Access to the Tools of Nanoscience

Lithography-in-a-Box

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Nano-Link

Midwest Regional Center for Nanotechnology Education

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The Need

We want to provide our students training on tools of nanotechnology.

Gold standard: Actual nanofabrication and characterization tools

However, these tools

- **are expensive**
- **require extensive training**

Approaches to Remote Access

- **Training the trainer:** Propagate skills and knowledge to teachers
- **Tool simulators:** bench top versions of nanotools that demonstrate concepts, along with instructions, experiments, activities
- **Remote tool access:** Provide the ability to operate and/or view operation of an actual instrument

Simulator Tools

- Objectives: give students a faithful demonstration of an actual tool or process
- The ideal simulator
  - is low cost to produce
  - Can be assembled by non-specialists
  - has minimal/low cost consumables
  - requires minimal chemicals and waste disposal

UM approach to Simulators

- Post the kits' parts lists, sources, instructions
- Schools reproduce the kits on their own, introduce improvements that are shared
  - No central kit repository
  - Perhaps assist with high-cost consumables

Simulator 1: Lithography in a Box

- Objective: demonstrate pattern transfer

Spin coating → Aligner/optical exposure

→ Pattern development → Etching

Lithography in a Box Kit

- Objective: demonstrate pattern transfer

Spin coater:

Lithography in a Box Kit

- Objective: demonstrate pattern transfer

Spin coater:

Aligner/exposure/developer

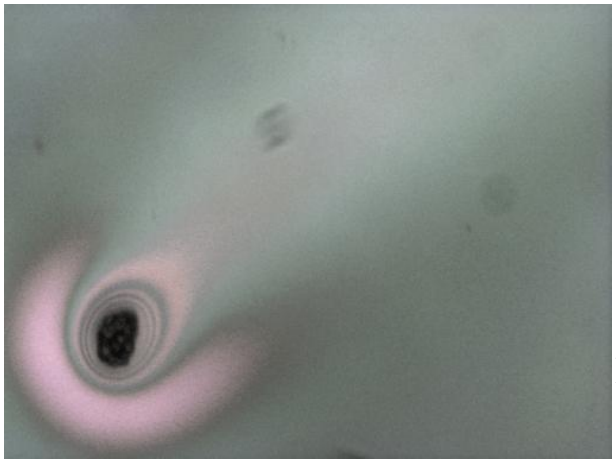
Result: Photoresist patterns that can be inspected with a microscope

Experience To Date

Lithography in a Box

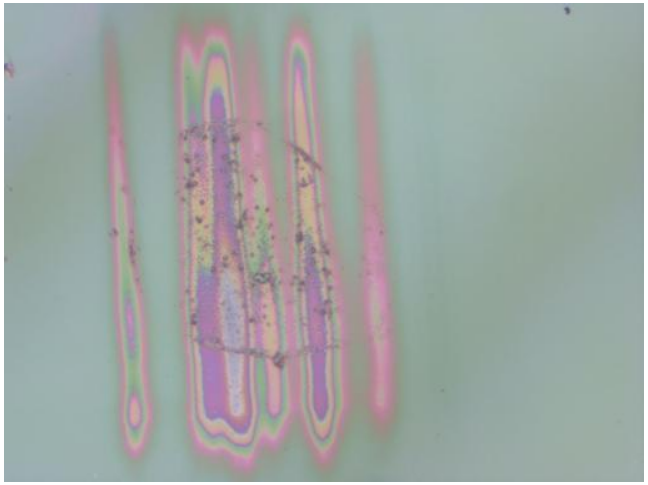
- Kit has been tested on several groups, grades 10 through undergrad
- Incorporated into DCTC lab course
- Some hardware upgrades and changes
- Curriculum development (ND State College of Science)
- Problems:
  - Photoresist is expensive!
  - Bringing chemicals into the classroom
  - Solvent disposal

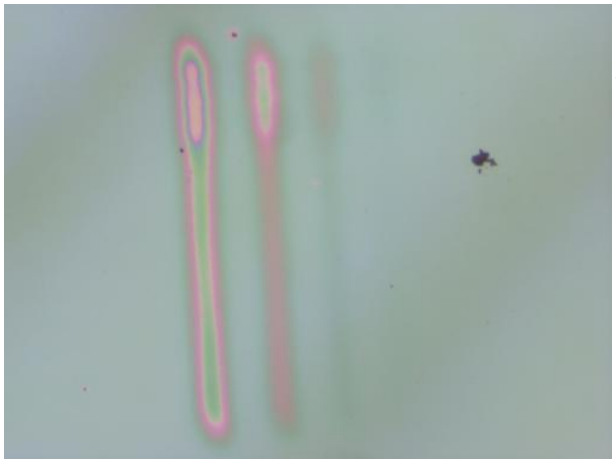
Process Pitfalls



Dust “Comet”

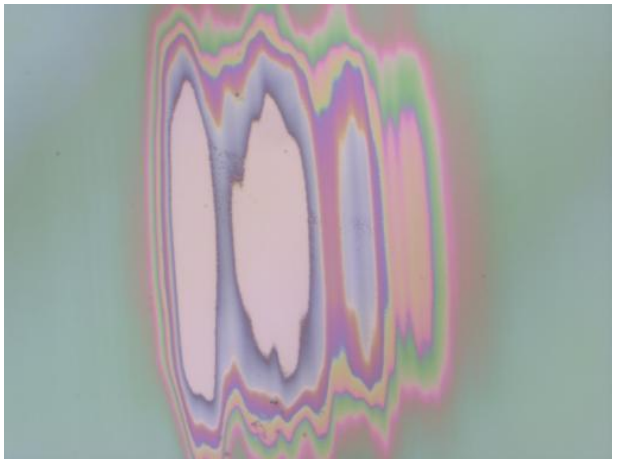
Underexposed
Overdeveloped





Underexposed

Overexposed



Moving towards a more classroom friendly lab

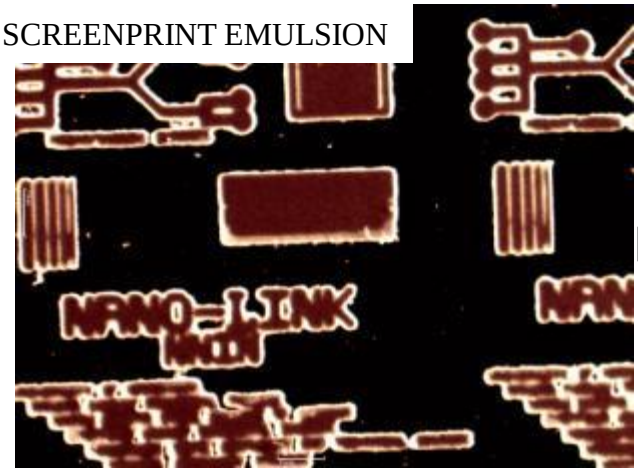
Lithography in a Box

- Problems:
  - Photoresist is expensive!
  - Bringing chemicals into the classroom
  - Solvent disposal

Off the retail shelf chemistry

- Solution:
  - Photosensitive water soluble chemistry – mask material for silk screening available at art supply stores - $30
  - Water develop and cleanup
  - Allow students to economically explore process optimization
- Tradeoffs
  - Reduced resolution

SCREENPRINT EMULSION



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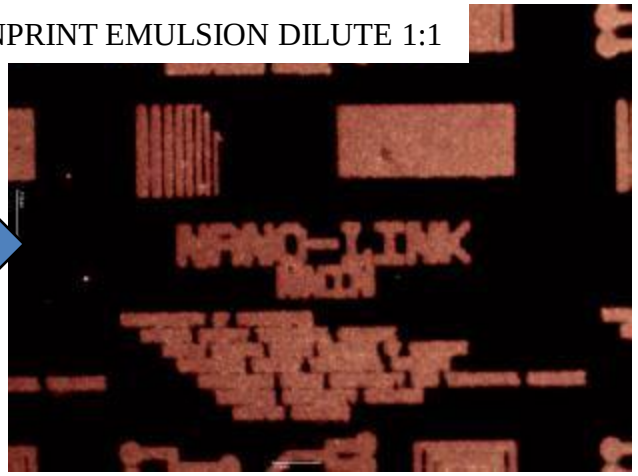
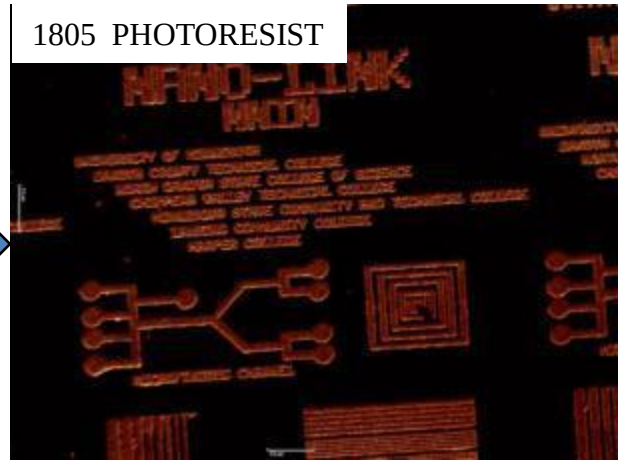


MASK

1805 PHOTORESIST



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