Keynote

CONTROLLING THE NANOSCALE: FROM NANOCATALYSIS TO NANOWIRES, DNA DAMAGE, AND WIGNER MOLECULES

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When reduced to nanoscale dimensions materials systems often exhibit new properties that differ from those found for larger sizes. This emergent behavior occurs when upon reduction in size one reaches a situation where the physical size of the system becomes of the same order as a length scale characteristic to the phenomenon being studied. This implies that smallness of a material system may manifest itself at different physical sizes depending on the phenomenon under investigation. For example, a metallic wire may exhibit quantized electronic conductance when it's diameter is reduced to the order of 1 nm, with the characteristic length being the Fermi wavelength of the electrons, while the mechanical properties of such a nanowire may vary from those of macroscopic wires already for wires with diameters that are of the order of 10 to 50 nm, with the characteristic length associated with the mechanical response being the diameter of a loop dislocation.

In this lecture several methodologies for the control of the physical and chemical properties of materials systems through manipulations of their size, as well as other characteristic parameters, will be discussed. Systems that will be illustrated include: size-control of the dimensionality and chemical catalytic activity of gold nanoclusters supported on a metal oxide surface, control of electronic transport in nanowires via size and composition manipulations, sequence dependence and control of post-ionization damage in DNA, manipulations of the states of electrons in quantum dots via shape control, control of the stability and breakup characteristics of liquid nanobridges and nanojets through manipulations of the background gaseous environment, and control of friction in nanoscale lubricated junctions via externally applied small amplitude mechanical modulation.