微纳光电子材料与器件工艺原理

Etching
Part III: CMP and others

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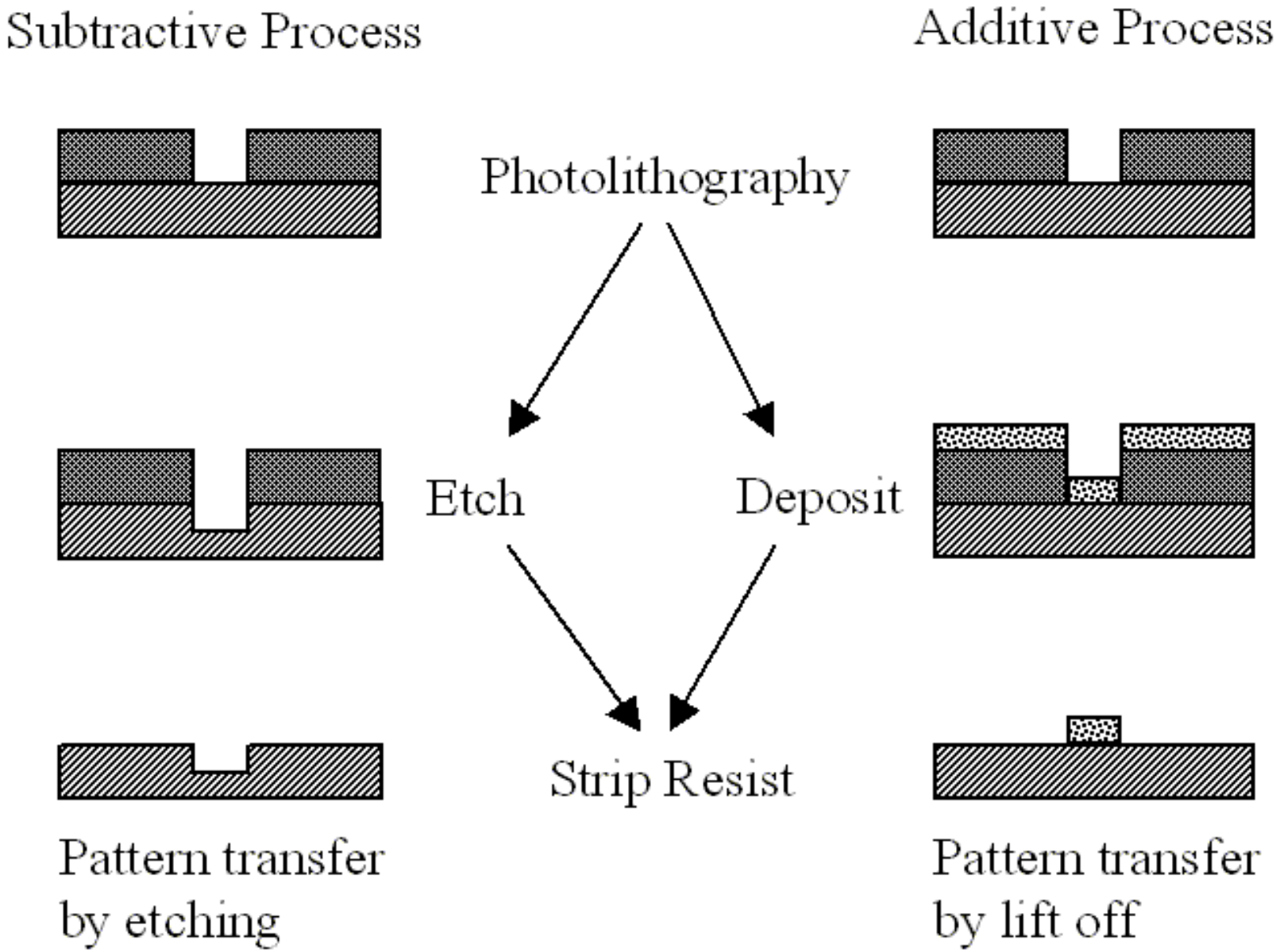
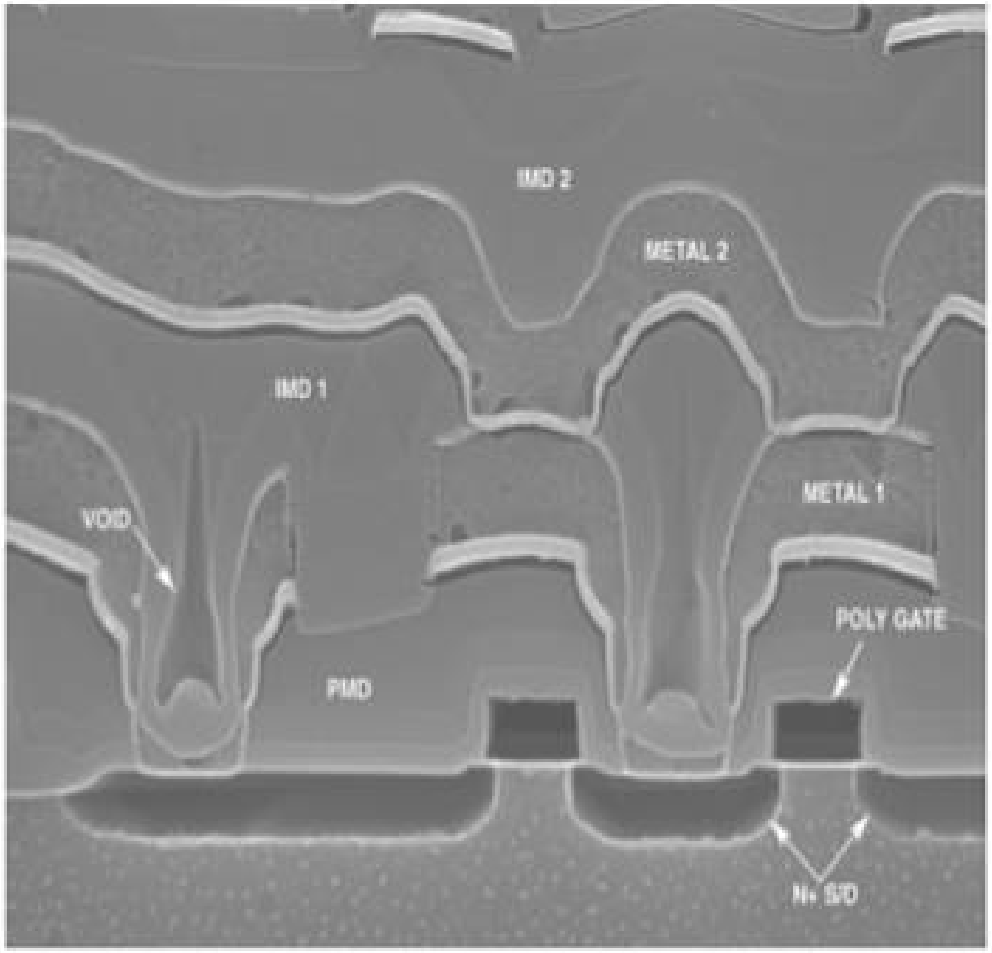
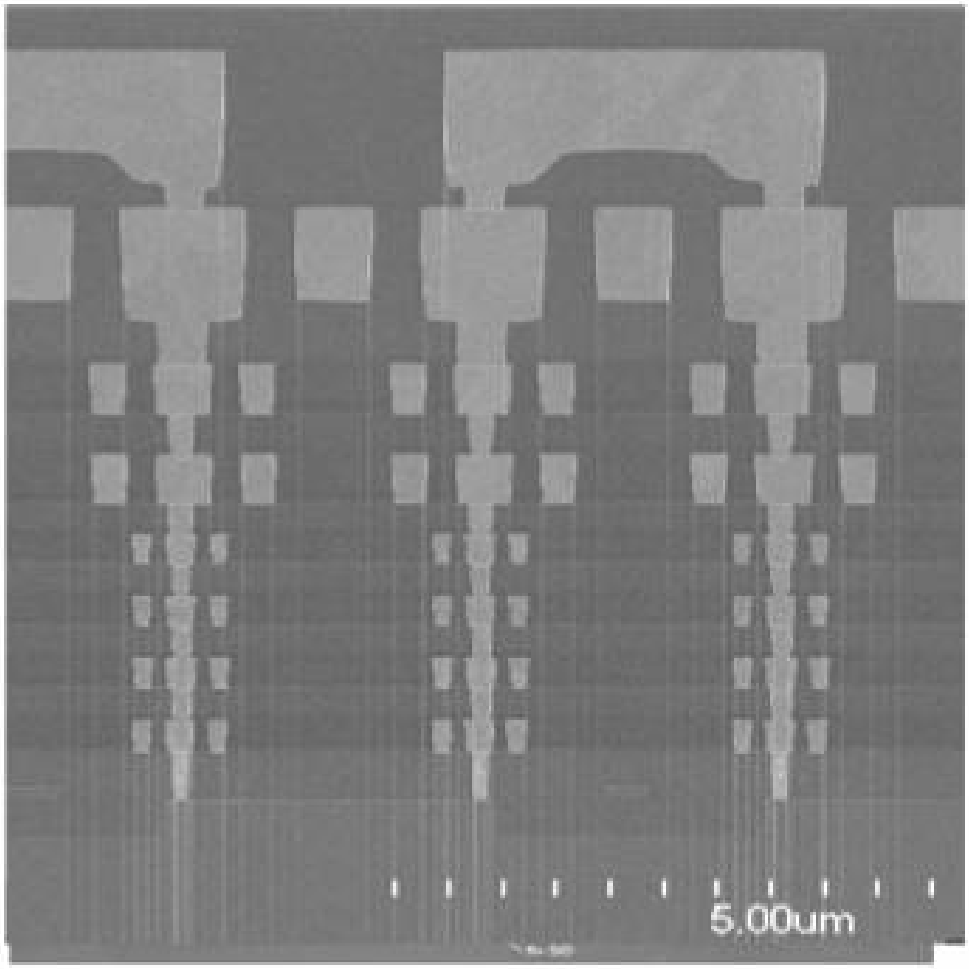
Pattern Formation



Planar Layers are Desirable

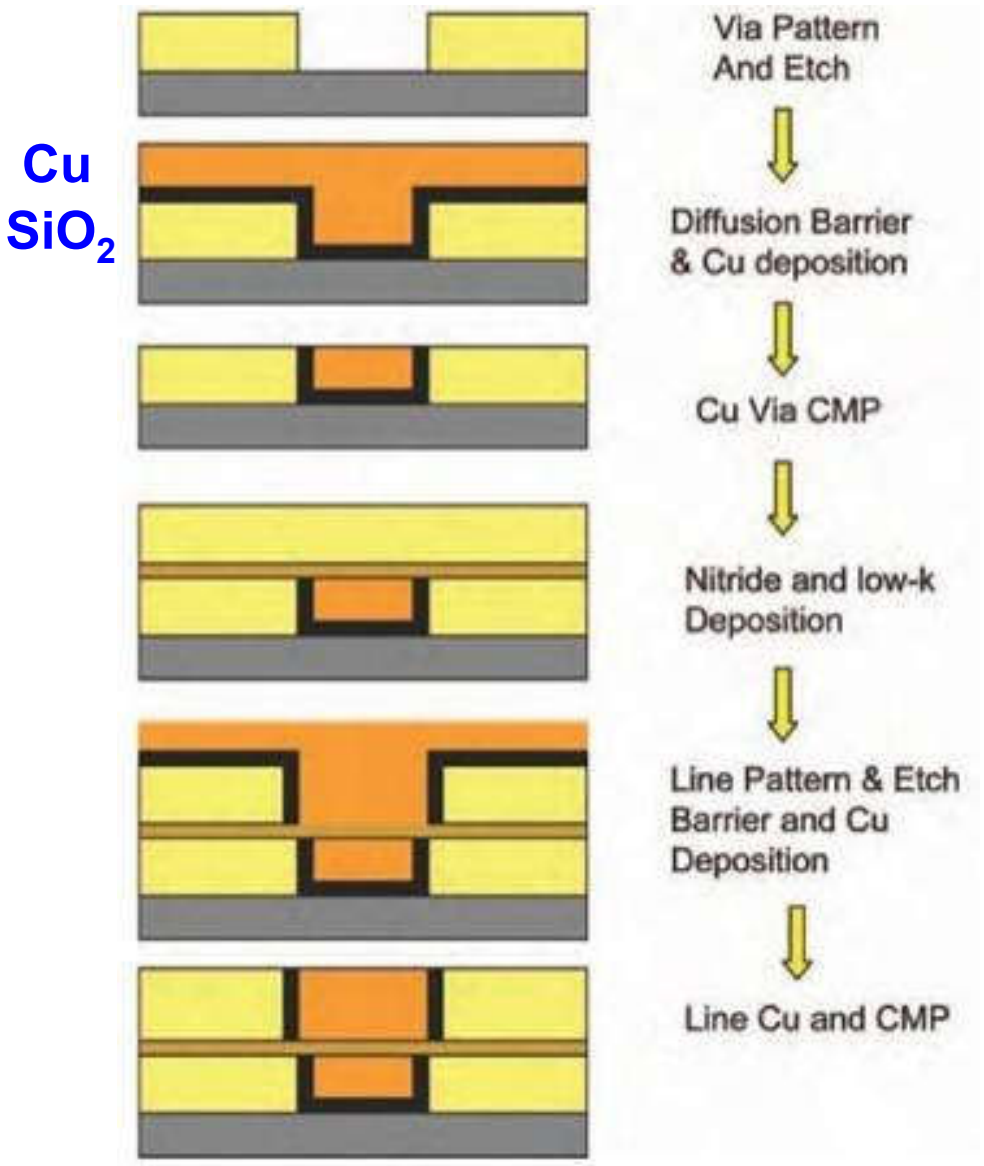


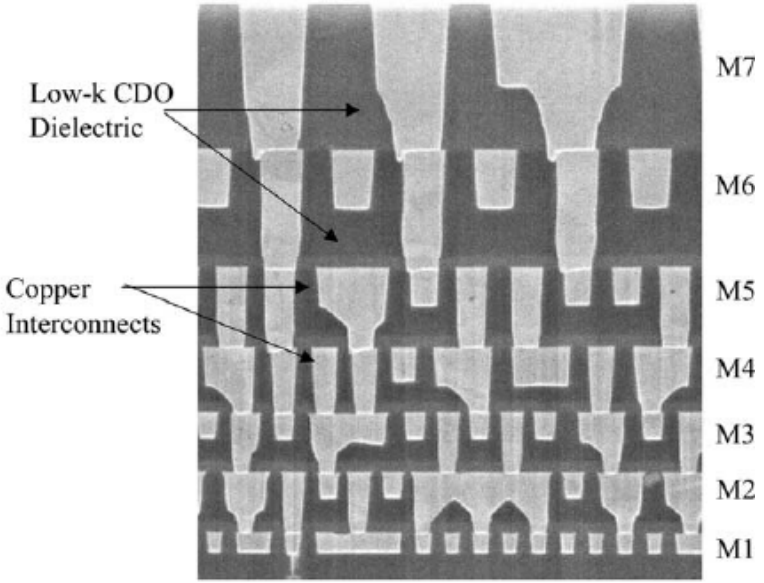
non-planarized IC



planarized IC

Damascene Process



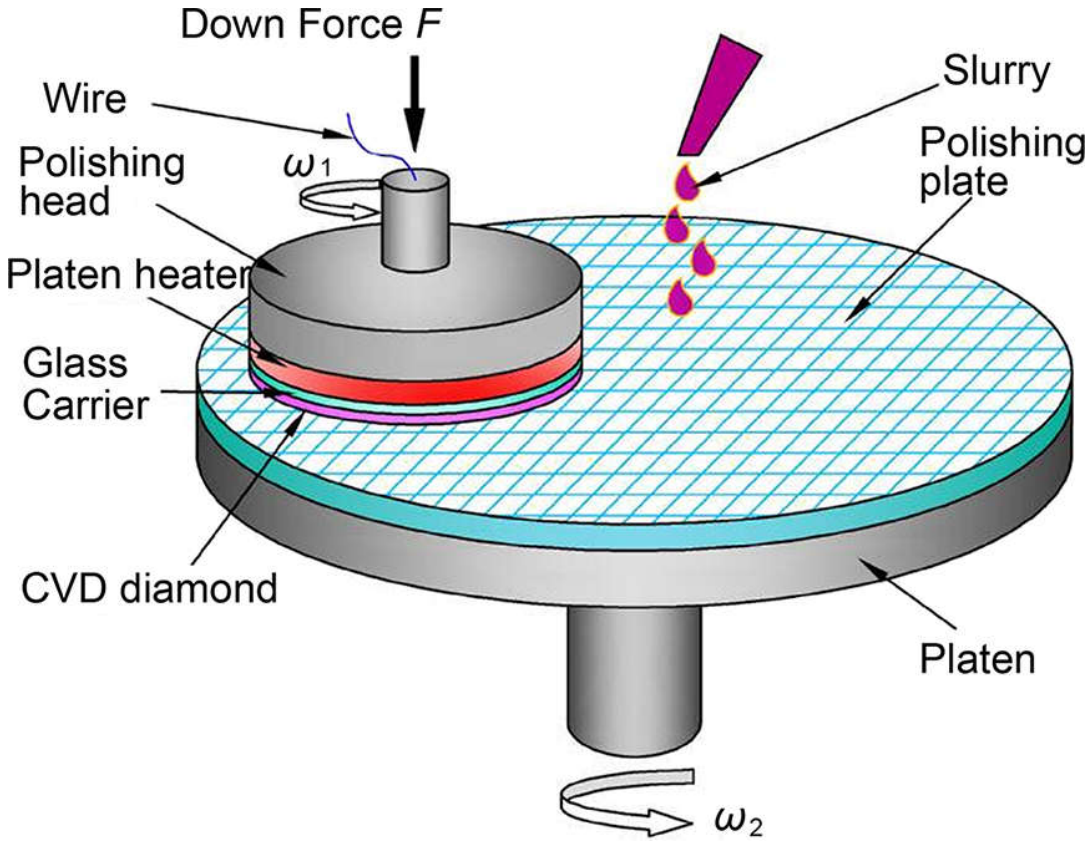


ancient art work

P. C. Andricacos, *et al.*, *IBM J. Res. Develop.* **42,** 567 (1998)

CMP: Chemical Mechanical Polishing

- **Chemical selectivity + Mechanical Planarization**
- **applied for Cu, W, SiO_2, ...**

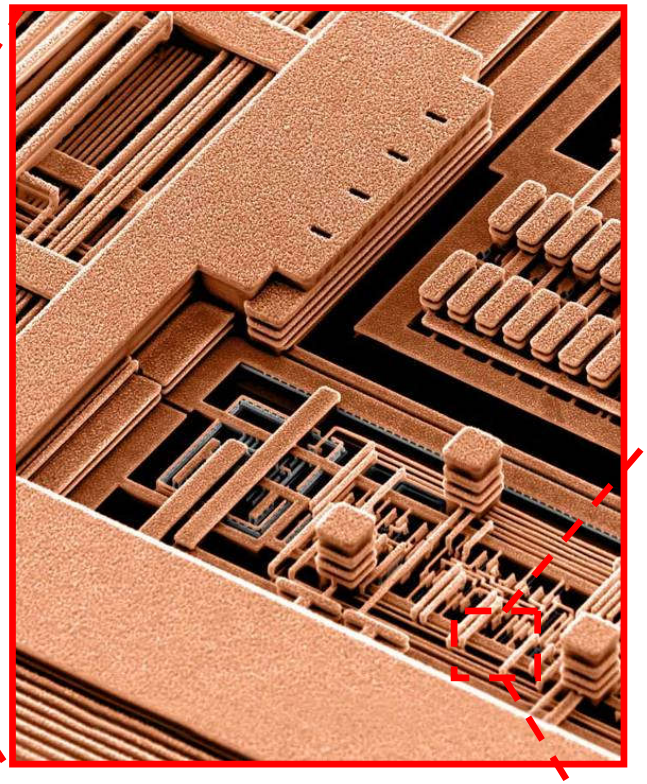


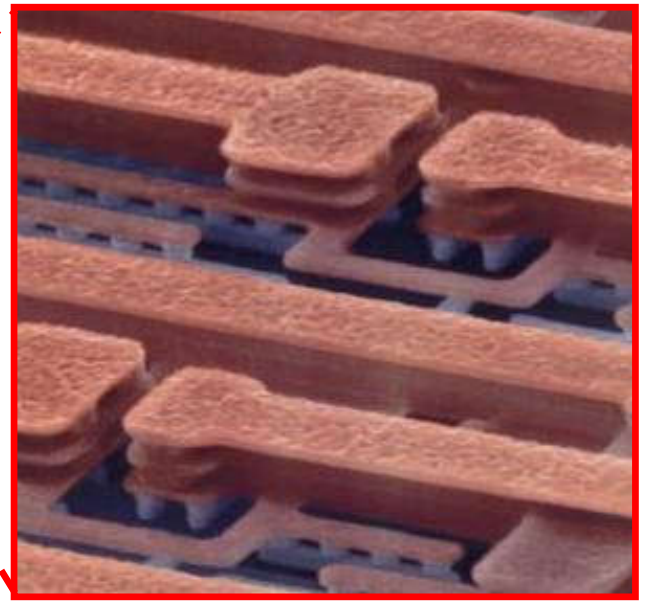
Video

3D IC

Electroplating + CMP

dirtiest process for the most advanced IC



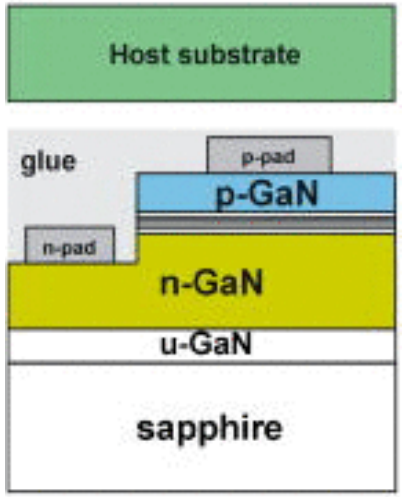


Other Methods for Etching

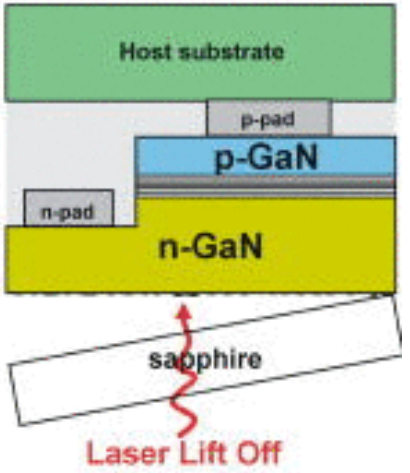
- Laser Lift-Off
- FIB: Focused Ion Beam
- Laser Milling
- ...

GaN Laser Liftoff

- GaN devices grown on sapphire
  - low cost
  - low thermal conductivity
  - electrically insulating
  - sapphire is very difficult to etch

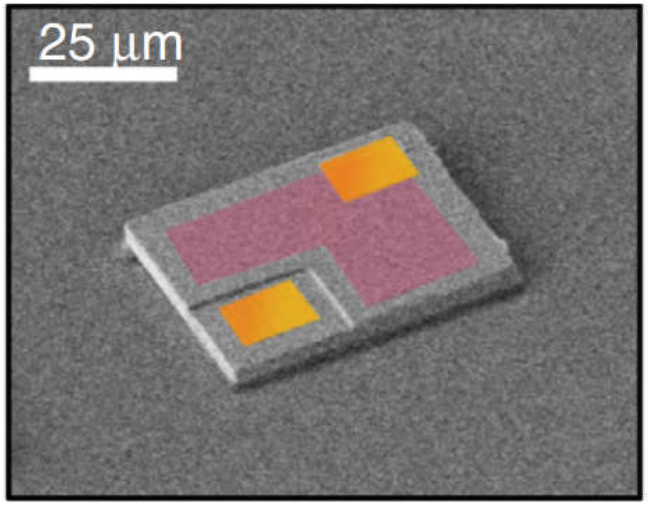


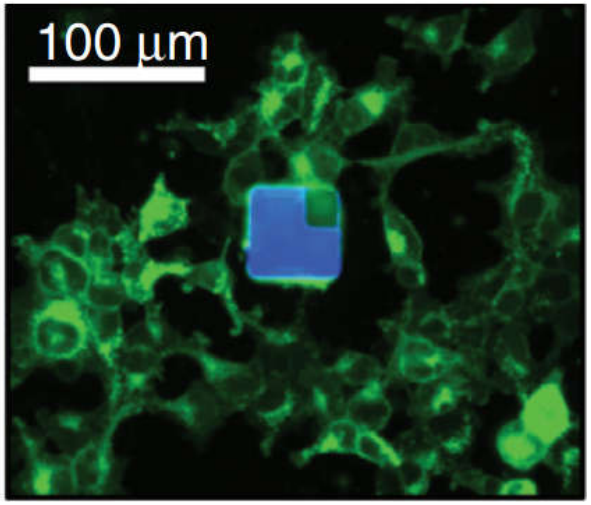
- Release by laser liftoff
  - KrF excimer UV laser (248 nm)
  - GaN = Ga + N_2 (gas)
  - bonding onto new substrates

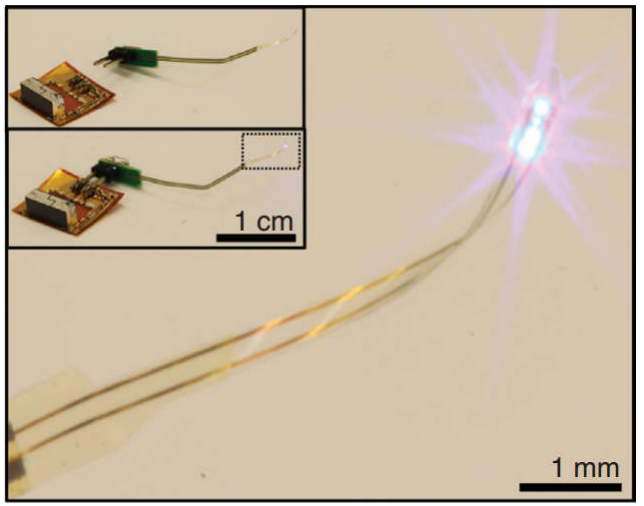


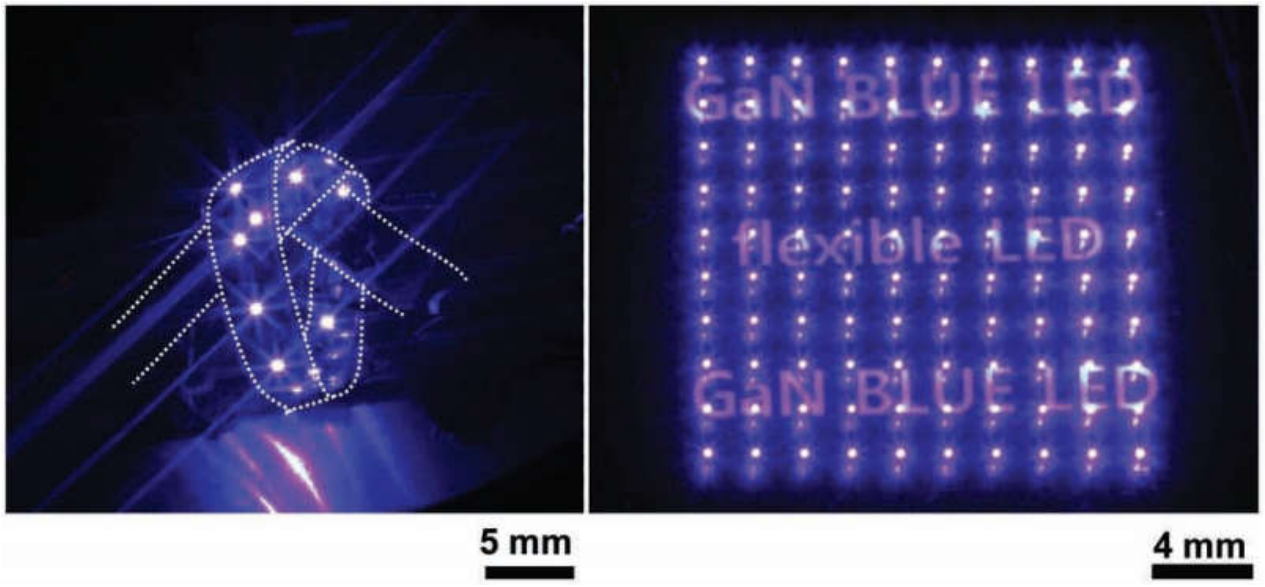
W. S. Wong, *et al.*, *Appl. Phys. Lett.* **72,** 599 (1998)

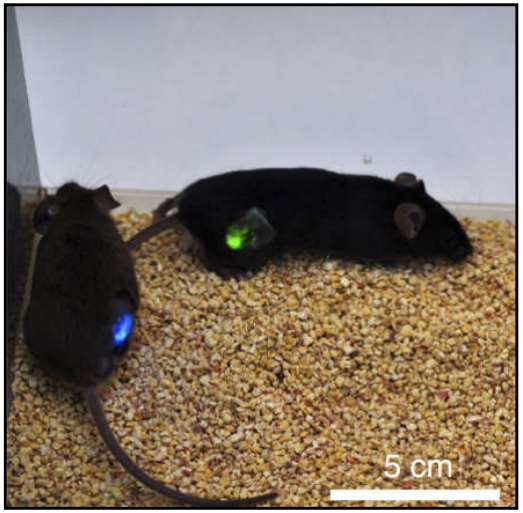
Flexible GaN blue LEDs





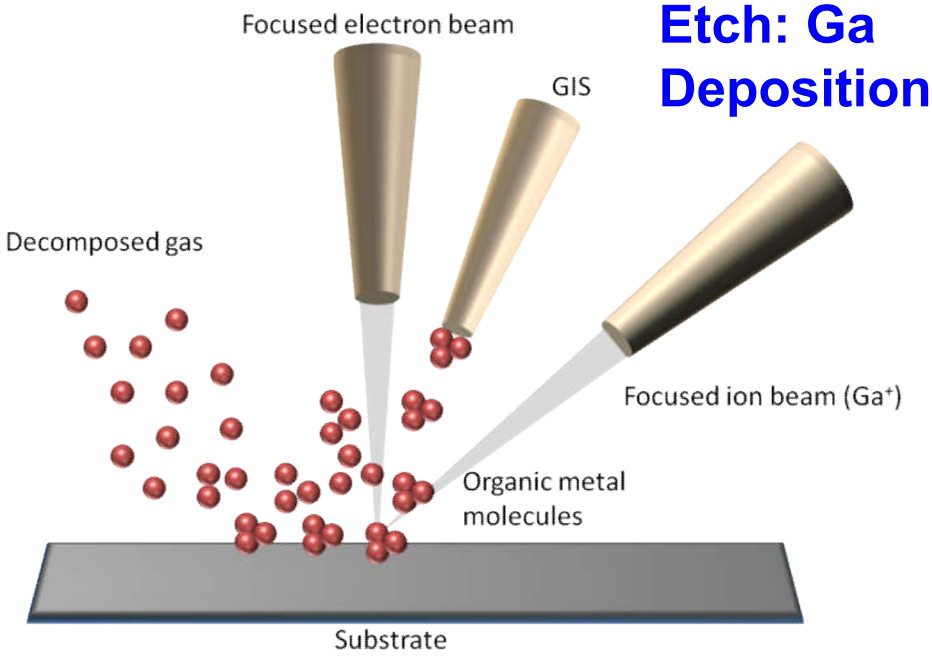




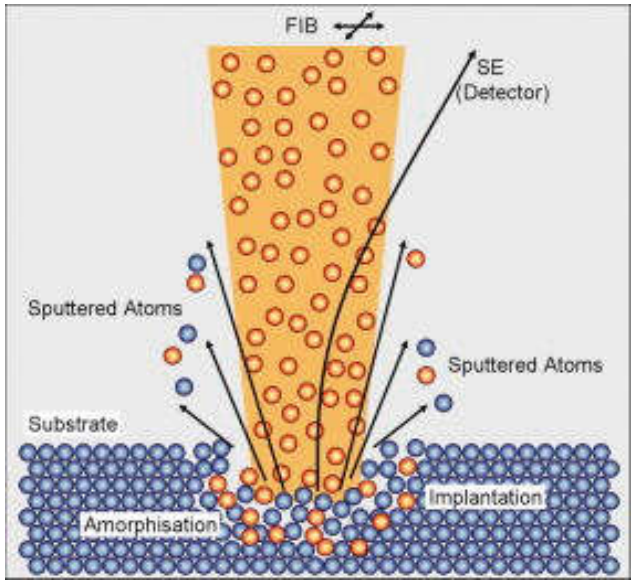


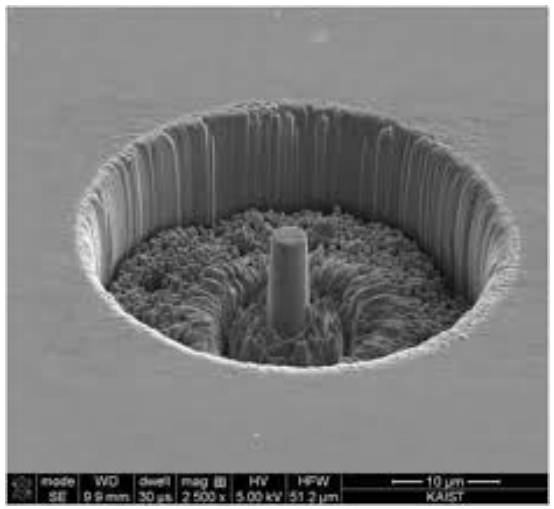
T. Kim, *et al.*, *Science* **340,** 211 (2003)

FIB: Focused Ion Beam



Etch: Ga
Deposition: Pt

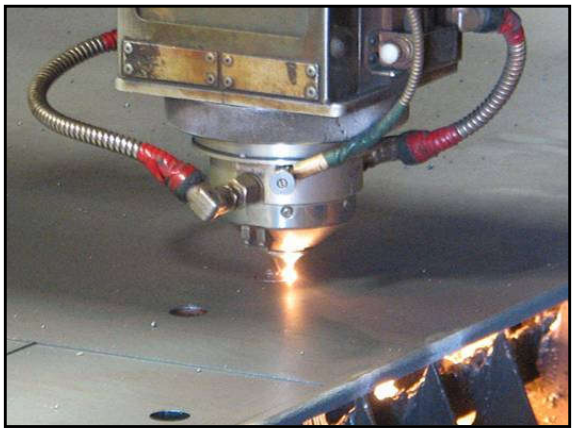




- **nanostructures**
- **SEM/TEM sample preparation**
- **doping**

Laser Milling

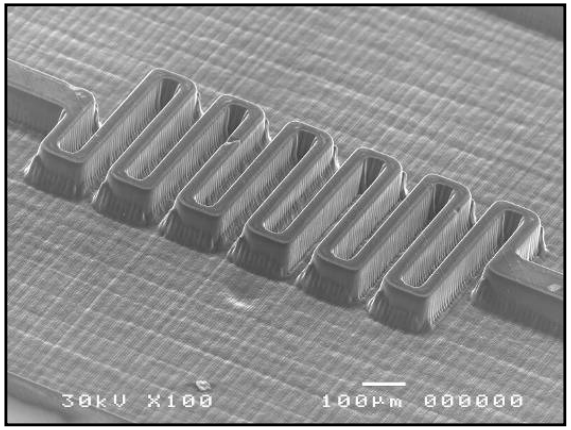
- **Types**
  - CO_2 laser 10 μm
  - Near-IR laser 1064 nm
  - UV laser 365 nm
  - Excimer laser 248 nm, 193 nm
  - ps/fs laser ...
- **Applications**
  - die cut, PCB cut, ...



shorter wavelength
shorter pulse

↓

better resolution



Thank you for your attention