

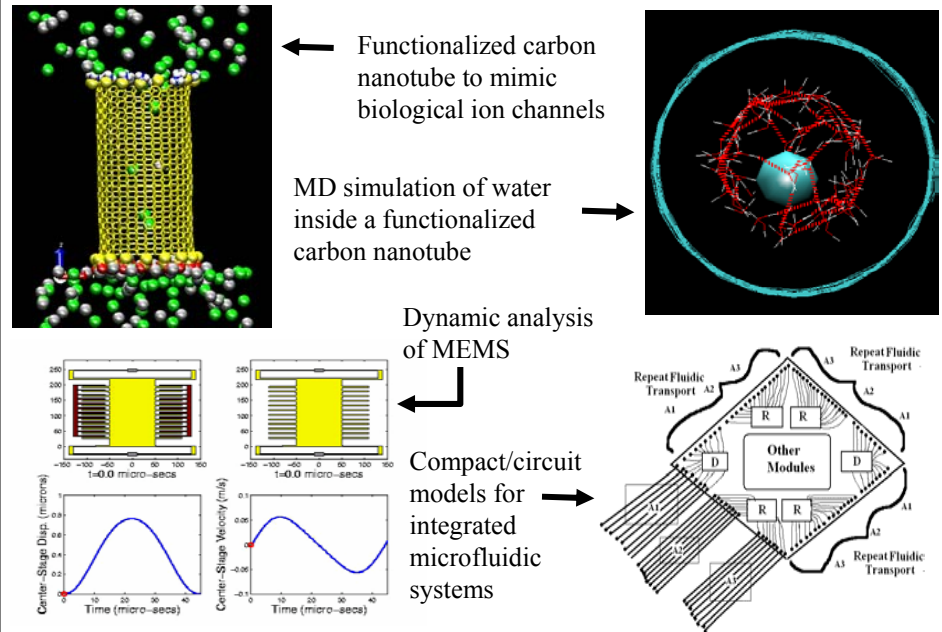
Goals and Potential Impact if Successful

- Develop fast and efficient design tools for mixed-domain analysis of microelectromechanical systems (MEMS)
- Develop physical models and computational tools for analysis of nanoelectromechanical systems (NEMS)
- Develop a fundamental understanding, physical models and multiscale simulation tools for liquid and gas flows through nanometer scale channels

The availability of accurate, efficient and robust design tools will enable rapid computational prototyping of complex and novel mixed-technology systems for various applications

Approach and/or Accomplishments

- Full Lagrangian and meshless techniques for efficient mixed-domain analysis of MEMS (mechanical, electrical and fluidic)
- Classical, semiclassical and quantum-mechanical models for analysis of NEMS
- Reduced-order and compact models for circuit-level analysis of integrated MEMS and microfluidic systems
- Atomistic, continuum and multiscale simulation tools for analysis of liquid flows in nanometer channels
- Identification of new physical phenomena (e.g. flow reversal) in nanopores
- Development of synthetic ion channels to mimic biological ion channels



Bottlenecks and Open Research Questions

- Development of efficient and accurate multiscale tools combining quantum-mechanical, atomistic, mesoscale and continuum approaches is challenging
- Lack of models for all the new physical phenomena encountered in nanotechnology
- Lack of proper experimental data (especially in nanotechnology) to validate simulation tools and physical models
- Automatic reduced-order models, complex 3D geometries, material properties, metrology, inter-atomic potentials, algorithms, uncertainty quantification, stochastic models, integrated system analysis,