# Nanoimprint Lithography Master Stamp Produced Via Morphologically Controlled Electrospun Fibers

Luke J. Suttey, Harold W. Pearson, Isaac C. Gilfeather, Xavier T. Vorhies, Jessica M. Andriolo, and Jack L. Skinner

*Montana Tech Nanotechnology Laboratory, Montana Technological University, 1300 West Park Street, Butte, MT 59701*

Nanotextured polymer surfaces have been shown to have antibiofouling and bactericidal properties dependent upon the size and morphology of the surface features.[1] Such surface features can be applied quickly and effectively with nanoimprint lithography (NIL). Traditionally, master stamps for nanoimprint lithography are produced via time intensive and expensive methods such as electron beam lithography, dry etching, and metal lift off.[2] Incorporation of morphology-controlled electrospinning (ES) methods into the NIL stamp fabrication process would provide a relatively quick method of small feature stamp fabrication.

Completed work has yielded an effective process (*Figure 1*) for production of a NIL stamp using aligned ES polycaprolactone (PCL) fibers for the original patterning of the substrate (*Figure 2*). Five processing steps are used to create the NIL stamp, including: ES fiber deposition, chromium deposition, ES fiber solvent lift-off (*Figure 3*), reactive ion etching with a combination of sulfur hexafluoride and oxygen gas, and chromium removal. The resulting micro-trenches are cylindrical in shape from a primarily isotropic pattern transfer into the silicon substrate and are approximately 1 μm in diameter (*Figure 4*).

The process for fabrication of NIL stamps with controlled electrospun patterning will be refined to produce various trench widths, densities, and patterns. The patterns will be transferred to polymer substrates (*e.g.*, PMMA) for use as antimicrobial surfaces. The resulting polymer NIL-patterned surfaces will be thoroughly studied for efficacy against bacterial adherence, growth, and biofilm formation using *Staphylococcus aureus* and *Pseudomonas aeruginosa.*

[1] A. Muñoz-Bonilla and M. Fernández-García, European Polymer Journal **65**, 46 (2015).

[2] C.M. Sotomayor Torres, S. Zankovych, J. Seekamp, A.P. Kam, C. Clavijo Cedeno, T. Hoffmann, J. Ahopelto, F. Reuther, K. Pfeiffer, G. Bleidiessel, G. Gruetzner, M. v. Maximov, and B. Heidari, Materials Science and Engineering C **23**, 23 (2003).

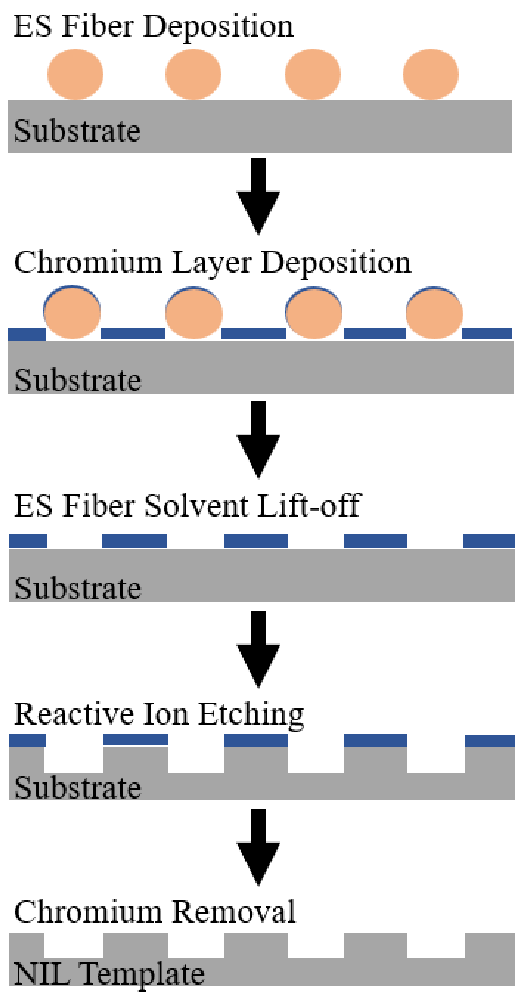


*Figure 1*. Process flow for the fabrication of nanoimprint lithography master stamps from ES fibers.

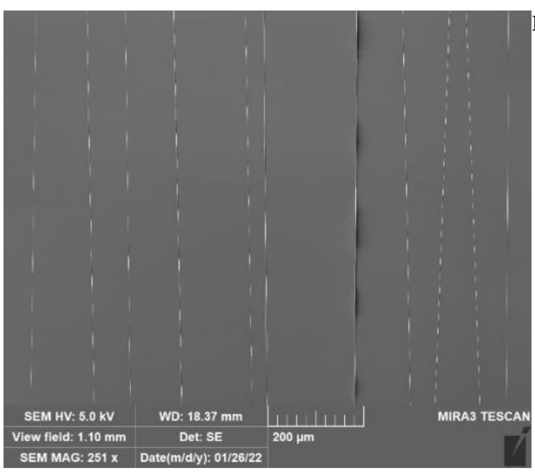


*Figure 2*. Scanning electron micrograph of aligned ES PCL fibers deposited onto the silicon substrate.

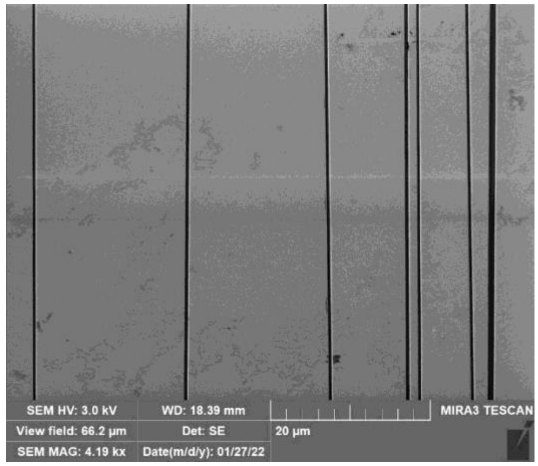


*Figure 3*. Scanning electron micrograph of the chromium hard mask after ES fiber solvent lift off.

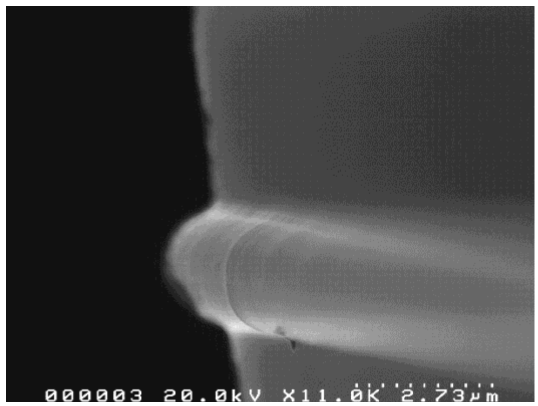


*Figure 4*. Scanning electron micrograph showing cross section of a micro-trench in the silicon substrate after chromium removal.