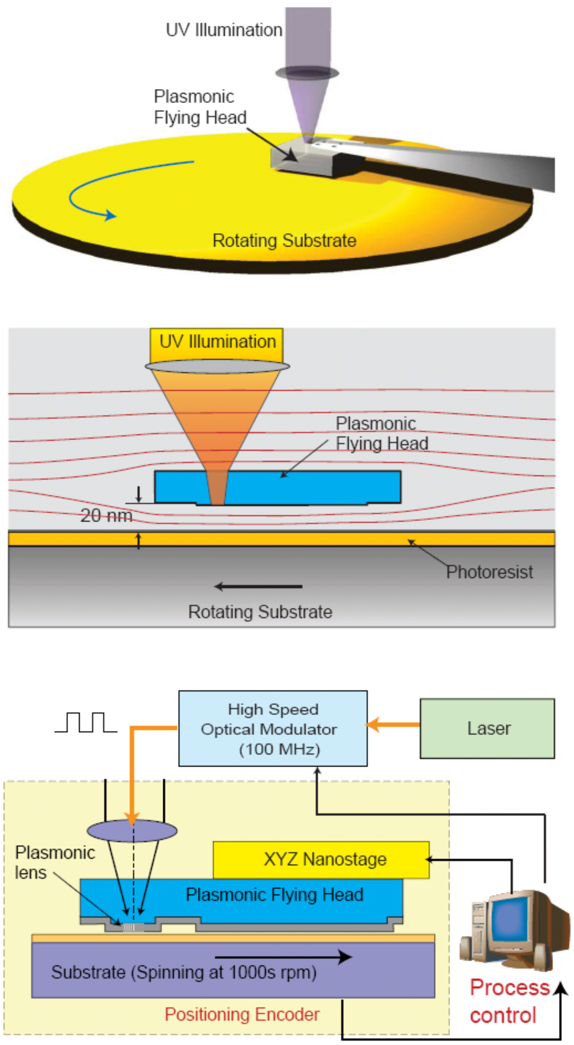
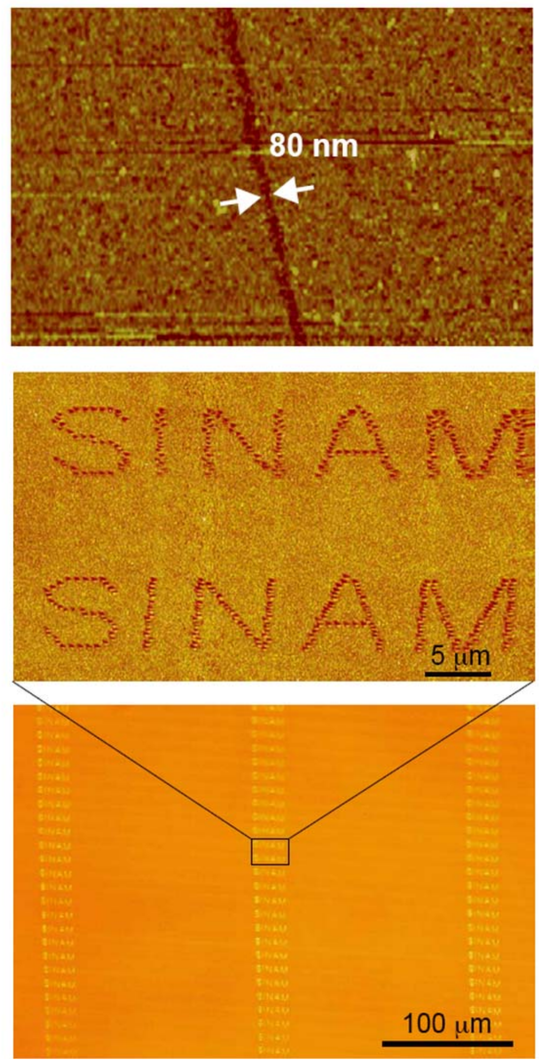
Flying-Head Plasmonic Imaging Lithography

A plasmonic lens utilizes the collective oscillation of electrons at the metal dielectric interface, so-called surface plasmons, to concentrate light into sub-100-nanometer (nm) spots. This nanoscale light confinement only exists at very close distance of the lens (near-field optics). A team led by Xiang Zhang at the University of California at Berkeley developed a high-rate nanolithography technique by integrating plasmonic light focusing with a flying head in a computer disk drive.





***At left**: High-throughput maskless nanolithography using plasmonic lens arrays. Top) Schematic showing the lens array focusing ultraviolet (365 nm) laser pulses onto the rotating substrate to concentrate surface plasmons into sub-100 nm spots. However, sub-100 nm spots are only produced in the near field of the lens, so a process control system is needed to maintain the gap between the lens and the substrate at 20 nm. Middle) Cross-section schematic of the plasmonic head flying 20 nm above the rotating substrate which is covered with photoresist. Bottom) Schematic of process control system. The laser pulses are controlled by a high-speed optical modulator according to the signals from a pattern generator. The writing position is referred to the angular position of the disk from the spindle encoder and the position of a nano-stage along the radial direction. **At right**: Maskless lithography by flying plasmonic lenses at the near field. Top) AFM image of a pattern with 80 nm linewidth on the TeOx-based thermal photoresist. Middle) AFM image of arbitrary writing of 'SINAM' with 145 nm linewidth. Bottom) Optical micrograph of patterning of the large arrays of 'SINAM'.*

A self-adaptive air-bearing surface, similar as that used in the magnetic recording heads of hard disk drives, was specifically designed to precisely control of the flying gap at 20±2 nm at a high speed up to 14 meters/second (m/s). By controlling the firing of the laser using a pattern generator according to the position of the plasmonic flying head over the surface of photoresist, the team experimentally demonstrated the capability of high speed arbitrary nano-patterning with a spatial resolution of to 80 nm at a writing speed at 10 m/s.

Srituravanich, W., L. Pan, Y. Wang, C. Sun, D. B. Bogy, and X. Zhang. 2008. Flying plasmonic lens in the near field for high-speed nanolithography**.** *Nature Nanotechnology,* **3**:733–737. Published online 12 October 2008, doi:10.1038/nnano.2008.303

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