

Jürgen Schlütter (LOT Darmstadt) Dip Pen Nanolithography: A new tool for the fabrication of nanostructures.

e-mail: schluetter@lot-oriel.de

AFM tip coated with molecules, water meniscus develops between and substrate such that a nanopattern can be constructed (Hans Jurgen Butt '96, Chad Merkin '99). Scalability, can work with multiple pens. Thiols and gold, linewidth of about 90nm, variation less than 10%. Photolithography is the workhorse of IC industry but has a practical limit is about 100nm. E-beam can create structure down to 5-10nm, nano-imprint also 10nm. Seek a bottom-up approach to the 5-10nm limit. Direct write techniques enable deposition of soft and hard nanostructures, with a spatial resolution of as small as 5nm, but typically 30-40nm. SPM does alignment, writing, and inspection. General molecule and substrate considerations: highly scalable with parallel pens systems (multiple AFM tips), passive arrays. Actively controlled tip arrays are more interesting with active ink delivery. Experimental factors affecting DPN: temperature increases with motion, humidity (stable between 30-60%), time (determined by tip speed, dot size increases with contact time). DPN Inks: soft materials - small functional molecules (dyes), SAMs, conducting polymers, and biopolymers (DNA, proteins). Hard materials include metal inks and solid precursors. Etch barriers for solid-state nanostructures (write regions of octadecanethiol on Au thin film. Selectively etch Au using wet chemical etchant, remove Ti and SiO₂. Etch resists for nanofabrication, 60nm wide, 12nm nanogap. DNA-functionalized nanoparticle device to fit in the gap and characterize the electrical nature of the structure. Template driven assembly via DPN, to make combinatorial DPN templates - millions of experiments on one area of a substrate. Carbon Nanotube and Nanowire Devices via DPN. Microfabricated electrodes, glue on molecular layer, assemble nanotube. Complimentary with microlithography: design pattern, print and inspect, cannot absorb nanoparticles, nanotubes. DNA as ink for nanolithography. Direct-write patterns on SiO_x, direct wrote ssDNA, complementary strands with different fluorophores gave different colored signals. Optical techniques are the draw back. Replace with 25 and 13nm gold. Took about 20 min to 400nm x 16 μm array with 8 pens with AFM stage.