Multi-Tip AFM Lithography System for High Throughput Nano-patterning

Young Oh, Chulmin Choi, Kunbae Noh, Diana Villwock, Sungho Jin*
Materials Science & Engineering, University of California at San Diego, La Jolla, CA 92093

and

Gwangmin Kwon, Haiwon Lee*
Department of Chemistry, Hanyang University, Seoul, Korea 133-791

The trend in electronic, magnetic and photonic devices is toward higher circuit and device density and overall miniaturization of device size. Nanofabrication technologies are crucial for producing extremely small feature dimensions for manufacturing of next generation, higher-density devices. Conventional e-beam lithography with its single–line writing characteristics is inherently slow and costly. Therefore, there is a need for a new, nanolithography technique which is simpler, faster and less expensive. Having such a technique can be useful for nanomanufacturing of devices.

In this study, we have created multiple and parallel AFM lithography probes with essentially identical heights on the same cantilever, aiming for a large area, rapid fabrication of both nano-island arrays and nano-line arrays. The multi-tip probe made of either carbon tip array (Figure 1(a)) or silicon sharp tip array (Figure 1(b)) on a singular cantilever was successfully applied to form the multi-dot pattern on a silicon wafer coated with a negative resist by low electric field induced AFM lithography. Pedestal nanopillar structures are convenient support features that enable easier control of multiple nanotip arrays for AFM writing. We have constructed such a nano-pedestal array, on each of which we have also fabricated an extremely sharp nano needle tip for AFM writing.

The dot array patterning on a negative resist using the multi-tip AFM probe is schematically illustrated in Fig. 2(a). The AFM cantilever is manipulated and moved stepwise to write a series of patterns over a larger area. The eventual aim is to produce many thousands of tips on the same cantilever for simultaneous writing. Shown in Figure 2(b) is an example island pattern produced by the multi-tip AFM write lithography, which is imaged by AFM metrology analysis. The multi-tip probe system does not need to have a multiplexing system for individual feedback and control of each tip since a single cantilever can easily produce a multiple and periodic island array pattern.

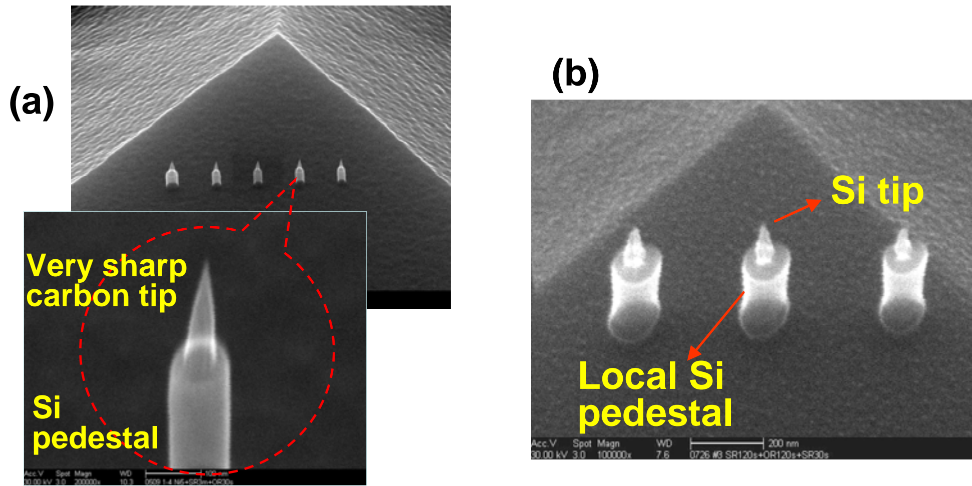

Figure 1; Multi-tip AFM probes fabricated. (a) Sharp carbon tips on a Si cantilever with Si pedestal array, (b) Sharp Si tips on Si pedestal array on a single AFM cantiver.

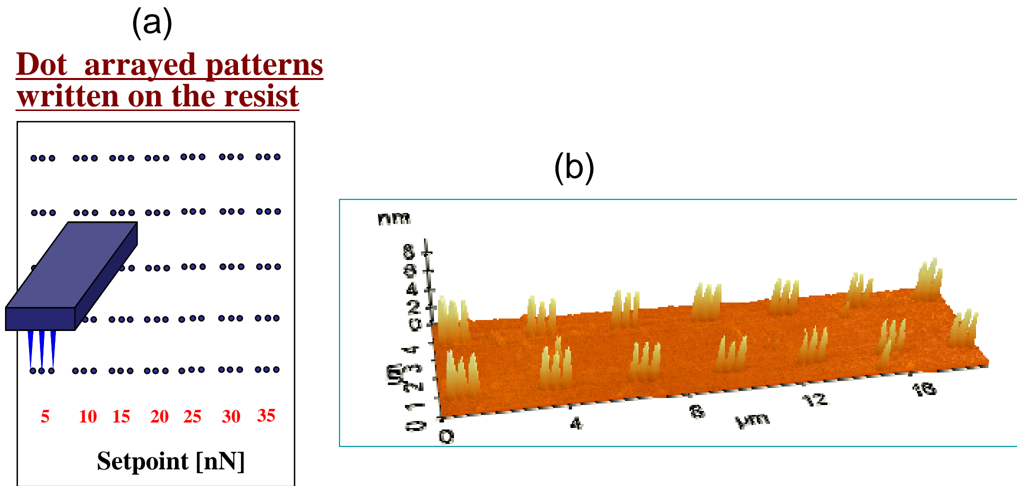

Figure 2 ; (a) Dot array pattern created by multi-tip AFM probe exposure using the Si multi-tip cantilever shown in Figure 1(b).