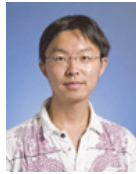


Active CMOS-MEMS Probe Array for STM-Based Parallel Nanofabrication



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STM tip-based nanofabrication (TBN) is capable of manufacturing nanostructures in a controllable way, i.e. the structure geometry and location can be accurately determined by probe manipulation and controlled reaction between the tip and the substrate. With an array of multi-probes, parallel structure fabrication will be achieved. To this end, we are developing a 1D multiple probe array STM system suitable for parallel imaging and batch nanofabrication. The 1D probe array system is fabricated using CMOS-MEMS technology. This technique promises to support a high level of integration on a single chip with actuation, sensing and feedback control circuitry as well as the mechanical structure. Further, while most probe array research up to now is limited to AFM mode, the CMOS-based multi-probe array is intended for STM application featuring an order of magnitude smaller scale manipulation than AFM.

A dual-probe STM system is first developed. Fig. 1 shows the system block diagram. The CMOS-MEMS probe array chip is mounted on the piezo scanner head of a commercial STM system. One of the array probes acts as the master probe, which is driven by the piezoelectric actuator on the system. The second, slave probe, is actuated by a bimorph electrothermal (ET) actuator embedded in the probe cantilever. Two custom servo-loops are designed for each probe, respectively. Scanning on an Au calibration sample, two images are obtained simultaneously (fig. 2). Performing dual nanowire writing on a Ti surface, two TiO₂ nanopatterns can be written (fig. 2). Fig. 3 shows the “CMU” pattern from the master probe. Software is being developed for extracting the 2nd pattern image from the slave probe. This dual-probe system can be extended to accommodate more tips by adding more slave probes and their corresponding servo-loops.

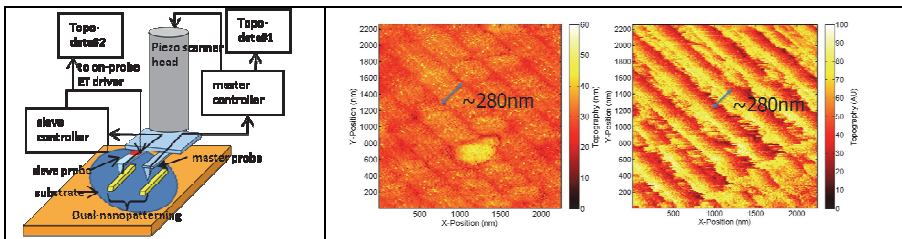


Fig. 1: system block diagram

Fig. 2: dual imaging on Au calibration sample

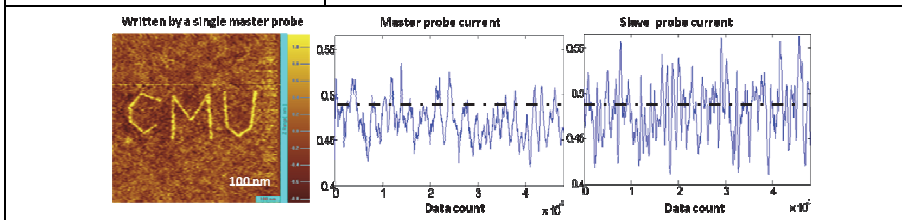


Fig. 3: Dual STM patterning on Ti, both probe scanning in constant current mode.