New Frontiers for Nanotechnology

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Abstract: Nanoscience and nanotechnology have opened an era of integration of fundamental research and engineering from the atomic and molecular levels, increased technological innovation, and an enabling base for improving human health and cognitive abilities in long term. The rudimentary capabilities of nanotechnology today are envisioned to evolve in four overlapping generations of new nanotechnology products: passive nanostructures, active nanostructures, systems of nanosystems, and molecular nanosystems. This lecture briefly presents what is nanotechnology and explores its scientific and technological frontiers.

The balance between the promised benefits and measures to address possible undesirable effects is discussed. The general risks associated with nanotechnology applications and the deficits of the risk governance process today will be presented, concluding with recommendations to international organizations, state governments, industry and other stakeholders.

The genesis of the National Nanotechnology Initiative in the U.S., its current outcomes and likely evolution will be outlined. The U.S. National Nanotechnology Initiative (NNI) is a long-term R&D program announced in January 2000 that coordinates 26 federal departments and independent agencies with a total budget of about $1.4 billion in fiscal year 2007. For the next five years, new priorities are envisioned in exploratory research for nanomedicine, energy conversion, food and agriculture, realistic simulations at the nanoscale, molecular nanosystems, and improving human potential.

Dr. Mihail C. Roco is the Senior Advisor for Nanotechnology at the National Science Foundation (NSF) and a key architect of the National Nanotechnology Initiative. Dr. Roco is credited with 13 patents and has contributed over two hundred articles and fifteen books, including "Nanotechnology: Societal Implications - Maximizing Benefits to Humanity" (Springer Science, November 2006), significantly advancing the body of literature in the field. Dr. Roco coordinated the preparation of the U.S. National Science and Technology Council (NSTC) reports on "Nanotechnology Research Directions" (NSTC, 1999) and the "National Nanotechnology Initiative" (NSTC, 2000). Under his stewardship the nanotechnology federal investment has increased from about $3 million in 1991 to $1.3 billion in 2005/2006. Prior to joining the National Science Foundation, he was a Professor of Mechanical Engineering. His research included experimental and simulation methods to investigate nanoparticles and nanosystems. He is the Editor-in-chief of the Journal of Nanoparticle Research. Dr. Roco is a Correspondent Member of the Swiss Academy of Engineering Sciences, Fellow of ASME, Fellow of AIChE,

and Fellow of Institute of Physics. Forbes magazine recognized him in 2003 as first among "Nanotechnology's Power Brokers" and Scientific American named him one of 2004's top 50 Technology Leaders. In 2005, he received the AIChE Forum award "for leadership and service to the national science and engineering community through initiating and bringing to fruition the National Nanotechnology Initiative." He is a member of several honorary boards and was elected Engineer of the Year by the U.S. Society of Professional Engineers and NSF in 1999 and again in 2004.