Poster

HIGH-SPEED NANOSTRUCTURING

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The ability to pattern surfaces on the nanometre scale in short timescales is of great importance in the fabrication of nanostructures and nanoscale devices. The development of a system to meet these requirements could have potential use in future commercial applications.

Previous work focused on two nanostructuring techniques, and the application of these on sub-microsecond timescales using atomic force microscopy (AFM). The two nanostructuring methods were ionic conduction in silver sulphide films [1], whereby mobile silver ions can be drawn to the surface of the silver sulphide layer, and the local oxidation [2] of titanium and silicon surfaces. It was found that patterning by ionic conduction could only be applied on millisecond timescales, whereas local oxidation could occur on timescales as low as 10 ns.

Local oxidation is achieved by applying a negative bias voltage between the tip and surface. The resulting electric field induces the formation of a water bridge between the tip and surface. Oxygen anions produced from the water molecules are driven towards the sample by the electric field and oxidise the sample. Figure 1 shows the oxide patterns resulting from repeated 10 ns pulsing whilst scanning the tip along the zigzag line, in both non-contact and contact operating modes, using a conventional AFM.

Identifying a nanostructuring process that can occur on sub-microsecond timescales represents half of the high-speed solution. An instrument capable of addressing the sample surface in short timescales is also required. To this end, we are using a resonant scanning microscopy (RSM). Operating in its high-speed AFM (HSAFM) mode [3], RSM is able to address a surface with a single probe at speeds three orders of magnitude faster than conventional AFM. Recent results have shown that local oxidation can still be achieved even whilst scanning the AFM tip at speeds of ~ 5 cms^{-1}. Figure 2 shows the outcome of combining RSM with local oxidation to pattern an area of 500 × 800 nm in only 1 s.

Presently we are developing the necessary electronics required to create individual oxide features at these increased speeds, before investigating whether it is possible to simultaneously write and image oxide nanostructures in real-time. Furthermore, conventional AFM is continuing to be used to create structures of greater complexity and assess whether an oxide-patterned surface can be used as a template for the absorption of biomolecules.

References:

[1] K. Terabe, T. Nakayama, T. Hasegawa, M. Aono, Appl. Phys. Lett., **80** (2002) 4009.
[2] J. Dagata, J. Scneir, H.H. Harary, C.J. Evans, M.T. Postek, J. Bennett, Appl. Phys. Lett., **56** (1990) 2001.
[3] A.D.L. Humphris, M. Miles, J.K. Hobbs, Appl. Phys. Lett., **86** (2005) 034106.

Figures:

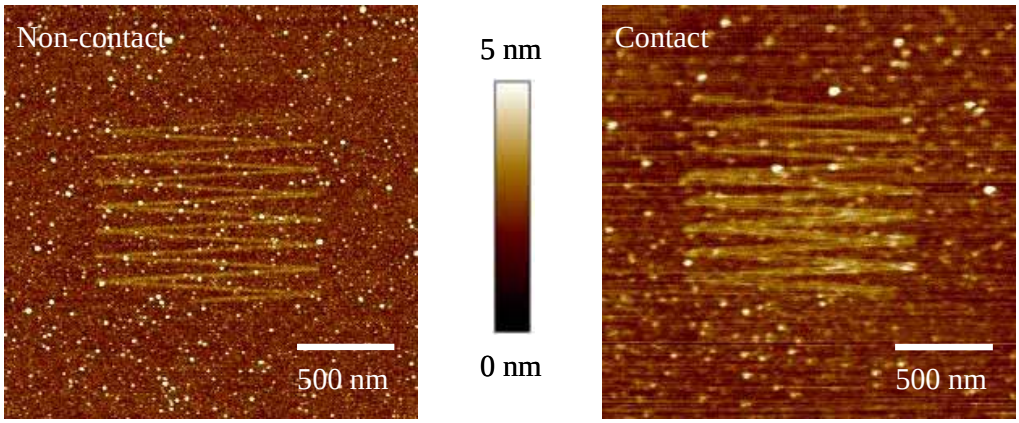

Figure 1. Examples of oxide patterns generated by continuously pulsing the tip with 10 ns pulses of -12 V while moving the tip across the surface. Both patterns are created using a conventional AFM, with the tip being operated in both non-contact and contact modes.

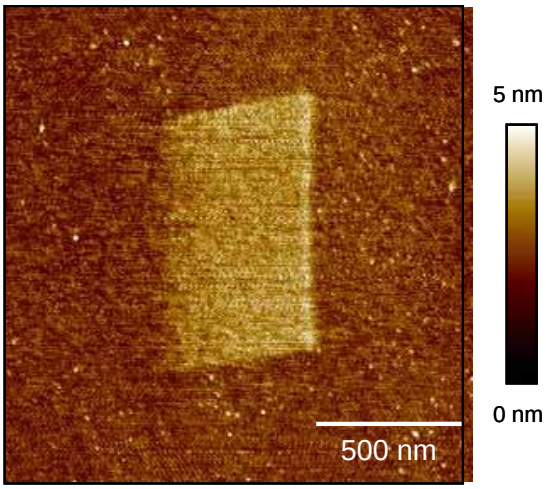

Figure 2. Local oxidation at high speed; produced by repeated pulsing of -12 V for 100 ns over a total exposure time of 1 s, whilst scanning the tip at ~ 5 cms^{-1}.