Amsterdam, October 20, 2016

FOM Institute AMOLF, Amsterdam, wishes to purchase a system for electron beam lithography that can define patterns in electron-sensitive resists at high resolution, and is compatible with a wide range of applications and substrate types. The system will be used in a research cleanroom by a wide range of users with different levels of expertise. The system will be employed towards different application fields (photonics, electronics, photovoltaics, biophysics, etc.). An important application is the definition of patterns to realize (nano)photonic structures. These include, among others, plasmonic nano-antennas, high-quality photonic crystal waveguides and cavities, large-area diffraction gratings with nanoscale structure, low-loss waveguides (straight, tapered, curved) and ring resonators, electrical contacts for nanowires and other self-assembled nano-opto-electronic structures. Several applications make use of large-area in-situ scanning electron microscopy imaging and direct overlay.

The system has to fulfill the following requirements:

1. Electron optics system
1.1 Software-controllable beam voltage in at least the range 10-50 kV
1.2 Large beam current (max ≥ 40 nA) with high position stability and current stability (≤ 0.5%/h)
1.3 Flexible software-adjustable beam current at least in the range 100 pA - 40nA
1.4 Cost-effective exchange and long lifetime of the electron source
1.5 Electron optics specially developed for electron beam lithography
1.6 Autofocus and autostigmator
1.7 Fast tail-free beam blanking
1.8 High resolution imaging and metrology for inspection and verification
1.9 Flexible alignment mark recognition

2. Substrate size and types
2.1 Sample size from 5×5 mm^2 (or smaller), to 12×12 cm^2, variable sample shape. 3”, 4”, 150-mm diameter wafers.
2.3 Substrate thickness in the range 0.3-2.0 mm

3. Pattern definition, quality, resolution
3.1 ≥20 bit Digital to Analog Convertor (DAC) pattern generator
3.2 Beam step size < 1 nm over ≥ 500×500 μm^2 writing field
3.3 Pattern generator capable of writing many different structures including; dots, single pixel elements, circles, etc.
3.4 Flexible fracturing and writing strategy aimed at writing low-loss photonic crystals, optical waveguides, ring resonators, etc. with minimal surface roughness. Integration of multiple shapes (disks, polygons, rectangles, triangles) in single write field, combining different patterning strategies (raster, concentric, tilted scanning) in single exposure using multiple beam currents for different polygons.
3.5 < 10 nm linewidth in single lines.
3.6 Roundness of a 200-nm diameter circular pattern better than 95 %.
3.7 Definition of combined optical waveguide and photonic crystal pattern with less than 10 nm variation in hole size relative to mean hole size after patterning.

4. Overlay and stitching
4.1 Overlay accuracy ≤ 25 nanometer (mean + 3 sigma) over a writing field 500×500 μm^2 or larger.
4.2 Stitching accuracy ≤ 30 nanometer (mean + 3 sigma) over a writing field 500×500 μm^2 or larger.

5. Software user interface
5.1 All necessary software to read in design files, fracture them in different formats and write patterns.
5.2 Intuitive graphical user interface. Software should support multiple users with different skill levels.
5.3 Extensive pattern design software
5.4 Extensive proximity correction software
5.5 Software license for off-line PC data preparation

6. General
6.1 Uninterrupted Power Supply (UPS) linked to automated safe shutdown procedure
6.2 Water-cooled chillers
6.3 Edwards nXDS10i pre-vacuum pump (because of availability of replacement)

7. Mandatory options (if not included in basic package)
7.1 Automatic height sensor
7.2 Laser interferometer stage
7.3 Stitching free writing modes by using continuous moving stage and moving beam to write large-area (1mm-1cm) gratings, photonic crystals, and curved and tapered access waveguides. These stitching-free waveguides should be interfaced with better than 30 nm precision (mean + 3 sigma) to structures written in individual write fields.
7.4 Stitched image field area larger than 5×5 mm. Use of acquired image as a template, in appropriate software, to make an overlay design that can be directly used in the writing software without dimensional conversions and without additional marker definition. Imaging is performed at beam current low enough dose not to expose resist above threshold. Placement accuracy 50 nm or better over full imaging area. This application is needed for rapid definition of nano-electrodes to contact self-assembled and randomly placed opto-electronic structures on substrates.

8. Training
8.1 Training for at least 4 persons, for at least 4 days.
8.2 Electronic manual in English.

9. Maintenance contract
9.1 1 year warranty including all parts
9.2 Maintenance contract for a period of at least 8 years, to start after the 1 year warranty period, included in the quotation.
9.3 Maintenance contract to include at least one preventive maintenance visit per year and one curative visit per year, covering all travel and personnel costs associated with these visits.
9.4 Yearly maintenance should include at least:
- check and adjustment of laser interferometer and laser source
- check and cleaning of load lock (if adapted)
- maintenance of vacuum pumps
- check of drives, exchange of wear parts
- system calibration (mechanical, electrical and electron optical components)

9.5 Maintenance contract should include software updates.
9.6 Maintenance contract should cover at least replacement of following parts:
- O rings, driving belts, seals, worn part of load lock
- Stage motors
- FEG source replacement (filament)
- Aperture strip replacement
- check of and replacement of UPS batteries

9.7 If not included in maintenance contract, the vendor should also provide: cost of 4-day extra on-site curative visit including all travel costs, hotel costs, personnel costs for a trained service engineer. In calculating the price of the maintenance contract as described we will assume one extra 4-day curative visit is needed every three years besides the one already included in the minimum contract described above (except if already included in the contract offered).

10. Safety regulations
10.1 Comply with relevant safety regulations.
10.2 Delivery should include a comprehensive and complete manual concerning operations instructions, inspection and maintenance, completed with information on the safety devices of the work equipment.

11. Company track record
11.1 Healthy company track record of delivering >10 electron beam lithography systems/year on average and turnaround of >5 million euro per year on average, as evidenced from recent profit/loss statements.

Questions:
1. Can you deliver a system according to these specifications? If so, specify the system, and provide evidence for the requirements in 3.4, 7.3 and 7.4.
2. Can you deliver this system before July 1, 2017?