Nanotechnology Highlight

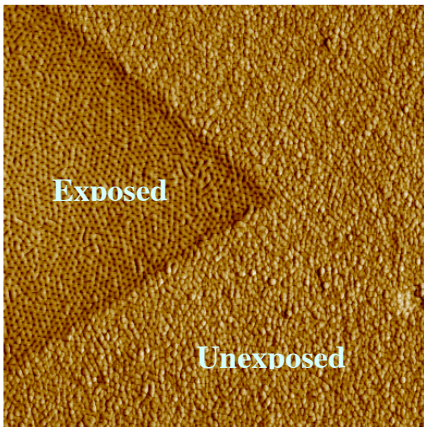
Integrated Devices from Self-Assembled Nanoscale Copolymer Templates

(DMI-0103024)

University of Massachusetts Amherst NIRT

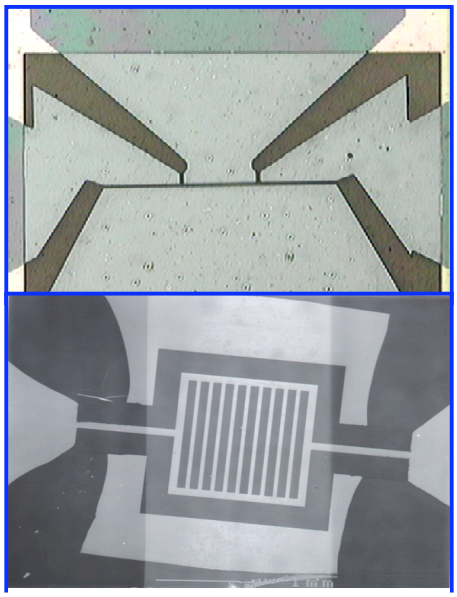
PIs: Mark Tuominen, Thomas Russell, Jacques Penelle, Vincent Rotello, and Thomas McCarthy

A present technical challenge in nanotechnology research is to establish a simple method to fabricate nanoscale structures and, moreover, to provide appropriate electrical interfacing in useful device configurations. The UMass Amherst NIRT grant team has developed a robust technique of device nanofabrication in which lithographic exposure is used to selectively degrade regions of a self-assembled diblock copolymer film to obtain a honeycomb-like nanoporous array template with arbitrary lateral design. Such templates are used for a variety of purposes, including the fabrication of arrays of vertical nanowires using electrodeposition. By integrating this process with other lithographic process steps, the fabrication of arrays of nanostructures interfaced to electrical probes for device applications is enabled. As one explicit example, a unique configuration of magnetoelectronic device is fabricated in which an array of vertical magnetic nanowires is interfaced to a pre-patterned thin film of gold.



An AFM image of a patterned diblock copolymer template. The pores in the triangular region are ~20 nm in diameter. *Prepared by M. Bal, UMass Amherst.*

This work demonstrates the general principle of using a patterned, self-assembling, nanoscale template as one step in a multi-step lithographic fabrication process, thereby providing a convenient route to integrated electronic devices exploiting nanoscale structure.. The opportunity exists to tune the design the nanowire arrays in all three dimensions through manipulation of the copolymer parameters and electrodeposition conditions. This simple process can be exploited for other nanodevice configurations such as field emission arrays, nanowire magnetotransport devices, thermoelectric coolers, patterned smart media, and nanoelectrode sensors. The UMass NIRT grant team collaborates with scientists from industry, national labs, and international institutions to advance several of these applications.



Two devices in which magnetic nanowires (~14 nm diameter) are interfaced to electrodes patterned by electron beam lithography. *Prepared by M. Bal and A. Ursache, UMass Amherst.*

Relevant References:

1.“Nanofabrication of integrated magnetoelectronic devices using patterned self-assembled copolymer templates,” M. Bal, A. Ursache, J. Goldbach, T.P. Russell, and M.T. Tuominen, Applied Physics Letters **81**, 3479 (2002).

2.“Tuning magnetic properties of ultrahigh density arrays by electrodeposition with a polymer template," A. Ursache, M. Bal, J. Goldbach, T.P. Russell, R. Sandstrom, C.T. Black, and M.T. Tuominen, Mat. Res. Soc. Proc. **721** (2002).

3. “Ultrahigh-Density Nanowire Arrays Grown in Self-Assembled Diblock Copolymer Templates,” T. Thurn-Albrecht, J. Schotter, G.A. Kästle, N. Emley, T.Shibauchi, L.Krusin-Elbaum, K.Guarini, C.T.Black, M. Tuominen and T.P. Russell, Science **290**, 2126 (2000).