

Long View in Nanomanufacturing

Dr. M.C. Roco

National Science Foundation and National Nanotechnology Initiative

* mroco@nsf.gov

Presentation

Abstract: Nanomanufacturing has been defined as an approach to design, produce, control, modify, manipulate, and assemble nanometer-scale elements or features for the purpose of realizing a product or system that exploits properties seen at the nanoscale. Nanomanufacturing R&D has as its goal enabling the mass production of reliable and economical nanoscale materials, structures, devices, and systems. Nanomanufacturing combines assembling of molecular systems with top-down miniaturization and precise hierarchical integration. Specific instrumentation and standards for nanoscale measurements need to be developed upstream in conjunction with simulations and design of productive processes. The current rudimentary capabilities for systematic control and manufacture at the nanoscale are envisioned to evolve faster after 2010 as we develop new models and instrumentation and enter production of nanosystems for revolutionary new products and processes. We have estimated the global market of final products that incorporate nanotechnology increases by about 25 percent per year reaching US \$1 trillion by 2015. This estimation made in 2000 holds in 2009, after passing half of the interval.

The research trends and application opportunities in nanomanufacturing will be presented by considering four generations of products by 2020. Each generation of new products is expected to include, at least partially as components, products from previous generation. Most of what has already made it into the marketplace is in the form of “First Generation” products (passive nanostructures with steady behavior). Many small and large companies have “Second” (active nanostructures, such as advanced transistors, amplifiers, targeted drugs and chemicals, sensors, actuators, and adaptive structures) and embryonic “Third Generation” (nanosystems, such as bio-assembling; networking at the nanoscale, nanoscale robotics and multiscale architectures) products in the pipeline. Concepts for the “Fourth Generation” products, including molecular nanosystems, are only in research. Convergence with modern biology, digital revolution, cognitive sciences and other areas is expected to accelerate nanotechnology manufacturing.