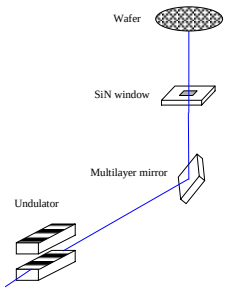
RECENT RESEARCH TOPICS AT THE CENTER FOR NANOTECHNOLOGY

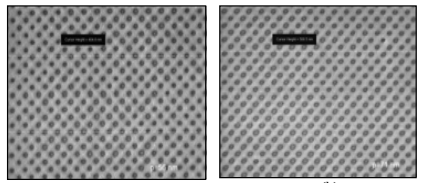
Photon Lithography: CNTech Beamlines

- **ES-0** (12-2): Under reconstruction to enable UV exposures. The system will have a monochrometer tunable from 126 nm to 193 nm wavelengths, with exposures in atmospheric helium. Typical exposures will be at 157 nm.
- **ES-1** (03-2): General purpose X-ray use. Exposures in vacuum or atmospheric helium. Typical uses: Photo-resist work, SAMs, MEMs.
- **ES-2** (11-2): Focused, high flux X-ray beam. Exposures in vacuum or atmospheric helium. Typical uses: Accelerated radiation damage of mask carrier materials.
- **ES-4** (11-1): General purpose X-ray use. Exposures in vacuum with quadrupole mass spectrometer. Typical uses: Photo-resist outgassing studies.
- **ES-5** (12-1): Vertically focused X-ray. Karl Suss Model 2M X-ray stepper tool for exposures. Typical uses: high throughput photoresist studies with masked exposures.
- **ES-6** (11-3): Scanning X-ray exposure system. Suss Advanced Lithography Model 4 exposure tool. High accuracy overlay exposures, state-of-the-art aligner.
- **EUV BRANCH LINE** (04-1): The U2 undulator provides a high flux source; the light is diverted either before the monochrometer for high band width, high flux light, or is diverted post-monochrometer for narrow bandwidth exposures. Typical uses: Interferometric patterning for nanolithography exposures and research.

EUV Beamline



2D patterns with four beams EUV Interference Lithography

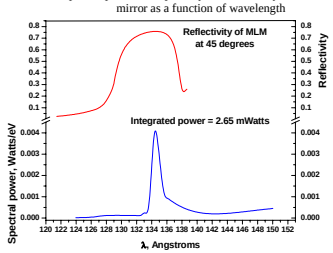


(a) (b)

Two-dimensional patterns created with EUV-IL in PMMA resist, where 80 and 100 nm period diffraction gratings were used to make the 56 nm and 71nm period hole arrays respectively

Radiation damage experiment (collaboration with Motorola, Inc.)

The undulator spectral power multiplied by the reflectivity of one multilayer mirror as a function of wavelength



$$PowerDensity = \frac{W}{\Delta^2}, where \Delta = 1.5mm \frac{L}{L} = 2.1\ mm$$

$$PowerDensity = \frac{2.65 mWatts}{(2.1\ mm)^2} = 60.1\ mWatts/cm^2$$

Measured PowerDensity = 69 mW/cm²

X-ray storage phosphors

A Edgar1, M Secu2, G V M Williams3, S Schweizer2, and J-M Spaeth2

1 School of Chemical and Physical Sciences, Victoria University, Wellington, New Zealand

2 Department of Physics, University of Paderborn, D-33095 Paderborn, Germany

3 Industrial Research Limited, Lower Hutt, Wellington, New Zealand

Abstract

The structural changes in a fluorobromozirconate glass ceramic containing a ratio of 5% bromine to fluorine ions, following thermal annealing in the range 240–300 ·C, are reported. The changes were monitored through xray diffraction, and the photoluminescence (PL) and electron paramagnetic resonance of Eu2+ dopant ions. In the range of 240–275 ·C, the barium and bromine ions in the glass precipitate to form the metastable hexagonal phase of barium bromide. The Eu2+ PL spectrum comprises a narrow band at 410 nm, and a weaker broad band centred at 485 nm. The 410 nm band is assigned to two unresolved 4*f* 65*d*1 → 4*f* 7 emissions from Eu2+ ions at the two Ba2+ sites in this phase, whilst the 485 nm band is assigned to an impurity associated site or cluster. On annealing at 290 ·C, the hexagonal phase transforms to the stable orthorhombic phase, and the PL spectrum comprises a single narrow band centred at 404 nm, assigned to a 4*f* 65*d*1 → 4*f* 7 emission from Eu2+ ions at the single Ba2+ site in the orthorhombic phase.

CNTech Extreme Ultraviolet Beamline

Lin Wang, Haroun Solak, Jangho Shin

- Monochromatic undulator beam, tunable from 50-350 eV.
- Motorized XY sample positioning stage.
- Primary applications:
  - Photoresist characterization at EUV wavelengths.
  - Interferometry
  - Multilayer mirror defect studies

The Aladdin undulator

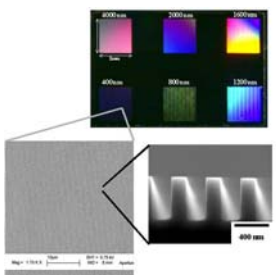
SAL Stepper/Aligner Development

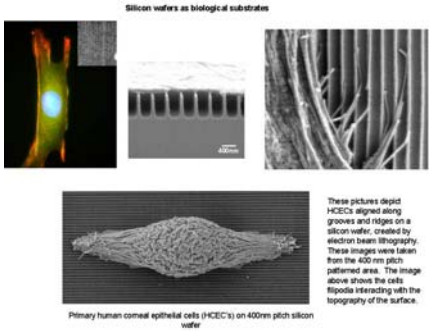
Partnership with SAL

- CNTech provides:
  - Access to Aladdin synchrotron
  - Scanning beamline development, construction, and support
  - Resist processing facilities and personnel
  - Metrology tools for stepper characterization
  - Support for Sanders device project
  - Lithography expertise
- SAL provides:
  - Access to a state-of-the art X-ray stepper/aligner – students and outside users all benefit
  - Opportunity to participate in stepper design
  - Stepper diagnostic and support tools
  - Support for Sanders device project
  - Tool expertise

SAL Model 4 X-ray stepper/aligner at CNTech

Silicon wafers as biological substrates





These pictures depict HCECs aligned along grooves and ridges on a silicon wafer, created by electron beam lithography. These images were taken from the 400 nm pitch patterned area. The image above shows the cells filopodia interacting with the topography of the surface.

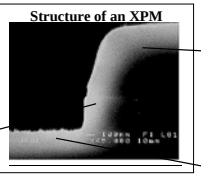
Primary human corneal epithelial cells (HCEC's) on 400nm pitch silicon wafer

See:

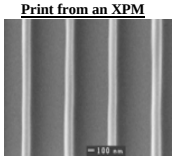
X-ray phase masks

ES-1 and ES-5: Phase Masks

Structure of an XPM



Print from an XPM



Si_3N_4 phase shifter; produced by RIE in O_2/CHF_3

Unetched Si_3N_4 membrane

Shipley SAL 605 photoresist etch mask; X-ray patterned on Aladdin through Au absorber mask

- **UV-3 resist**
- **Si_3N_4 XPM**
- **SAL X-ray stepper on *Aladdin***
- **10 μ gap**
- **100 nm isolated lines**
- **150 nm lines at 25 μ also printed**

Mesa mask fabrication

Relieved, or mesa; X-ray mask design alleviates flatness requirements on the bonded mask blank.

University of Wisconsin Center for NanoTechnology