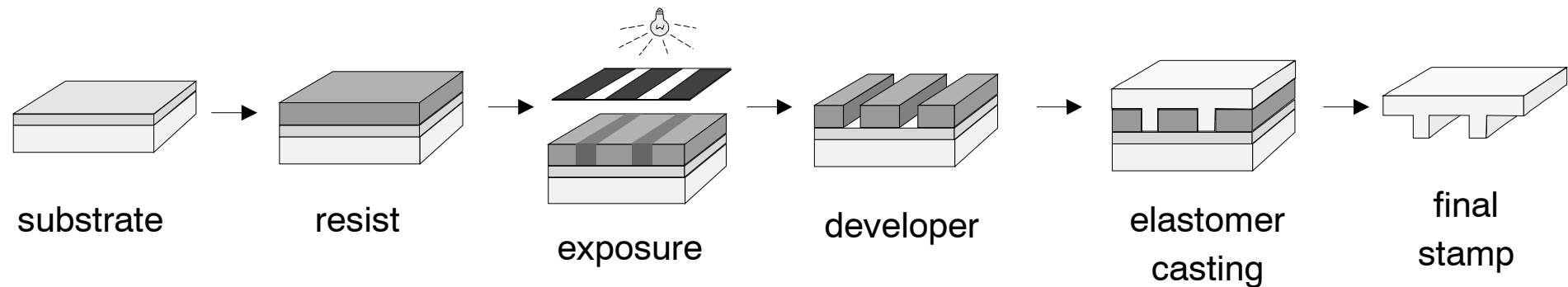


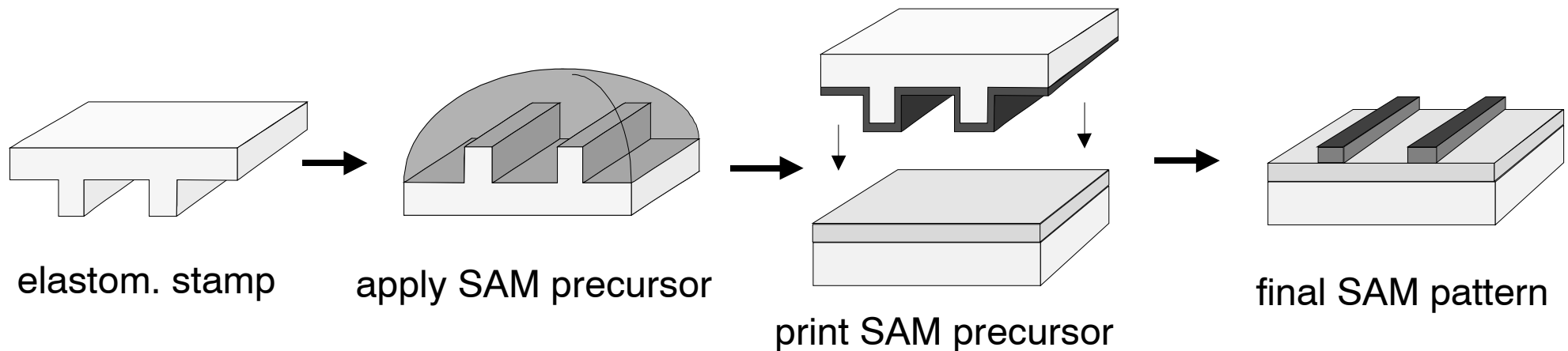
Microcontact Printing (μ CP) 1

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Macromolecular Chemistry
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- **Transfer of SAM precursor with elastomeric stamp** onto substrate:
 - ⇒ **master** generation by **photolithography** and similar techniques:
 - stamp is obtained by **casting** of **elastomer** (PDMS, e.g.) over **master**

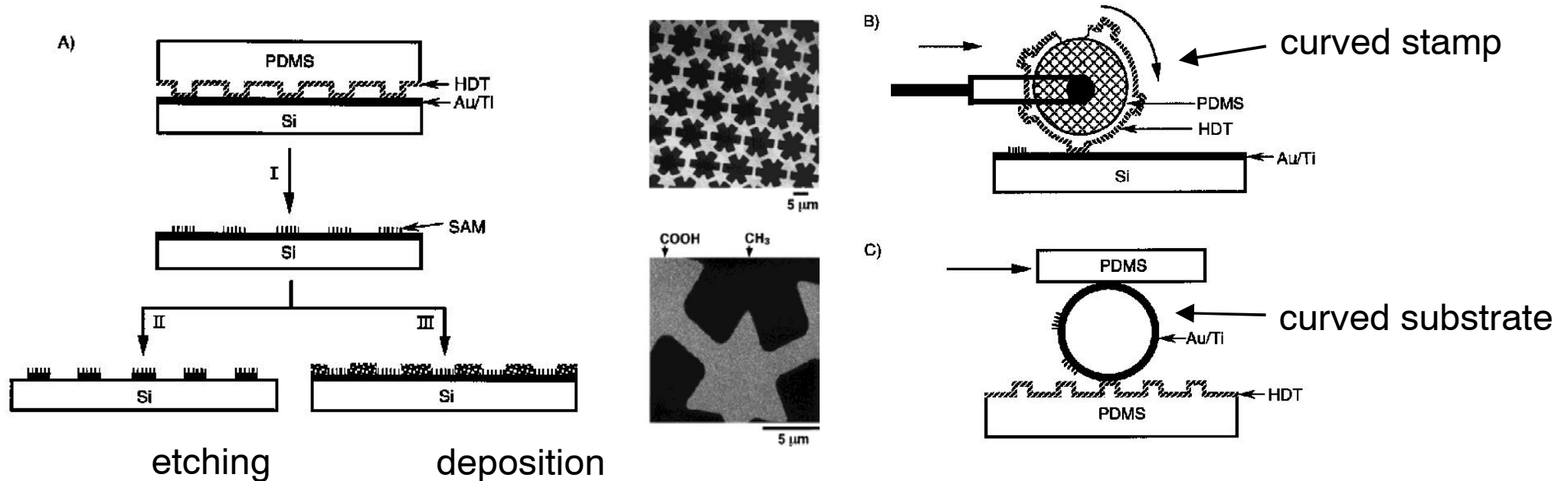


- ⇒ **pattern** generation by **stamping** of SAM precursor onto substrate:

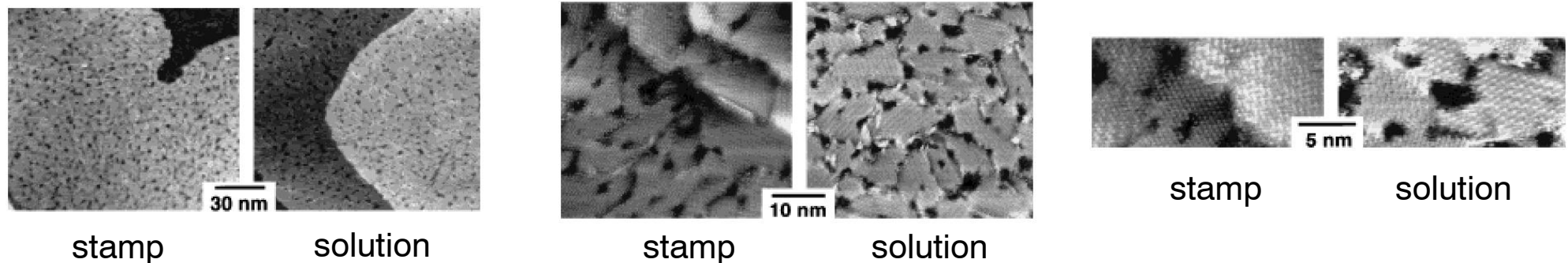


Microcontact Printing (μ CP) 2

- Stamped **SAM pattern** can be further **processed** by **etching** or **deposition**:
 \Rightarrow μ CP technique can also be applied to **curved surfaces** of stamp or substrate

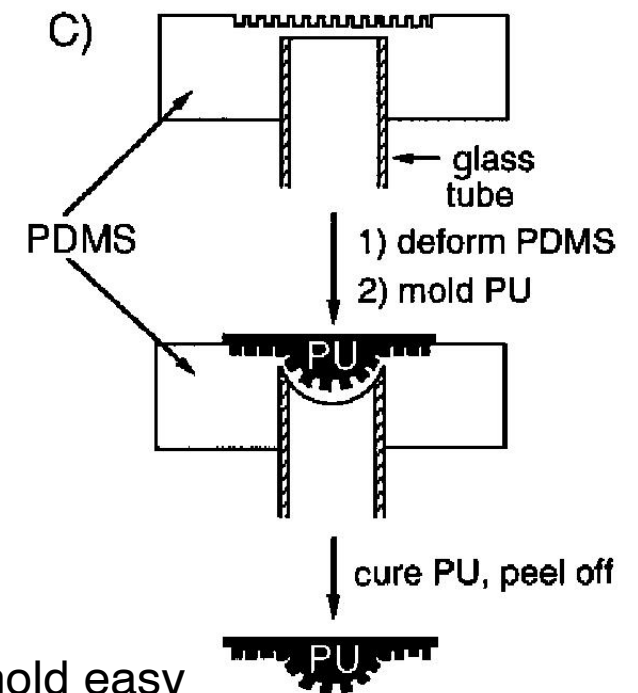
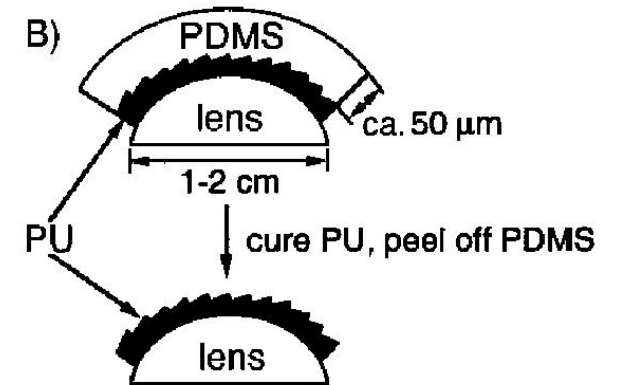
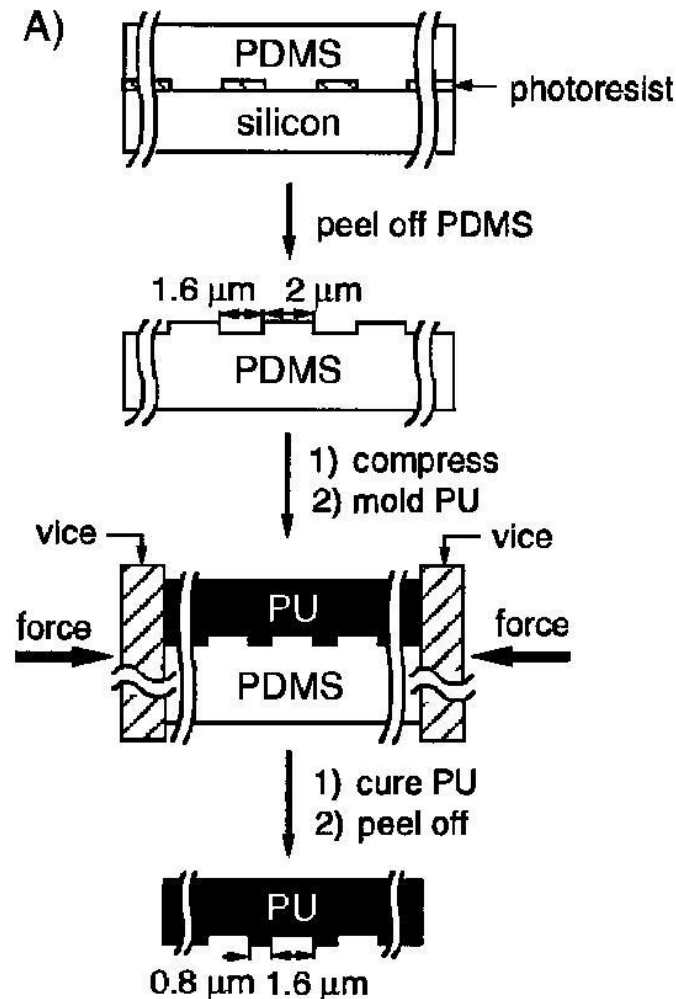
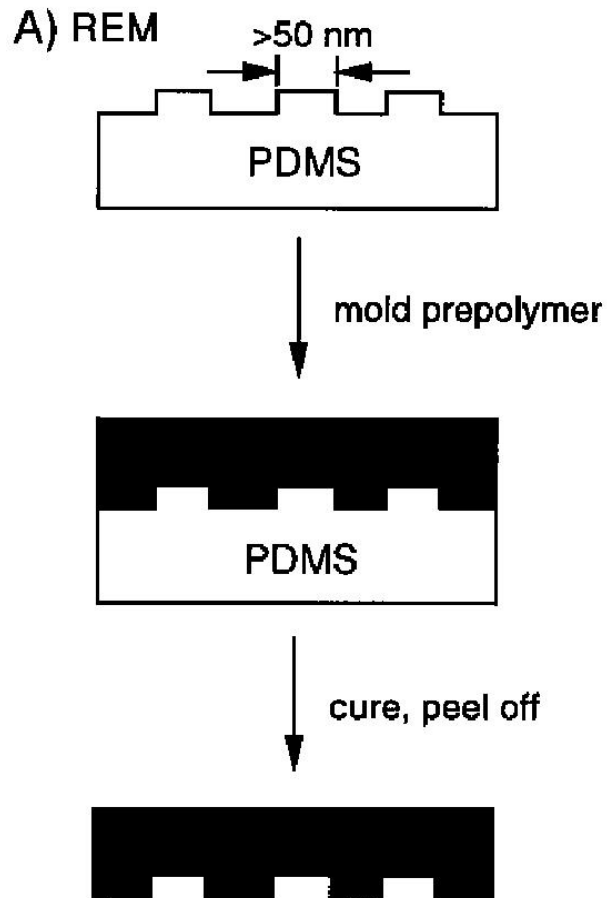


\Rightarrow **quality** of μ CP SAMs is **comparable** to films obtained by **adsorption** from solution



Replica Molding (REM)

- Use **elastic stamp** as **master** for **molding** of rigid polymer:

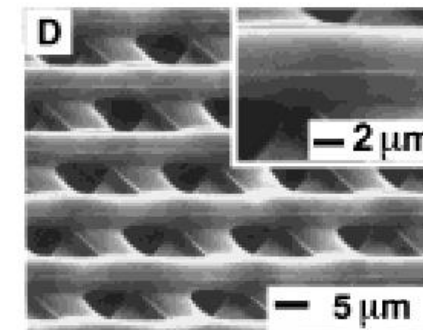
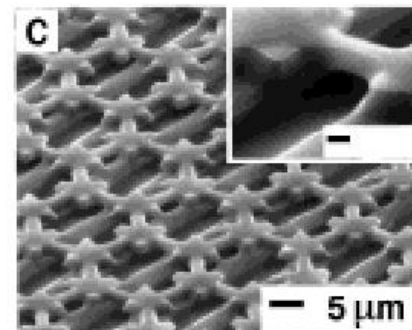
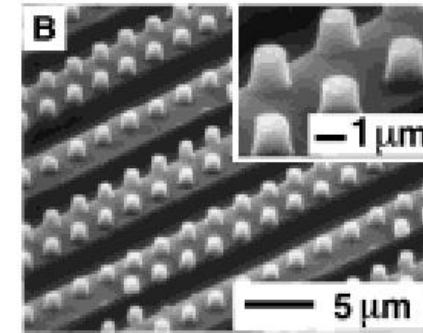
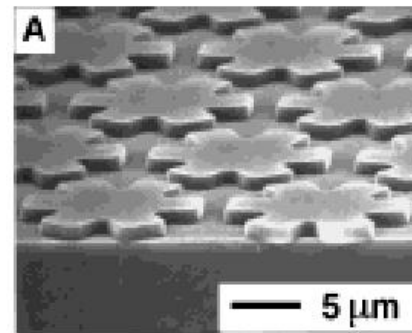
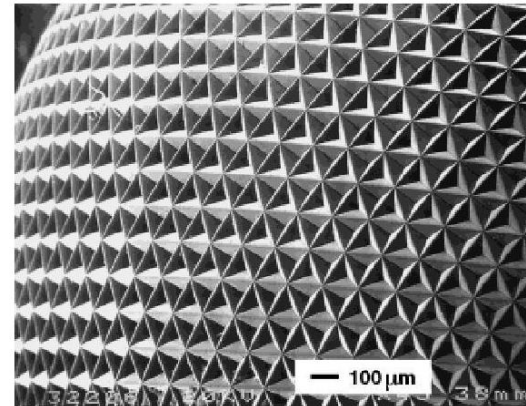
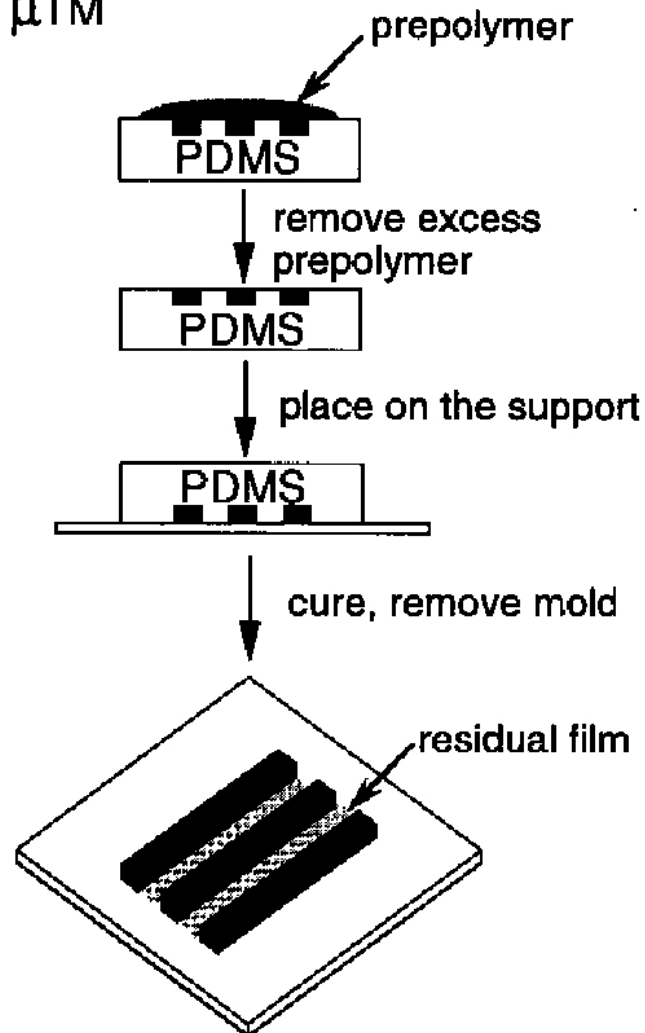


⇒ **elasticity** and **low surface energy** of stamp make **release** of mold easy

Microtransfer Molding (μ TM)

- **convenient method** for fabrication of **microstructures** on **nonplanar substrates** and **3D structures** layer by layer:

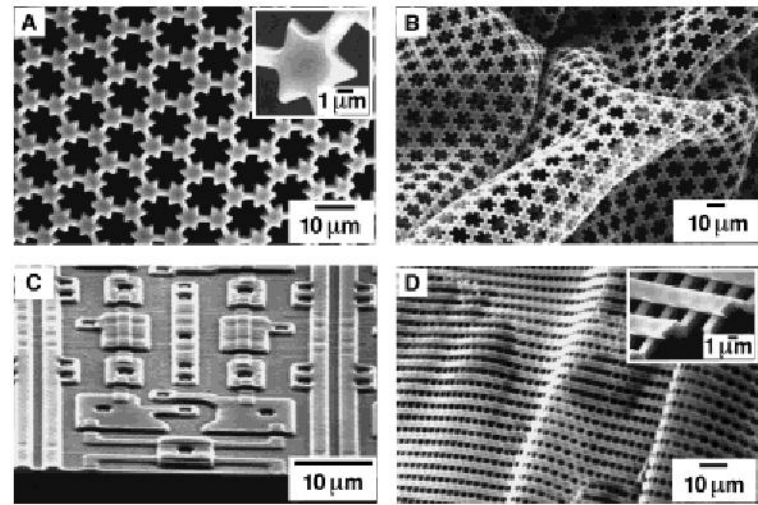
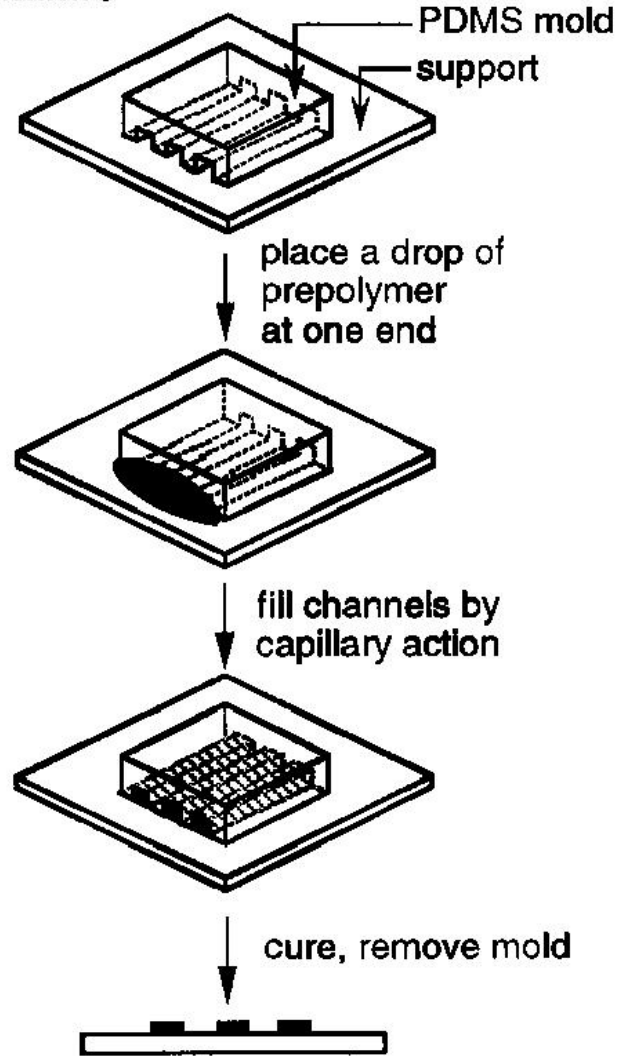
B) μ TM



Micromolding in Capillaries (MIMIC)

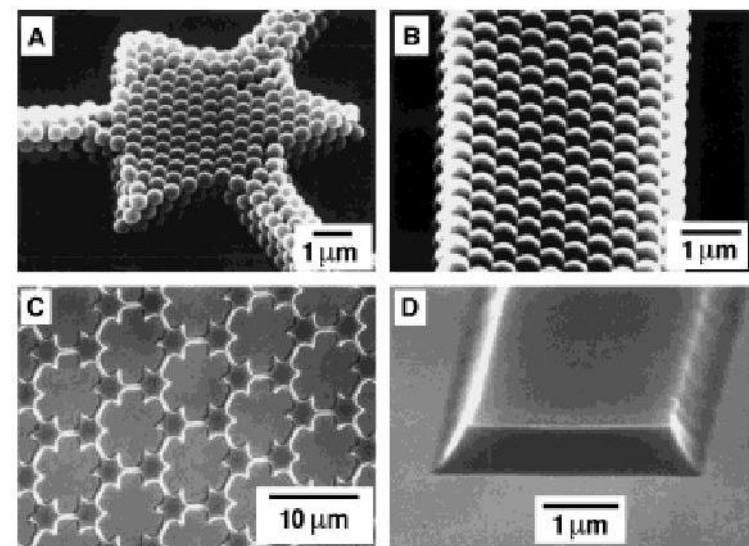
- 3D microstructure formation by filling of microcapillaries with liquid precursor:

C) MIMIC



polymer precursor:

- A, C: polyacrylate
 B, D: polyurethane

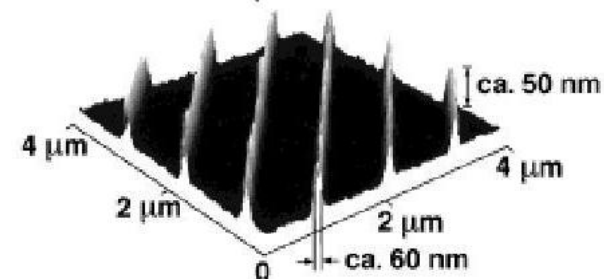
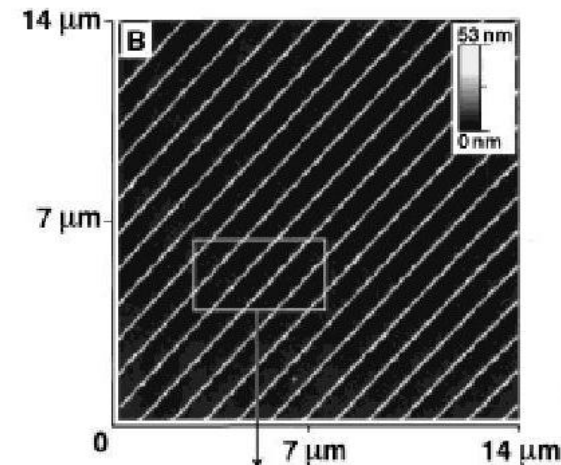
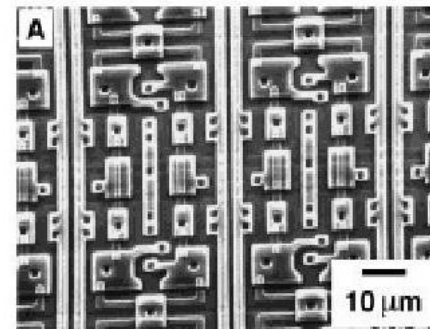
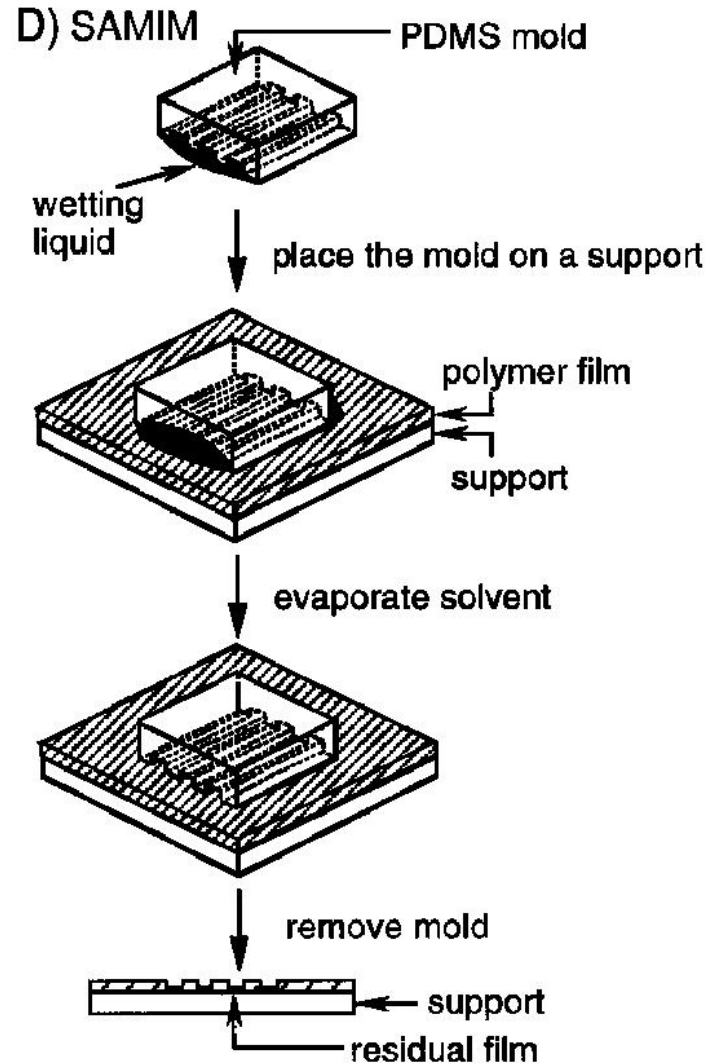


precursor w/ solvent:

- A, B: polymer beads
 C, D: polyaniline emeraldine · HCl

Solvent-Assisted Micromolding (SAMIM)

- **Quasi-3D microstructure** formation in **polymeric substrates** by **solvent etching** in **microcapillaries**:

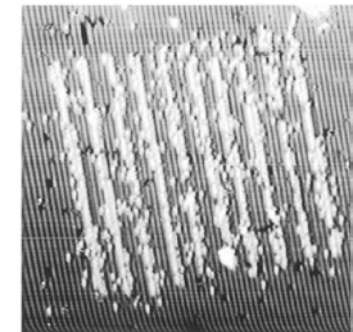
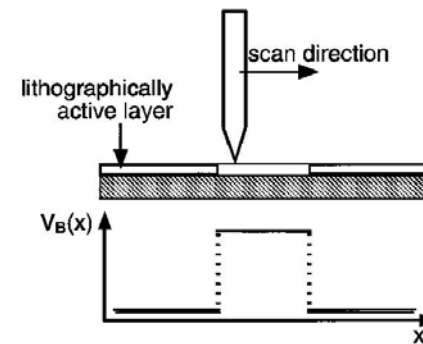


polymer film:
photoresist,
solvent:
ethanol

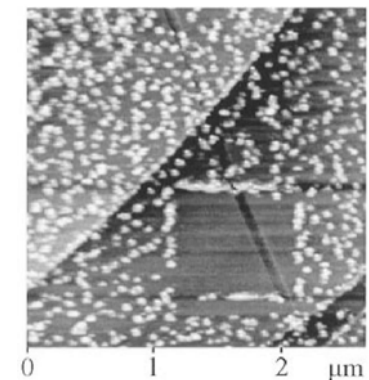
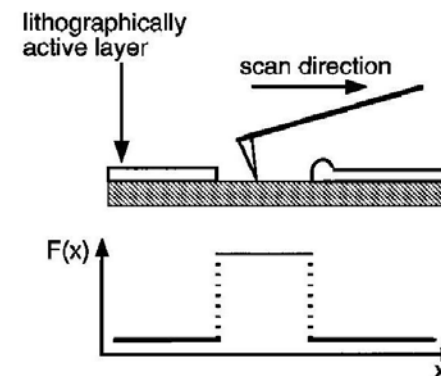
Proximal Probe Lithography / Scanning Probe Lithography

- Use of **scanning probe microscopes** for surface **modification** down to the **nm** range:

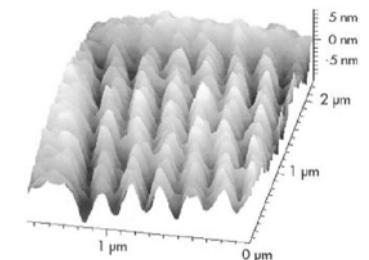
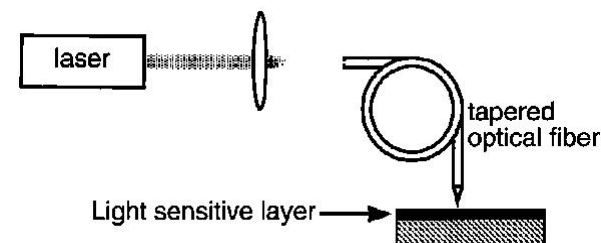
⇒ **electrical** methods: scanning **tunneling** microscope (STM) tip generates local **field** / **current** which modifies region under tip (SiH → Si)



⇒ **mechanical** methods: scanning **force** microscope (SFM / AFM) tip **scrapes** or **transfers** material at the surface

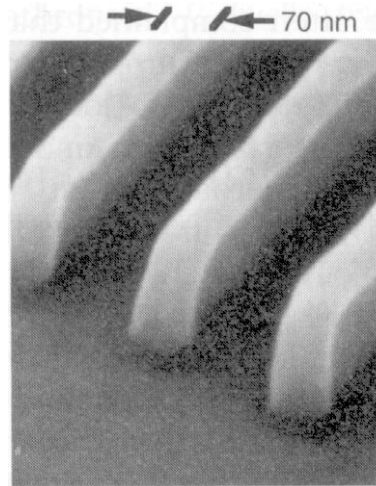
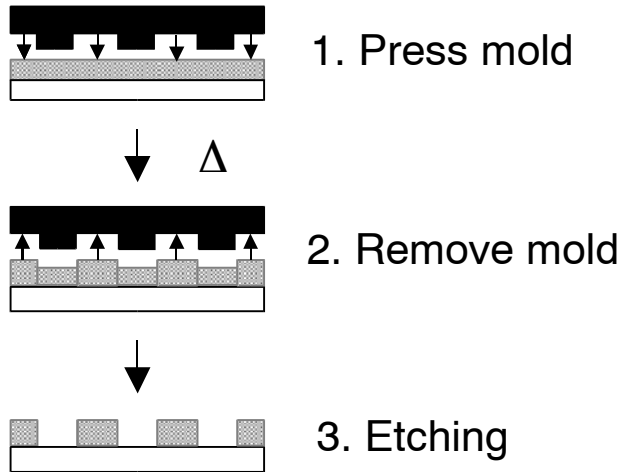


⇒ **optical** methods: **near-field optical** scanning microscope (NSOM) tip **exposes** photoresist under tip

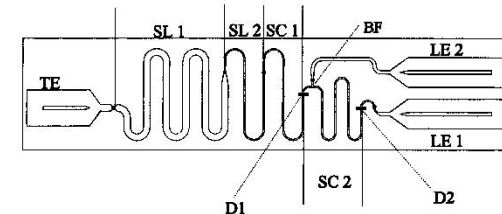


Embossing

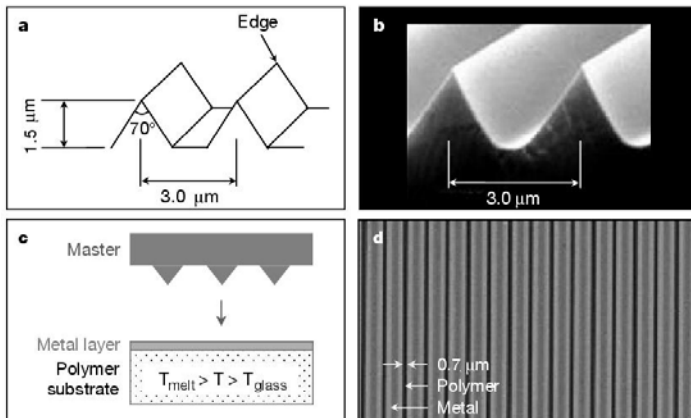
- **Rigid master** (stamp, Ni or SiO₂, e.g.) is **pressed** into thermally **softened polymer** substrate (PMMA, polycarbonate → CD, e.g.) to transfer relief structure to polymer:



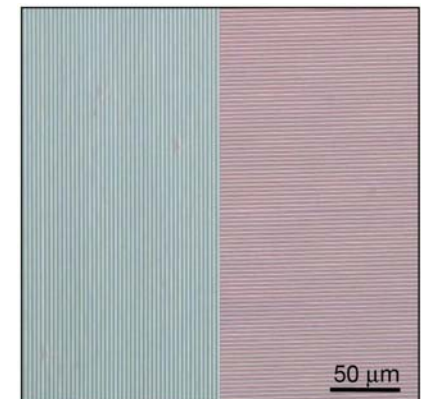
- application: microchip for isotachopheresis (electrophoretic separation technique for ionic compounds)



⇒ **Microcutting**: embossing of **metal-coated** polymer films creates metallic **micro-objects**

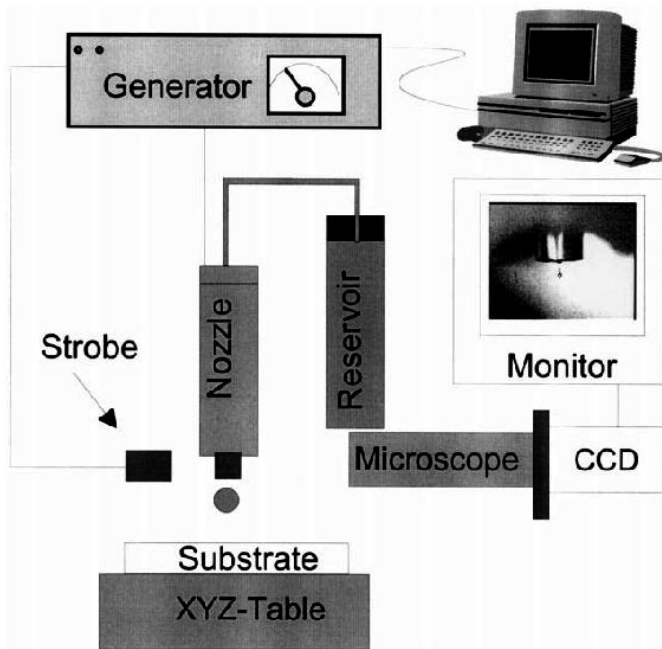


- application: IR-polarizer, polarization-dependent color filter (on the right)

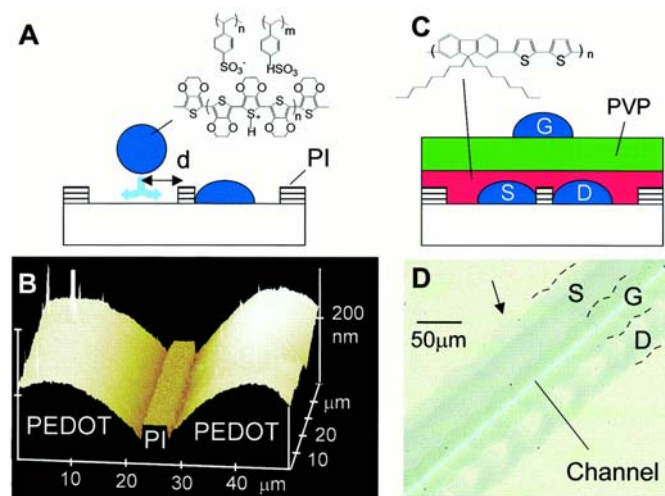


Printing (Inkjet)

- **Inkjet printer** can be used to generate surface **pattern** with appropriate "ink" (resolution $\sim 50 \mu\text{m}$):
 - **resist**: by using a resist precursor as ink the mask can be printed directly
 - **electr. active materials**: "printing" of electronic devices, like thin film transistors (TFT)
 - **DNA**: generate DNA arrays for sequencing applications
 - **polymers**: printing of polymer precursors for rapid 3D prototyping (layer-by-layer)



⇒ TFT printing:



⇒ microlens printing:

