EXTENDING ELECTRON AND ION BEAM LITHOGRAPHY SCHEMES TO INNOVATIVE NANOFABRICATION PROCESSES

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One of the main drivers of new trends in nanotechnology is the improvement and customization of commercially available instrumentation. These tools serve as enabling technologies for nanofabrication with minimum feature sizes in the nm-regime.
That is why in today's research and development based laboratories – of various disciplines – both electron beam lithography (EBL) and focused ion beam (FIB) based technologies are regarded as a "must have". Providing resolution in the 10 nm regime and below, these techniques are cost effective, flexible and therefore well suited for nanoresearch. Nanoscale integration of devices is already challenging and becoming more complex. That is why tool requirements are changing dramatically towards the simple, but more versatile provision of innovative schemes for efficient and reliable fabrication of (0D- to 3D-) nanostructures, and particularly their connection to the macroscopic world.

Apart from system nanofabrication capabilities which use standard lithography or milling techniques, it is increasingly desirable to have additional infrastructure and functionality embedded in the very same system – preferentially in situ.
Direct patterning techniques like electron beam induced deposition (EBID), ion beam induced deposition (IBID) and gas assisted etching (GAE), used in combination with analytical tools and highly precise nanomanipulators, are essential for in situ characterization or modification and thus rapid prototyping of nanodevices. In conjunction with suitable innovative patterning strategies, the system then allows for more than mere relocation and inspection of a nanostructure, which can be subsequent treatments like:
- shaping, indenting, adding or subtracting (tuning) features and materials
- analysis/characterization by determining chemical composition
- measuring topography and critical dimensions
- building contacts to macroscopic measures suitable for electrical probing
- in situ electrical probing

In this talk a few EBL and (low current) Focused Ion Beam Lithography techniques and applications will be illuminated in a little more detail, taking into account the specific benefits from various experimental setups e.g. including a gas injection system and nanomanipulators.
Innovative and unique exposure strategies using electrons or ions without stitching errors or in 3D will be described. These techniques find broad use in optoelectronic device prototyping but also in the exciting domain of exploration of Bose-Einstein condensates such as have been realized in atom chip arrangements e.g.

A new application domain for Ion beam patterning techniques will be presented: the combination of EBL and IBL lithography strategies for the uncompromised

production of devices while remaining compatible with established protocols (like GDSII design files) and using conventional production techniques.

Additionally, low dose applications for ions open new scenarios for research in the fields of nanomagnetism, selective epitaxy or defect engineering, just to name a few out of a broad bandwidth of applications.