High-speed, Sub-15 nm Feature Size Thermochemical Nanolithography

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Atomic force microscopy (AFM) based techniques have been successful in generating protein nano-arrays on various substrates. However, several challenges still exist in terms of resolution, writing speed, cost, substrate choice, protein bioactivity, multi-component patterning, and surface passivation. Recently, by using a resistively-heated AFM tip, we have demonstrated the ability to thermally activate a chemical reaction at the nanometer scale by thermochemical nanolithography (TCNL). TCNL can write chemical and topographical features at a rate of mm/s, with sub-10 nm resolution. [1, 2] In particular, we have demonstrated that tetrahydropyranyl (THP) esters and carbamates can be deprotected by TCNL to give carboxylic acids and amines, respectively. The process can be performed on spin-coated polymers on a variety of substrates.

For the THP ester copolymer, TCNL-written acid features can be further modified by tip-heating to >190 °C to form anhydrides.[2] This last result shows that TCNL can locally tune surface wettability with in situ write-read-overwrite capability.

For the carbamate copolymer, TCNL deprotected amine nano-patterns are shown to be anchor sites for various specific-binding biomolecules. These ordered nano-arrays of proteins and DNAs are important for studies on cellular focal adhesion, and transfer of single protein molecules moving among DNA molecules. [3]

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2. D. Wang, R. Szoszkiewicz, T. Okada, S. C. Jones, M. Lucas, J. Lee, W. P. King, S. R. Marder, and E. Riedo, *Appl. Phys. Lett.* **91**, 243104 (2007).
3. D. Wang, V. Kodali, W. D. Underwood, J. E. Jarvholm, T. Odaka, S. J. Jones, C. Rumi, W. P. King, S. R. Marder, J.E. Curtis and E. Riedo, (2008) *submitted*

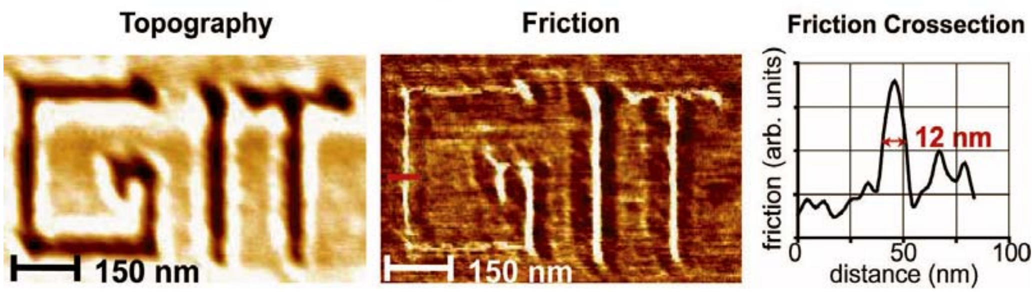

Fig 1: TCNL Writing of GIT: AFM topography and corresponding friction image of a TCNL modified THP ester copolymer film written at a speed of 0.5 mm/s, with the indentation depth kept within 3 nm. The resulting friction cross-section shows about 12 nm FWHM within the modified zone; topographical changes are minimal.