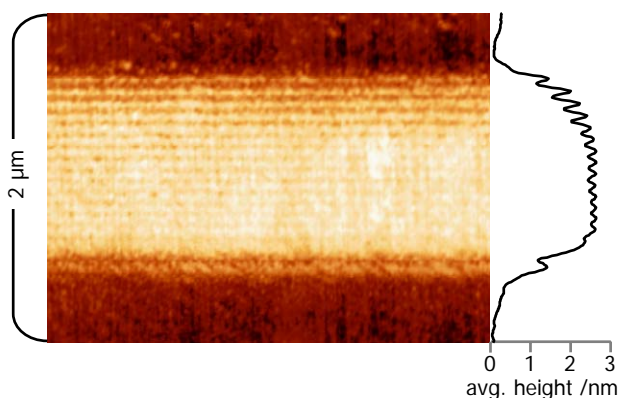


### **Hot Scanning Probe Tips Create Highly Ordered Polymer Monolayers**

A new nanolithographic technique uses a hot scanning probe tip to deposit polymer nanostructures. In this technique, called thermal Dip Pen Nanolithography, a heatable tip is first coated with the polymer to be deposited. When the tip is heated the polymer ink melts, flows down the tip, and is deposited onto the surface. Because the tip is hot and moving during deposition, the polymer is both annealed and stretched. The resulting nanostructures show exceptional high degrees of ordering. The image shows a monolayer thick film of the conducting polymer poly(3-dodecylthiophene), or PDDT, that has been aligned by rastering the hot AFM tip. Polymers that have been aligned this way have demonstrated behavior not observed in the bulk such as anisotropic conductivities, novel hydrogen sensing properties, and mechanical stability during phase transitions. Recent work indicates that the high degree of alignment can be transferred to nanoparticles mixed with the polymer to create highly-ordered nanoparticle-polymer composites.



*Tapping-mode AFM images of a single monolayer of PDDT deposited on SiO<sub>2</sub> and aligned using multiple passes of a hot AFM probe. The PDDT coated tip was raster scanned from the top right to the bottom left at 5 μm/s with 47 nm per line while it was heated at 117 °C. To the right is a plot showing the average height of the polymer. It indicates that the polymer is probably bundling.*

Yang *et al.*, *J. Am. Chem. Soc.* **128**, 6774 (2006); Lee *et al.*, *Soft Matter* **4**, 1844 (2008).

**Patents or other steps toward commercialization:** patent application accepted

**Contributing Agency:** DoD / NRL