Advances in Polymer Self-Assembly Enable Unprecedented Device Densities on Si Wafers and Pathways to High Volume Processing of Nanoscale Materials on Roll-to-Roll Platforms

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The NSF funded researchers at the Center for Hierarchical Manufacturing (CHM) have produced significant advances that are offering new opportunities for precision and cost effective nanomanufacturing. In the area of directed self-assembly, CHM research demonstrated reductions in feature size and attainment of long range order necessary to generate templates for 10 terabyte/in^2 media, an order of magnitude greater than previously possible. The Center also demonstrated that by employing strong specific interactions, highly-ordered microphase-separated periodic morphologies could be obtained from blends of commercially available disordered materials, which removes cost and materials barriers for high-volume processing of self-assembled media and devices. CHM investigators further demonstrated that metal and semiconductor nanoparticles designed with ligands that exhibit strong selective interactions with block copolymer or surfactant segments induce assembly and drive strong order in hybrid materials, enabling high loadings of inorganic particles and robust assembly. In addition, the Center is developing a roll-to-roll (R2R) nanoimprint lithography tool to enable surface texturing to direct the orientation of self-assembled domains and continuous patterning at the device level (Figure 1). Taken together these advances provide the basis for low cost, R2R assembly of nanostructured media and devices using the principles of directed self-assembly, a possibility that did not exist at the inception of the CHM. This new approach offers breakthrough opportunities in low cost nanomanufacturing. Applications of the R2R platform within the CHM include: polymer batteries, photovoltaics, high permeability magnetic meta materials for communications, data storage, integrated sensors and nanoseparations.

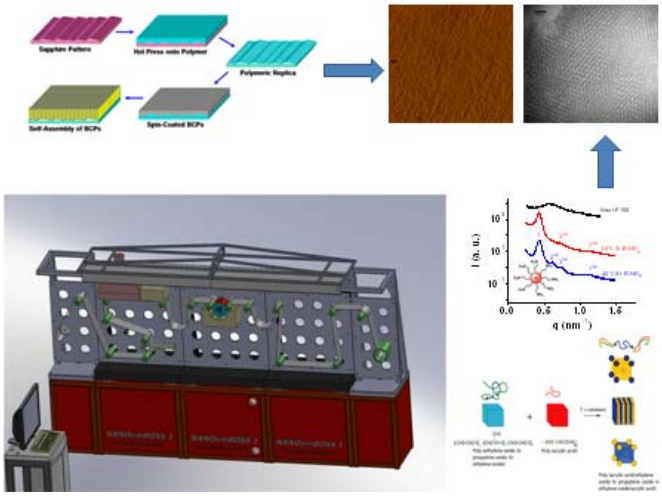

Figure 1. Translation of Fundamental Research on Directed and Additive Driven Self-Assembly from Batch Process on Silicon to Roll-to-Roll Processing on Flexible Substrates

References

[1] For further information about this project link to http://chm.pse.umass.edu/