Frontier Nanotechnologies for and by Life Sciences

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Outline

- What's Nano?
- Why (and When) Nano?
- Nano Lessons from Nature
- From Nano to Nature

Why Nano…

Wavelength of visible light

$$c = \lambda \nu$$

$$E = h \nu$$

$$E = h c / \lambda$$

(λ = wavelength, c = light speed = 300000 km/s, h = Planck's Constant)

Why Nano…

Electrons Wave

QUANTUM MECHANICS

$\lambda_{electon} = h / p$ De Broglie Relation

($\lambda_{electron}$ = electron wavelength, h = Planck's Constant, p = electron momentum)

Nano-technology

Nanotechnology includes handling and processing atoms and molecules to produce novel materials, devices, and machines.

Nano" often used as synonym of "innovation"

Historical nanomaterials and nanostructures…

Famous Ex: Lycurgus Cup (5th-4th century B.C.) @ British Museum.

There's plenty of room at the bottom…Richard Feynman, CalTech 1959

Roadmap to miniaturization:

- Transistor invention (1947)
- Integrated Circuits (60s)
- Moore's Law

  G. E. Moore, Electronics **38** (1965).

  www.intel.com/technology/mooreslaw/index.htm
- Top down vs. Bottom-Up approaches (90s)

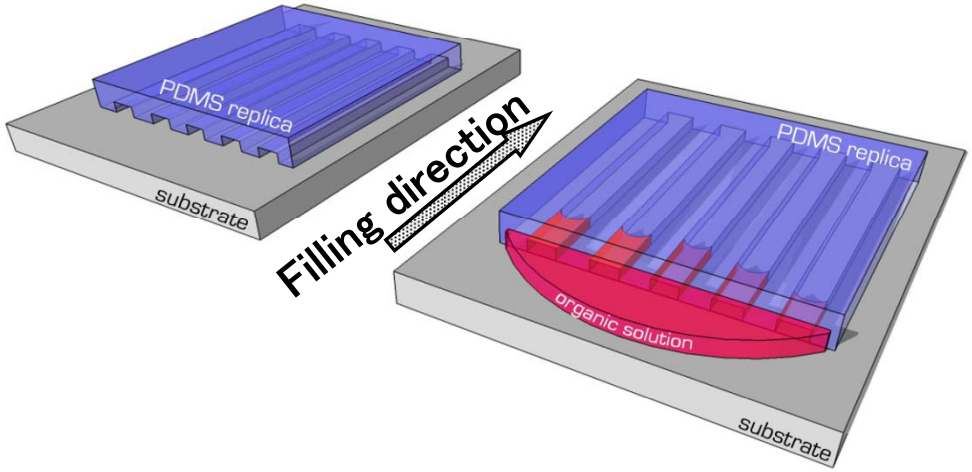
Other modern applications: Life science, Biodiagnostics, Food industry…

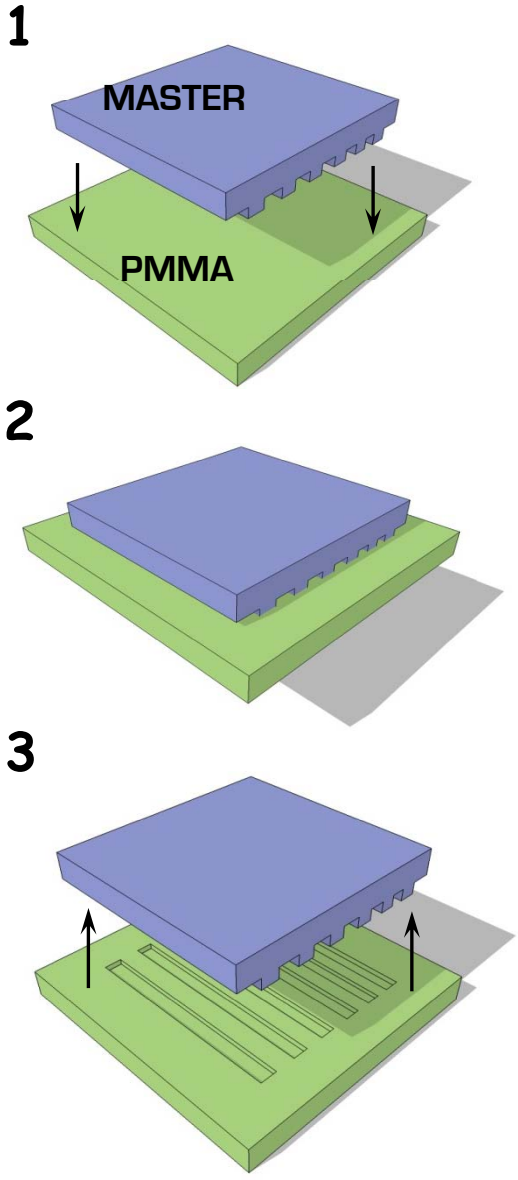
Learning from Nature: Macro- vs Nano-scopic properties

Molecular Photonics

- Realization of new molecules able to transport electrical charges and to emit light
- Processing materials and devices by solutions and at room temperature
- Low costs
- Flexibility

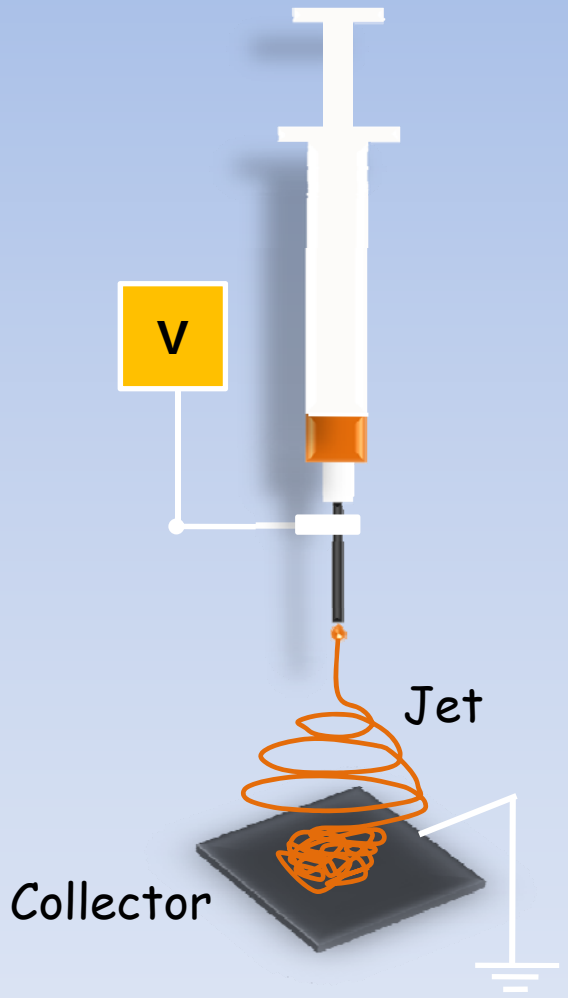
Nano-Photonics





E. Mele, et al., Nano Lett. **5**, 1915 (2005)

Electrospinning



Applications

Polymer nanofibers

See also F. Di Benedetto, et al., Nat. Nanotechnol. **3**, 614 (2008)

Nano and Microfluidics

See also S. Girardo et al., Lab Chip **8**, 1557 (2008)

Nano-Lithographies for Proteins

See also N. Sgarbi et al., Biomater. **25**, 1349 (2004)

Nano-Lithographies and Nano-structures for Cells

See also A. Polini et al., Soft Matter **6**, 1668 (2010)

What's Next?

Cells + Nanostructures or Nanosystems
re-implanted in Body

Nano-Assisted Regenerative Medicine
In-body Real-Time Monitoring
Intelligent Drug-Delivery