**Maskless Lithography With Scanning Probes**

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**1 cm Linear Cantilever Array**

- 50 cantilevers spaced at 200 μm
- 100 Å radius of curvature single crystal silicon tips

Integrated PR sensor and ZnO actuator

Sensor, actuator, and lithography leads for each device
Automated Parallel AFM

- 16 channels per board
- AT bus interface
- Synchronizes with other boards
- Controls data acquisition
- Electronics with devices to 200 kHz

10x1 Imaging

10 tips in parallel at 1mm/s. No feedback.
Task ID: 460.003: Maskless Lithography With Scanning Probes

32x1 Images over 6.4 mm

Automated Data Acquisition, Constant Height

Hybrid AFM / STM Lithography

NETWORK FOR ADVANCED LITHOGRAPHY
Quate Group, Stanford University
**SPL Resolution & Transfer**

- **6:1 Aspect Ratio**
  - Linewidth=30 nm
  - SAL601 Exposure & Etch

- **10:1 Aspect Ratio**
  - Linewidth=26 nm
  - PMMA Exposure, Lift-Off, & Etch

**Single Pass Exposures of SAL601**

- 65 nm thick SAL601 samples processed identically for EBL and SPL exposures
- SPL requires a factor of 25 greater incident electron dose than EBL for SAL601 exposure
- SPL has greater exposure latitude than EBL
**SPL Patterning Linearity**

Pixels: 1 2 3 4 5 6

- 37 nm
- 40 nm
- 239 nm

**SPL Linewidth Control**

- 600 nm
- 430 nm
- 150 nm
- 1 μm
With Scanning Probes

Linewidth=36 nm

Independent 2-Tip Lithography

Patterned linewidth is independently controlled by each tip through individual dose setpoints
**50x1 Lithography over 1 cm²**

- 50 AFM tips used to oxidize (100) silicon
- Oxide pattern was transferred into the bulk using KOH
- Lines are on a 200 µm period, the cantilever spacing
- The blue box at the bottom left represents the scan area of a typical AFM

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**Plans and Directions For Next Year**

- Investigate new methods for current control for each tip in the array
- Move to larger arrays of 64 x 1 (Feb 1 ’99)
- Demonstrate 2-D arrays (Mar 1 ’99)
- Synthesize carbon nanotubes suitable for use as tips (May 1 ’99)