Thermal Scanning Probe Lithography

Felix Holzner[1,2], Philip Paul[1], Cyrill Kuemin[1,2], Ute Drechsler[1], James L. Hedrick[3], Heiko Wolf[1], Nicholas Spencer[2], Urs Duerig[1] and Armin W. Knoll[1]
[1] IBM Research, Rueschlikon, Switzerland
[2] Laboratory of Surface Science and Technology, ETH Zurich, Switzerland
[3] IBM Research, Almaden, USA

Thermal Scanning Probe Lithography (tSPL) is a novel and versatile nanopatterning method, which uses a sharp heatable tip to structure or modify surfaces at the nanoscale.
Primarily, tSPL uses organic resists that respond to the presence of the heated tip (~ 5nm radius) by local material evaporation. The patterning depth can be controlled independently for each pixel (~1nm accuracy), giving this technology an unique 3D patterning capability [1], [2]. We achieved controlled patterning of up to 500000 pixel/s with a positioning error of less than 10 nm [3]. A scan range of 50 µm is accessible with a scan speed of up to 20 mm/s. In addition, the method comprises fast in-situ metrology, hence offering extremely short turnaround fabrication times and stitching of patterning fields with an accuracy better than 5 nm. Standard transfer processes like RIE (reactive ion etching) are compatible with tSPL.
Besides standard nanolithography applications, tSPL offers novel applications of which some will be presented:
Shape-matching nanostructures for the assembly of nanoparticles have been written using the 3D feasibility of tSPL. Gold nanorods (25 x 80 nm^2) were trapped and aligned in these nanostructures with 10 nm positioning accuracy. A transfer process using a removable template was developed which allows a versatile and precise integration of oriented nanoparticles into devices. [4]
The heated tip has also been used to trigger chemical reactions and surface functionalizations with high resolution, e.g. for local binding of proteins.

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