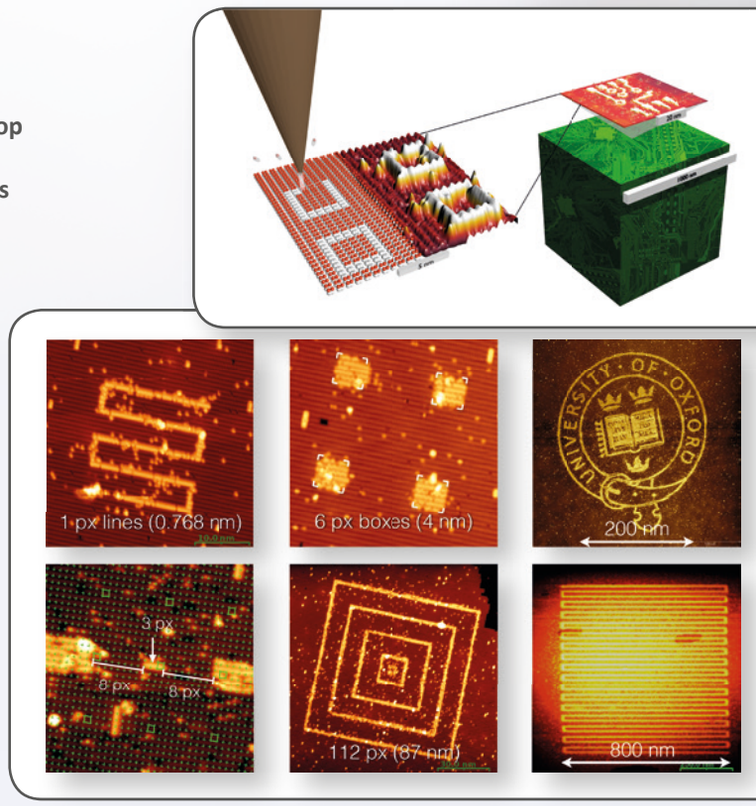
ZyVector

STM Control System for Atomically Precise Lithography

Scanned Probe Lithography

Scienta Omicron & Zyvex Labs announce collaboration

Scienta Omicron and Zyvex Labs announce a collaboration to develop and distribute tools for research and manufacturing that require atomic precision. The ZyVector STM Control System from Zyvex Labs turns a Scienta Omicron STM into an atomically-precise scanned-probe lithography tool, and will be distributed world-wide by Scienta Omicron.



Scienta Omicron brings together the two leading innovators in Surface Science – the former VG Scienta and Omicron NanoTechnology. This exciting new company creates new capabilities for the research community by combining the technology leaders in electron spectroscopy, scanning probe microscopy and thin film deposition. These capabilities are available in custom tailored systems from one source with sales and service groups located in all major markets around the world.

Zyvex LLC pursues the vision to develop Atomically Precise Manufacturing (APM).Recently, Zyvex Labs has developed ZyVector for automated STM Lithography to enable users to create quantum computers and other transformational systems that require atomic precision. By pairing it with Scienta Omicron STMs, unmatched lithography will be possible, with much higher reproducibility and throughput, scaling up from research level patterning towards APM.

For more details:
www.zyvexlabs.com
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Or contact Scienta Omicron, the worldwide distributor:
www.scientaomicron.com
info@scientaomicron.com

Capabilities

ZyVector automates the process of performing Hydrogen Depassivation Lithography (HDL), using an STM tip to remove H atoms from a surface. It can write arbitrary patterns defined in a vector or a bitmap format. Patterns can be written using a lithography pixel defined by the atomic lattice. As well as developing ZyVector as a tool for atomically precise patterning on small scale, researchers at Zyvex Labs are leveraging its capabilities to create nano-functional devices on the micrometer scale. ZyVector therefore opens up new possibilities to scale up SPM based lithography by setting new standards in reproducibility, automation, thermal drift and piezo creep compensation.

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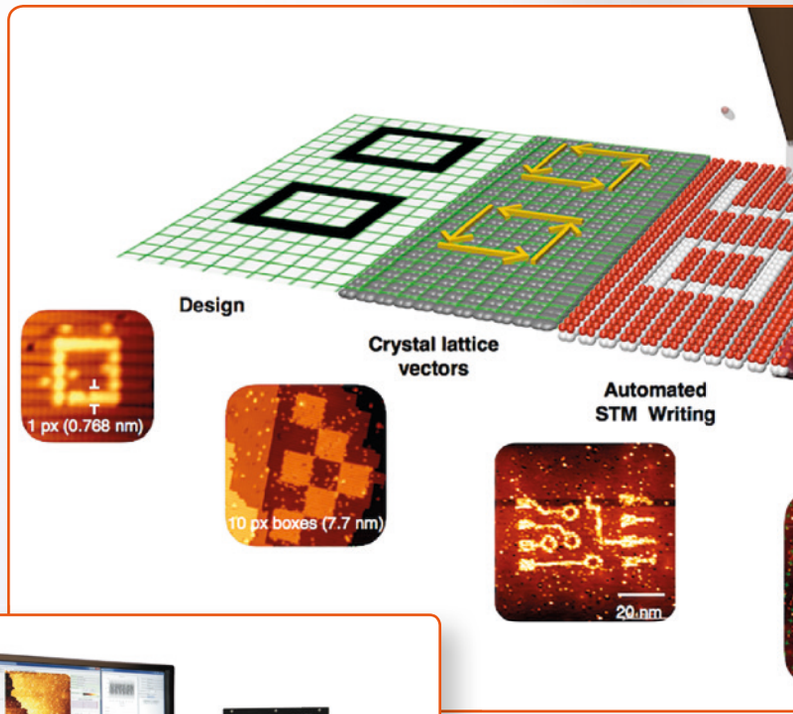
ZyVector

STM Control System for Atomically Precise Lithography

ZyVector turns a Scienta Omicron VT STM into an atomically-precise scanned-probe e-beam lithography tool.



The ZyVector controller, with Scanz software

Digital Vector Lithography

Unlike conventional optical or e-beam lithography, ZyVector takes into account the atomic structure of the surface. Writing is done as vectors, moving along the surface lattice vectors, with a standard pixel size of 2 dimers on a single dimer row. Using different settings of voltage and current, multiple beam widths are available, from one pixel wide up to several nm, to optimize write time for larger patterns. There is no partial exposure; either a H atom is removed, or it is not. Proximity effects also do not exist here.

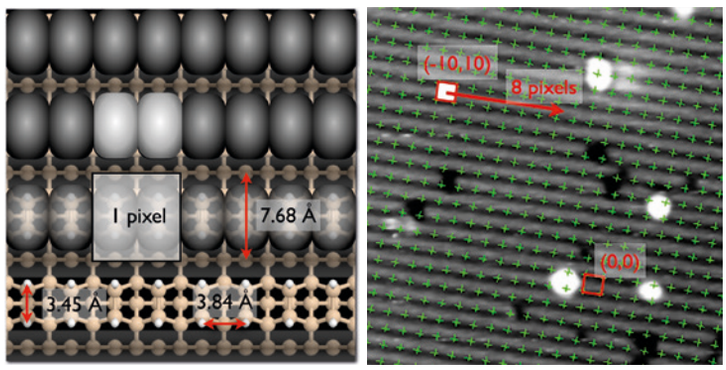
One final advantage over conventional e-beam lithography is the ability to image nondestructively with the same tip as used for writing. Thus the surface can be imaged prior to writing, allowing alignment to fiducial marks or areas of previous patterning. After writing, the quality of the lithography can be checked, enabling some error correction.
Finally, the written pattern can be imaged with atomic precision, so that developed nanostructures can be referred back to the original pattern.

Automation and Scripting

ZyVector enables automation and user scripting of almost every part of the software, including both imaging, and writing. Patterns to be written can be input via the user interface, or in a script as a list of vectors or as a bitmap, which is converted into write vectors by ZyVector, with one bitmap pixel corresponding to the 0.768 nm pixel defined by the Si(001) lattice.

Precise Tip Positioning and Motion

Piezoelectric elements used in commercial STM systems suffer from time-dependent errors called creep. These creep errors are corrected in real time in our control system, so that STM images are undistorted, and lithography vectors follow their desired path.
The system can also automatically find fiducial marks on the surface, and align to them, so that different parts of a pattern are kept in registry with each other.



A pixel is defined as 2 dimers on a dimer row, a 7.68Å square. Write vectors follow the pixel grid, which is laid out across the surface.

ZyVector at a glance:

- **Digital Lithography**
- **Sub-nm pixel**
- **Vector Writing, aligned to atomic lattice**
- **Multiple beam widths**
- **Built-in Metrology**
- **Automation and Scripting**
- **Automated Imaging, Moving and Writing**
- **Vector or Bitmap pattern input modes**
- **Precise Tip Positioning and Motion**
- **Real-time Creep Correction**
- **Fiducial recognition and alignment**
- **Pattern alignment to lattice**

Technical Specifications

4 fine x/y channels (± 135 V)
1 fine z channel (± 135 V)
3 coarse xyz channels (± 200 V)
1 tip bias channel (± 10 V)
Current gain control for Omicron pre-amp
Bias gain control for Omicron pre-amp.
Scan Range: up to 9.5 µm on VT STM.

Fits Scienta Omicron VT STM pre-amp and PIC cabling. No modification of UHV hardware required.

- Local piezo tube calibration based on lattice recognition
- Lattice phase recognition for precise lithography positioning
- Linear creep correction in xy
- Two spot size modes:
- AP mode(single-dimer-row width)
- FE mode multi-nm linewidth, rough edges)

Python-based scripts for test patterns, creep and lattice calibration, and other basic functions are provided. Some example lithography scripts are also included. User-written scripts can be run via a menu, or using the command line interface.

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STM Control System for Atomically Precise Lithography

Two XPS samples on a sample holder - one masked with Au foil.

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