

Nanomaterials technical plan as a new IEA annex

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Nanotechnology

- Less than 100 nm in size
- Unique properties NOT available at other scales
- Assembly of atoms, molecules, & particles for specific properties or functions

Nanomaterials & devices

Bottom up fabrication of new materials

Use of nanoscale particles to achieve functions that otherwise unavailable

Nanostructured materials & devices

Macro-scale materials enhanced by controlling the structures at nanoscale

Potential impacts on transportation

- Nanostructured coatings potentially could last 2-5 times longer with better friction and wear characteristics
- Low friction materials by oriented deposition of molecules on metal surfaces (Honda Motors)
- Nanocomposites with high temperature capability as piston liner materials to enable more energy efficient technologies
- Enable light weight materials to have desirable friction and wear characteristics (mg alloys when doped with 1% nanoparticles of alumina improve both hardness and ductility by 40%), carbon nanotube reinforced metals have improved wear resistance by 50%

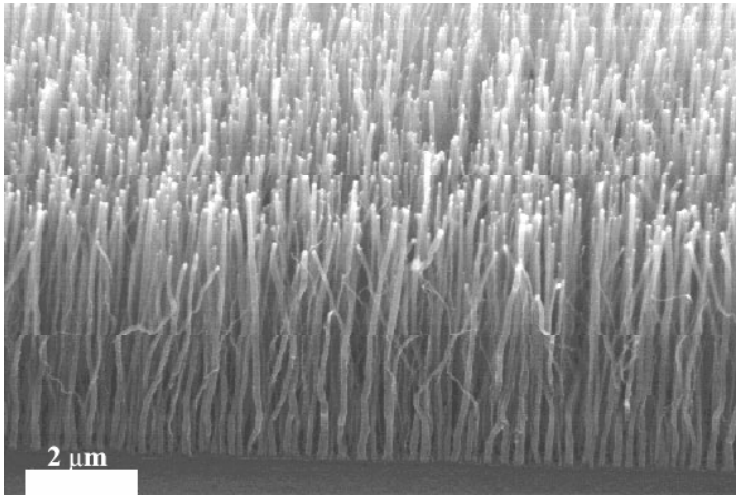
Nanomaterials started with nanoparticles

- C_{60} and C_{80} carbon structures
- Carbon nanotubes
- Nanofibers
- Nanowires
- Silicon dioxide particles
- Nanoparticles of pure metals

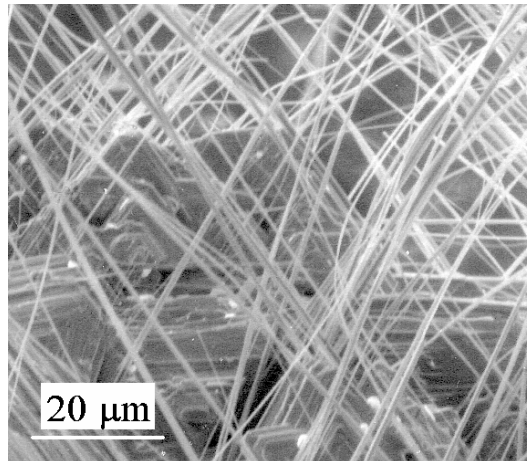
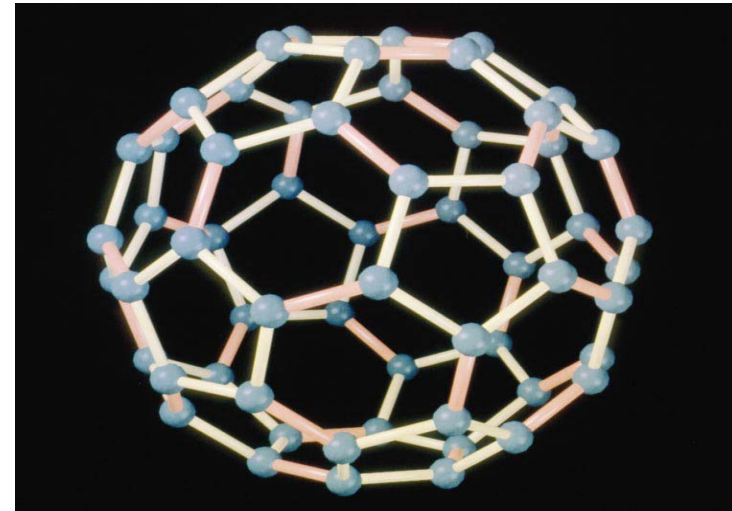
Characterization and property measurements of these particles are very difficult

Nanoparticles

Multiwalled carbon nanofibres

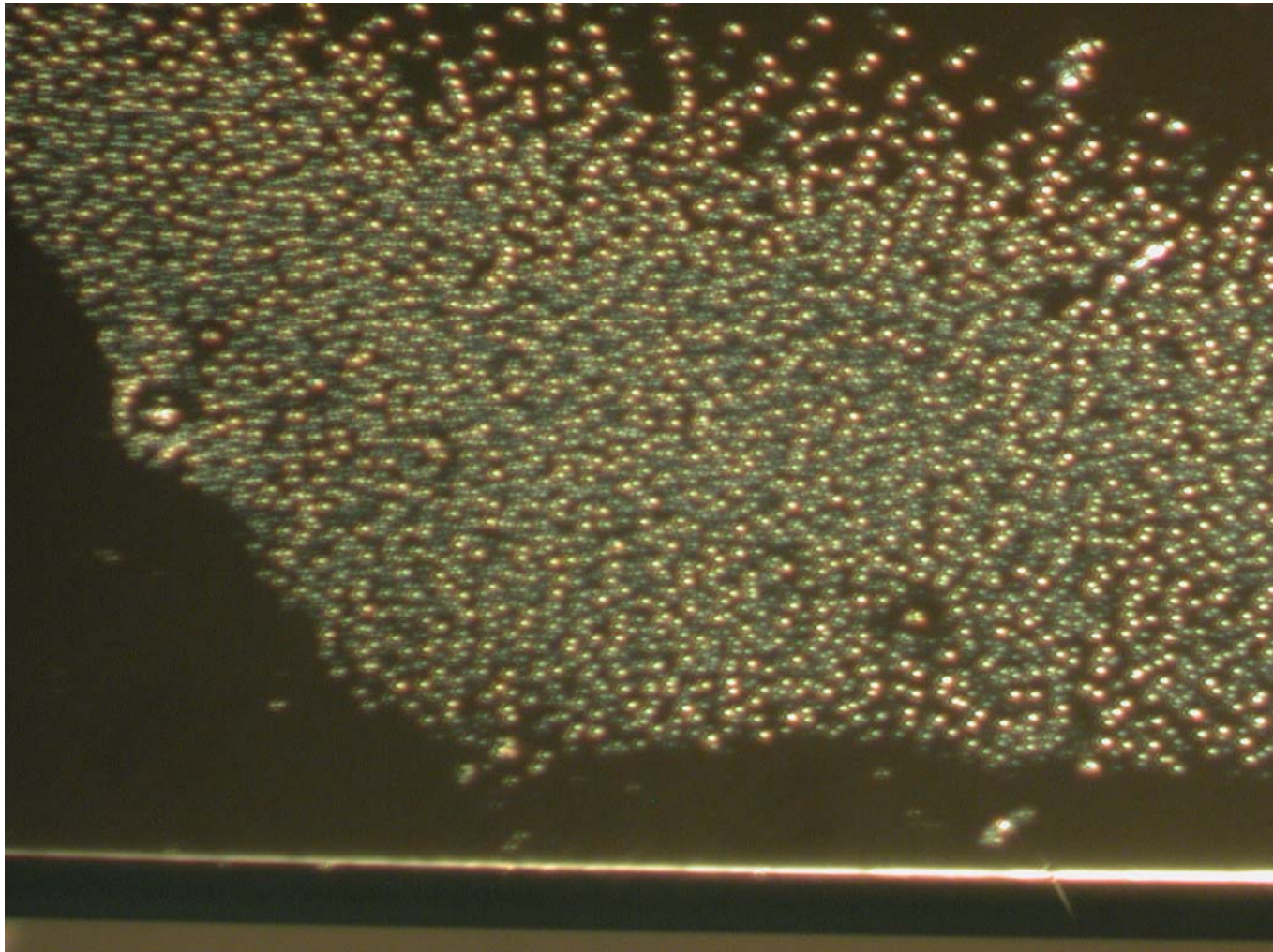


buckeyball



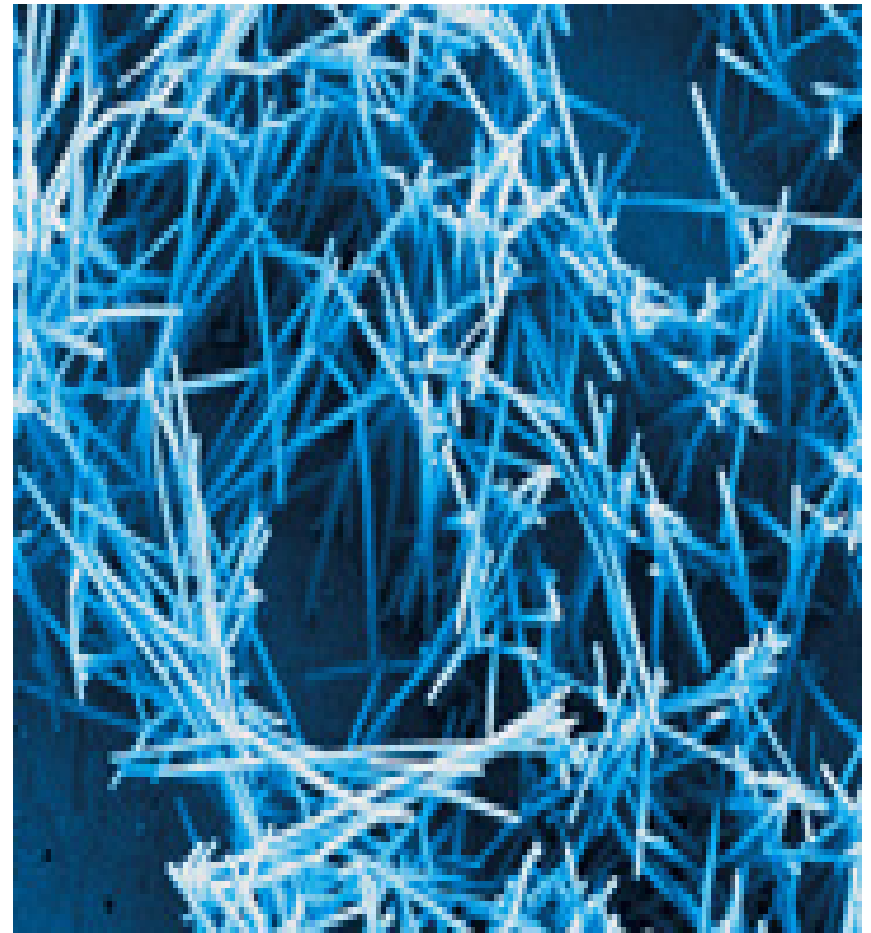
Needle-like crystals Ag

SiO₂ particles in dispersion



GE

**Home grown
Nickel nanowires
produced at GE
have the potential
to impact
products across
virtually all its
businesses.**



Property measurement of nanomaterials and nanostructured materials

Develop instrumentation, measurement methods to measure local and global properties

- Determination of size, shape, composition of materials at a resolution of 100 nm or less
- Quantification of nanoparticles used
- Determine where the nanoparticles in the materials
- Develop measurement techniques for hardness, elastic modulus, wear, friction properties sensitive to compositional variations
- Linking local property to macro-properties in applications
- Develop design guidelines for such materials

IEA cooperative topics

- Nanoparticle characterization
 - Quantification of nanoparticles
 - Identification of where are the nanoparticles in the materials
- Nanoscale measurements of local properties using nanoindentations, scratch techniques to quantify properties of nanocomposites in friction, wear, hardness, durability comparisons
- Evaluate the global properties under simulated engine environment, provide linkage to nanoproperty controls
- Develop design guidelines for such materials

Need a task leader

- Provide samples for round robin study
- Serve as the focal point
- Develop detailed technical plans
- Develop schedule and collaborating partners
- Report the work in the Exo meetings

Potential outputs/impacts

- Compilation of current measurement techniques for such materials
- Develop intercomparison data through a common sample measured by collaborators from different countries
- Test methods development for advanced materials specifically aimed at HD truck applications
- Accelerate energy efficient technology development across national boundaries