

## TECHNICAL VISIT

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### Technical Visit to the Synchrotron Light Laboratory ELETTRA

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#### Introduction

During EuroNanoForum 2003, 100 participants, including journalists, were given the opportunity to visit the Synchrotron Light Laboratory ELETTRA on 10-11 December 2003.

The Synchrotron Light Laboratory ELETTRA, located at the AREA Science Park, produces and uses high-brilliance electromagnetic radiation in the ultraviolet to hard X-ray spectral band. The range of applications available attracts researchers from universities and laboratories in Italy and elsewhere in Europe; from national and foreign scientific institutions (among which CNR - National Research Council, INFN - National Institute for Matter



Physics, ICTP - International Centre for Theoretical Physics, and the Austrian and Czech academies of science) for joint programmes – both in terms of funding and personnel – in basic and applied research; and from industries in Italy and abroad, for pre-competitive research. There are sixteen currently active beamlines, with a further three in commissioning phase. Another six beamlines are under development.

Current figures indicate around 800 Laboratory external users each year: 40 % from Italy, 46% from other countries of the European Union, and 14% from non-EU states.

250 persons are working at AREA Science Park. In addition, around two hundred researchers from other national and international institutions work permanently at ELETTRA.

#### The LILIT beamline at the TASC Laboratory

During their visit to the Synchrotron Light Laboratory ELETTRA, EuroNanoForum 2003 delegates were accompanied by researchers from the **INFN - National Institute for Matter Physics – LILIT Group - TASC** Laboratory to the LILIT beamline.

LILIT was the original name of the X-ray lithography beam line installed at the ELETTRA storage ring, name that afterward was extended to the homonymous research group.

LILIT (Laboratory for Interdisciplinary LIThography) is devoted to fabrication of structures with spatial resolution ranging from microns to few nanometers.

### ***Research activities***

The wide field of activity in the domain of nanofabrication and microfabrication for novel physics experiments, as well as for applications ranging from bio-medicine to microsurgery to nanoelectronics and nano-optics, has found a very fertile ground at LILIT. The quick growth of interest from many scientists and technologists about nano-patterned/nanofabricated objects and systems has imposed a substantial broadening of experimental approaches to nanofabrication, beyond the beamline specialty of near-contact X-ray lithography.

The main technique used in the LILIT activities is the combination of X-Ray lithography (XRL), thus a parallel (high speed) writing tool, and electron beam lithography (EBL), a direct writing (from a computer draw to the semiconductor sample), small area, high resolution (20-30 nm) system.

Usage of EBL to realize XRL masks allow the fabrication of hi-density (thousands of square mm) and hi-resolution devices.

The peculiarity of the beamline design consists mainly in its wide lithographic window that can be selected to work from soft (1.5 keV) to hard (10 keV) X-Rays wavelengths. The soft X-ray range (photon energy between 1 and 2 keV) is devoted to achieve the highest lithographic resolution (30-40nm). Sensitive materials of thickness of tens of microns can be exposed in the hard X-ray region (photon energy higher than 5 keV).

The LILIT team is made up of specialists in techniques such as e-beam lithography, focus ion beam (FIB) lithography, contact printing, and in-situ lithography, which are strongly complementary and substantially needed in order to provide a state of the art facility for nanofabrication of advanced functional objects and devices.

The LILIT Lab has the knowledge and the facilities that allow using extensively micro and nanofabrication methodologies necessary to the fabrication of innovative devices.

Extremely important are the role of lithography, deposition techniques, etching, growth etc. for the miniaturization and the functionality of the devices where the control falls in the micro and nanometer region.

The LILIT technical activities and micro and nano process development include:

- FIB (Focused Ion Beam)
- Resist characterization for optical, electron and X-ray lithography
- RIE processes development for Si, Si<sub>3</sub>N<sub>4</sub>, GaAs, SiO<sub>2</sub>
- Electrochemical growth characterization for Ni, Au, Cr, Cu
- Processes optimization for high resolution, high aspect ratio and deep lithography
- Lift-off process development
- Deep RIE process development for GaAs/AlGaAs and Si
- Micromachining process development applied to gas sensors
- Micromachining process development applied to devices for space applications.
- 3D lithography process development for photonic crystals and micromachining for drug delivery
- Development of calculation tools for diffractive optics and optical tweezers
- Structural and microfluidic modeling

### ***Know-How and Technologies***

The advanced performance of ELETTRA stimulates research in areas such as:

- solid state structures and dynamic surface phenomena;
- superconductors;
- structure of metals and composites;
- biological structures.

The research programmes in progress focus on three particular avant-garde fields:

- structural biology, for the study of protein and virus structures;
- study of magnetic materials: second only to semiconductors, these represent the most widespread technology on the market, and are used in areas like the manufacture of memory supports such as hard disks for computers or integrated in conventional electronic devices;
- microelectronics for integrated circuits and micromechanics: manufacturing of gears and components for miniature mechanical devices, with applications including the biomedical field.

### ***Products, Services and Applications***

The synchrotron beamlines find application in a very wide variety of sectors, in particular:

- molecular, atomic and electronic structures of materials and of organic and inorganic substances in all states of aggregation;
- services of metrology, advanced electronic design, data control and analysis (including remote applications);
- electron and X-ray microlithography;
- production of radio-frequency equipment for electron accelerators.