NANO HIGHLIGHT
Beam Pen Lithography

NSF NSEC Grant 0647560

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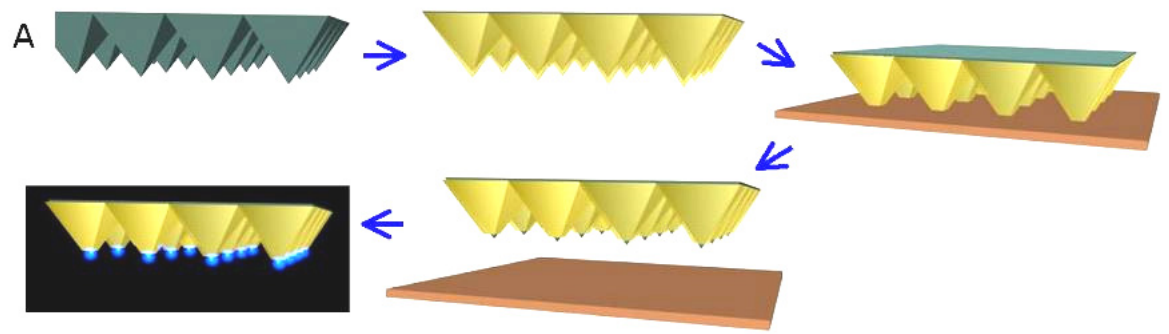
The ability to pattern nanoscopic features is fundamentally important to a wide number of fields including catalysis, cell biology and nanoelectronics. For example, the width of a single transistor in a microchip is now 32 nm, and there is considerable effort being put forth to shrink this dimension to the sub-10 nm range. Furthermore, a number of unique effects related to quantum mechanics, catalysis and cell-surface interactions manifest when the dimensions of a material are shrunk down to the sub-10 nm range. The ability to pattern a large area of sub-10 nm features would therefore enable a number of fundamental studies in electronics, surface science and biology.

These NU-NSEC researchers integrated the techniques of "soft" nanolithography – which are biocompatible, inexpensive and don't require sophisticated clean rooms – with photolithography, a standard industrial lithography technique. Beginning with polymer pen lithography (an enabling approach that combines the elements of stamp-based contact printing – which is fast but can only duplicate a pattern, with dip-pen nanolithography – which can generate arbitrary feature size and shape, but is slow), they coated the tip array with an opaque metal layer. This was followed by generating apertures at each tip, which ensured that the only parts of the underlying substrate that were exposed to the incident light were those directly beneath the tips. The resulting technique, called beam pen lithography, not only allows light to be used in nanoscale patterning, but also allows the generation of features smaller than the diffraction limit of the incident light. Furthermore, by blocking off portions of the incident light, the tips can be addressed independently. This allows neighboring tips to write different patterns, and is an important step in addressing a fundamental challenge in stamp-based printing techniques. This new technique enables a number of important photochemical and biological studies.



Beam Pen Lithography uses light incident on polymer arrays coated with a layer of gold to form patterns in photoactive surfaces. It also allows tip addressability via selective illumination of the beam pen array with a mask as well as arbitrary nanoscale pattern generation.

*Credit: F. Huo, G. Zheng, X. Liao, L.R. Giam, J. Chai, X. Chen, W. Shim, C.A. Mirkin. Nature Nanotechnology, **5**, 637, 2010.*

[1] F. Huo, G. Zheng, X. Liao, L.R. Giam, J. Chai, X. Chen, W. Shim, C.A. Mirkin. *Nature Nanotechnology,* **5** (637), 2010.