

## **Exploring the Matteredverse with Nanomaterial Megalibraries**

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The evolution of materials has progressed over time from simple stone used by early man to the complex materials we rely on today. The use of new and advanced materials has revolutionized electronics, medicine, energy, and catalysis; however, the traditional approach of synthesizing and characterizing new materials is a slow and time-consuming process. To tackle this challenge, we have developed a nanoscale scanning probe lithography approach that, through the deposition of polymeric nanoreactors and thermal annealing, enables the preparation of “megalibraries” of nanomaterials with distinct chemistries. This approach has allowed the rapid synthesis and screening positionally encoded nanomaterials with many different elements, phases, and interfaces and offers exciting possibilities for creating new materials with desired properties. For instance, this approach enables the identification of new materials and catalysts for important chemical transformations and polyelemental particle generation can have significant implications for various fields, including energy and medicine. It offers a new understanding of how materials behave and how they can be engineered to create new and improved materials. However, in materials discovery efforts, synthetic capabilities far outpace the ability to extract meaningful data from them. To bridge this gap, we present a machine learning–driven, closed-loop experimental process to guide the synthesis of polyelemental nanomaterials with targeted structural properties. Together, this approach lays the foundation for creating an inflection point in the pace at which we both explore the breadth and discover the capabilities of the “matteredverse”.