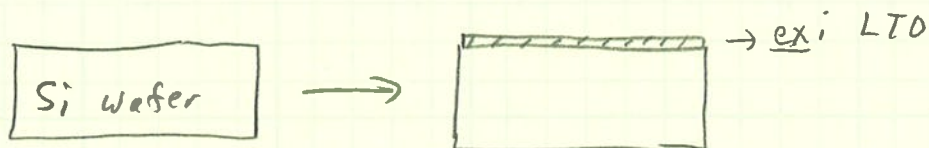
Photoresist, polyimides, Spin-On-Glass (SOG)

⑦ Parylene \rightarrow CVD deposited polymer coating

⑧ Laser CVD (LCVD) \rightarrow grows carbon structures

2. Surface Micromachining process { Simplest }

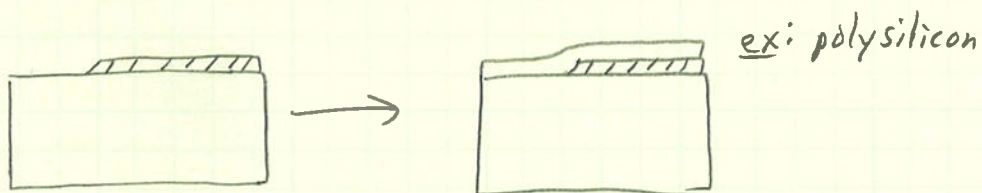
① coat wafer with thin film layer for use as a sacrificial layer



② pattern the thin film layer → Photolithography Mask 1



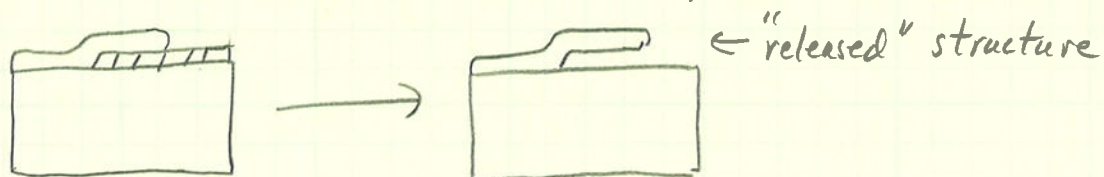
③ deposit thin film structural material



④ pattern the structural layer → Photolithography Mask 2

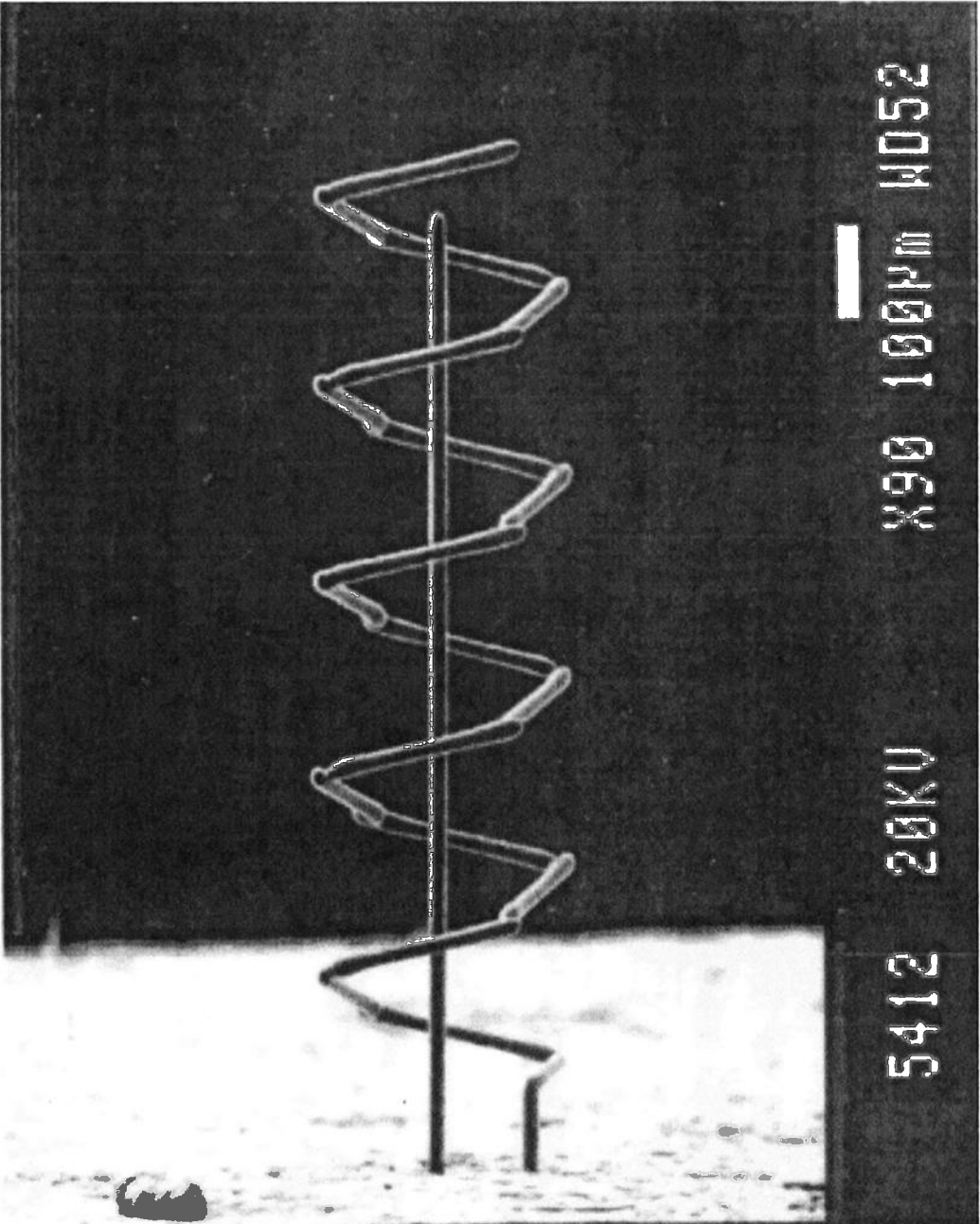


⑤ release etch to remove sacrificial layer



→ more complicated devices might have multiple ① → ④ steps before the release etch ⑤

LCVD Carbon 3-D structure



5412 20KV X90 100µm WD52

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