Hi-Tech Solutions from Interface, Ltd.

Software/hardware for e-beam lithography

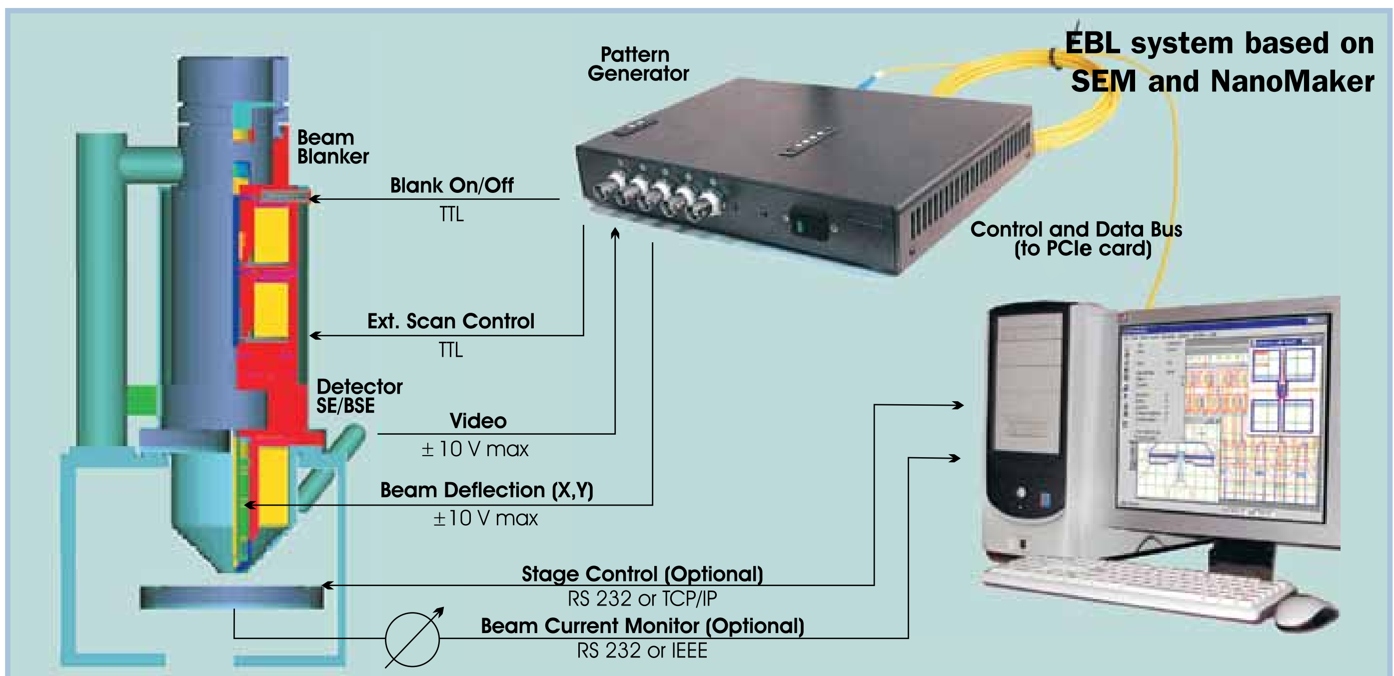
Converts any scanning electron microscope (SEM) into an e-beam lithography system for nanoscale fabrication

System features:

- High Speed Pattern Generator comprising two 16-bit DAC to control beam position in column and one 8-bit ADC for image acquisition
- PCIe Card for computer control
- Software drivers to communicate with SEMs, dedicated EBL systems, and FIB tools
- Control of fast beam blanker. Possibility to expose without blanker
- Software (based on OS Windows™ 2000, XP or 7) provides:
  - Design of 2D/3D structures
  - 2D/3D Proximity Effect Correction
  - Predictive EBL results through development simulation
  - Compensation for the distortions of a scanning system during exposure and image acquisition

The software package provides three basic functions:

- Data preparation for exposure:
  - Structure design with Integrated Graphical Editor
  - Proximity Effect Correction
  - Modeling of exposure and resist development
  - Data import and export (GDSII, DXF, ELM, NME, BMP, TIFF...)
  - Special data processing (Union, Overlaps Out, Dose Stratification, Negative, Dividing, Frame etc.) to meet peculiar properties of EBL
  - Exposure control
  - Variable exposure (dwell) times to provide proximity correction
  - Synchronized movement of electron-beam and a motorized stage
  - «On-the-fly» compensation of dynamic delays and distortion to speed-up writing



INTERFACE

Contact us: **Headquarters**: Interface, Ltd., 4, Bardin str., Moscow, Russia, 117334
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- Video control for alignment and system tuning
  - Alignment of successive exhosures via a set of marker windows
  - Measurements and software compensation of inaccuracies of a scanning system and a stage movement system
  - Digital microscope mode, including frames editor, image acquisition, image processing, etc.

Fields of application:

- Microelectronics
- Nanotechnology
- 3D nano-micro structuring
- Diffractive optics (synthetic holograms) for visible and X-ray range, including «Rainbow» holograms
- Digital microscopy

Nanomaker system can be delivered both complete and module wise in accordance with the requirements:

– available
– emulation

	NanoMaker Complete deliverable	**NanoMaker Workbench** To prepare data on offline PC	**NanoMaker Writer** To design, perform exposure and image acquisition
Graphics Editor (specialized CAD system)	available	available	available
Import of lithographic structures and images from: *.DXF, *.CSF, *.GDS, TIFF Image Files (*.TIF), Bitmap Image Files (*. BMP)	available	available	available
Export of lithographic structures and images to: *.DXF, *.CSF, *.GDS, *. ELM	available	available	available
Recommended Parameters Reference Table (specialized Database)	available	available	available
Postprocessing (Negative, Union, Frame, Shrink, Erase, Overlaps Out, Dividing, Dose Stratification)	available	available	
Proximity Effect Correction (including 3D structures)	available	available	
Resist Development Simulation	available	available	
Dose Curves using (for 3D structuring)	available	available	
Exposure	available	emulation	available
Image Acquisition and Processing	available	emulation	available
Stitching and Alignment of Exposure fields	available	emulation	available
Job Processing	available	emulation	available
Active Compensation for Distortion and Dynamic delays	available	emulation	available
User Guide in electronic form	available	available	available
Pattern Generator + Drivers	available	emulation	available
Stage and Microscope Control Drivers (optional)	available	emulation	available

Elli30 PCIe Pattern Generator

Elli30 PCIe Pattern Generator is an advanced data acquisition product with high speed Digital-to-Analog addressing capabilities and Analog-to-Digital sample conversion in conjunction with improved noise immunity

- Pattern Generator solutions include:
  - Digital board for PCIe bus slot inside the PC
  - Analog desktop unit with its own stabilized power supply
  - 2 meters fiber optic cable
  - Set of interface cables
  - Software Drivers for OS Windows 2000, XP, 7

Analog unit is connected to Digital board by fiber optic cable to perform galvanic decoupling from PC and to provide high speed noise protective data transfer

- Pattern Generator board carries:
  - Two 16-bit Digital-to- Analogue Converters (50 MHz DACs)
  - One 8-bit Analogue-to- Digital Converter (ADC)
  - Beam Blanker On/Off switch (TTL output level)
  - Internal/External scan mode switch (TTL output level)

Output XY DACs and input ADC voltages can be tuned for arbitrary intervals in ±10.0 V range.

Time characteristics of the Pattern Generator

Minimal exposure dwell time	50 ns (20 MHz)
Dwell Time resolution	10 ns (100 MHz)
On-board image accumulation (per accumulation cycle)	50 ns (20 MHz)
Minimal image acquisition time (time of XY DACs addressing + transferring of ADC signal)	0.8 μs (implying 12 accumulation cycles)

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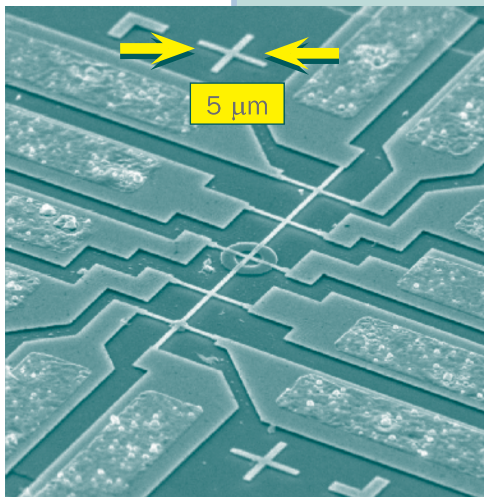
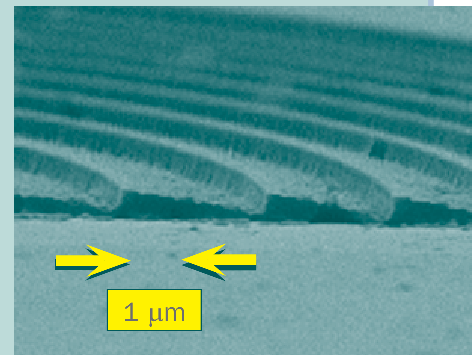


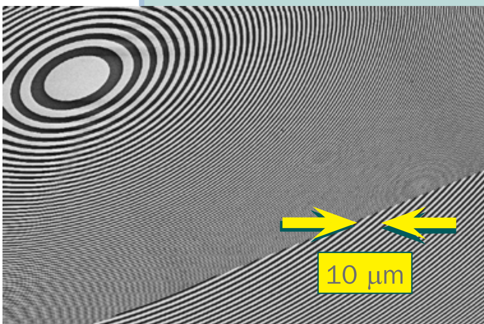
Alignment for successive e-beam lithographies

Contact pads were made by photolithography then e-beam lithography was used to make mesa structure (rings). Another e-beam lithography layer was then incorporated to produce the metal contacts.



3D Proximity Correction and 3D Structuring

Kinoform optical device produced by 3D lithography. By using 3D proximity correction, objects with arbitrary 3D shape can be created during a single exposure.



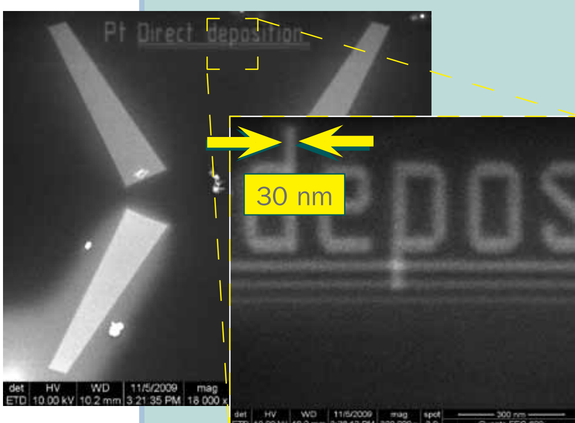
A fragment of device for X-ray optics and spectroscopy (by the courteously of A. Firsov, BESSY II)

Large scale device production in combination with high resolution interferometer stage

NanoMaker's unique features of exposure fields stitching based on dynamic compensation of beam position in combination with an interferometer stage, demonstrate excellent results in production of large-scale devices (up to a few centimeters).

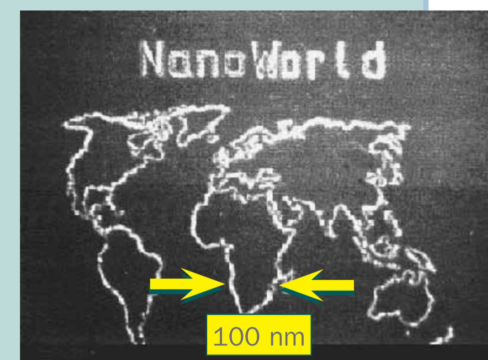
Rainbow holograms (OVD) writing with a SEM

Kinematic rainbow hologram produced at Bessy II using LEO 1560 SEM controlled by NanoMaker (by courtesy of A. Firsov) . 400 nm PMMA resist covered by 50 nm of AL. Sample size is 2 cm by 1 cm



Gas Assisted Focused Electron Beam Induced Deposition

The NanoMaker can be successfully used for controlled deposition of thin film coatings on substrates by decomposing of metal-organic vapors induced by focused electron beam irradiation (so called Gas Assisted EBL). Photo demonstrates deposited thin Pt lines of 10, 20 and 30 nm width. By courtesy of Dr. L. Rotkina, UPenn.



Ultra High Resolution

This smallest world map produced by EBL. It has been produced by Proxy-Writer (the MS DOS prede-cessor of NanoMaker) in connection with a scanning electron microscope (UHV FE-STEM HB 501). The substrate was a SiN membrane covered with the electron sensitive material AlF3.

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