THE CHALLENGES OF NANOTECHNOLOGY

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Science and technology on the nm scale is not simply a continuation of miniaturization from the micro to the nano scale, respectively. Nano is different. The transition from micro to nano is in many ways a disruptive step, a discontinuous continuation, in component size, in technologies, in analytics, in material properties, and in concepts. Nano science and -technology stand at the confluence of classical and quantum mechanical properties and behavior and of a multiplicity of fields such as condensed matter physics and technology, macromolecular chemistry, and biology. Solid state technology brings along the concept of addressability, chemistry that of assembly of nano objects and components, and biology those of self assembly of nano systems and of working with complex systems

Already the extension of present day's technologies to their limits somewhere in the high nm range poses formidable technical challenges. To go beyond, however, sets a different stage. Of the grand challenges of nanotechnology we will encounter a nano material science requiring local growth of nanostructures of both solid state and molecular properties as well as control of local reactions. A second set of challenges will deal with nano interfaces both as connections and active components. Further grand challenges concern novel components of electronic, mechanical, chemical functionality, energy and information transfer to autonomous nano systems, theory, in particular computational sciences, for complex nano systems, and others like the nm sized liquid-solid interface.

Nano-mechanics and nano-chemistry are expected to forge new pathways between the 'virtual' world of data processing of all kinds, including mechanical, chemical and thermal processing, and the 'real' world of sensing and actuation, bringing about a pervasive wave of new, integrated processing, sensing, and actuation technologies.