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Gradient and High-Throughput Methods for the Accelerated Development of Nanomaterials and Nanometrology

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Increasingly, new materials are highly tailored towards specific applications, are formulated from many components, and exhibit behavior governed by a multitude of physical, chemical and processing factors. Accordingly, the discovery and optimization of materials are met by considerable challenges inherent to the understanding of large, complex parameter spaces. In this respect, combinatorial and high-throughput (C&HT) approaches are advantageous, since they present the ability to rapidly assess materials properties over large parameter ranges. The NIST Combinatorial Methods Center (NCMC, see www.nist.gov/combi) specializes in the development of quantitative C&HT measurement methods for materials research. In large part, the NCMC concentrates on continuous gradient (CG) combinatorial methods, which involve the fabrication and HT measurement of systems that gradually vary parameters over a single specimen, and which offer an alternative to the (often costly) robotics-driven C&HT paradigm used by the pharmaceutical industry. CG techniques are particularly suited for materials science since they naturally produce thorough maps (e.g. continuous phase diagrams) that relate materials properties to chemical, compositional, physical and processing parameters. This presentation focuses on NCMC research applied to the advancement of polymer-based nanotechnology. Topics to be discussed include CG techniques for the design and optimization of self-assembled systems, ultra-thin films, and intelligent surfaces; and HT methods for measuring thin film morphology and mechanical properties. In addition, the application of CG methods to the advancement of nanometrology, specifically scanned probe microscopy, will be discussed.