Nanoparticles
Will Measurements Lead to Greater Safety?

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Cooperation in International Measurement Development and Prenormative Research

VAMAS: The Versailles Project on Advanced Materials and Standards

- To support world trade in products dependent on advanced materials technologies by providing the technical basis for harmonized measurements, testing, specifications, and standards.
- VAMAS.org

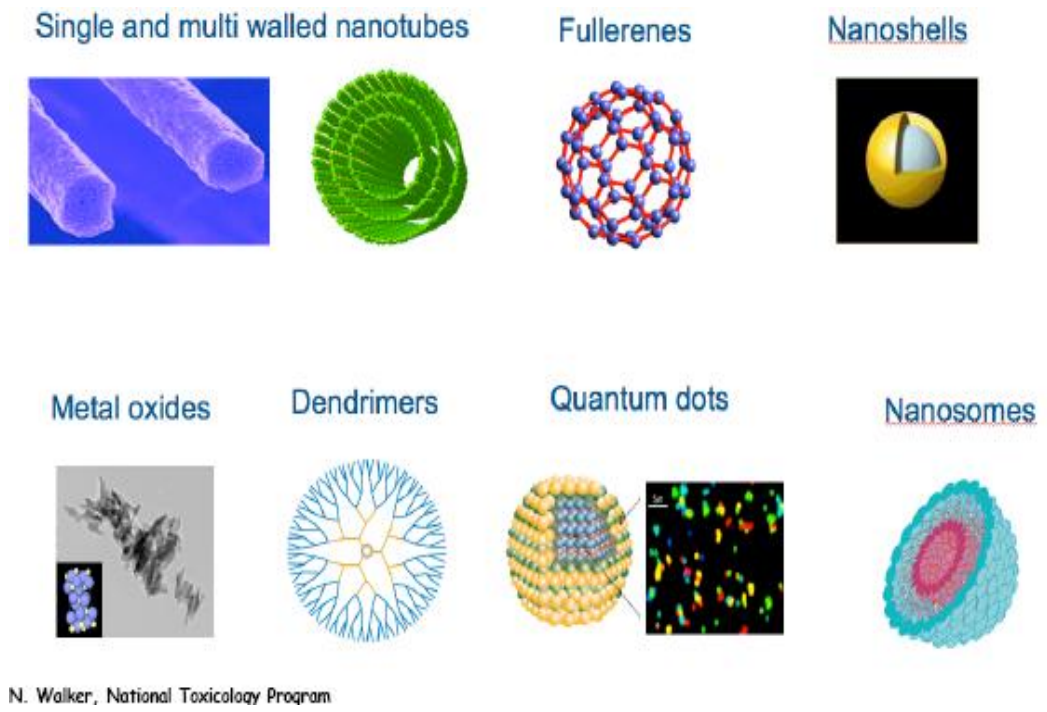
VAMAS Technical Working Areas (current 2011)

- Surface Chemical Analysis
- Thermoelectrics
- Polymer Composites
- Measurement of Residual Stress
- Tissue Engineering
- Nanomechanics Applied to SPM
- Crack Growth in Weldments
- Modulus Measurements
- Materials Databases Interoperability
- Nanoparticle Populations
- Superconducting Materials
- Mechanical Measurements of Thin Films and Coatings
- Performance Properties for Electroceramics
- Cryogenic Structural Materials
- Full Field Optical Stress and Strain Measurement
- Spectrometry of Synthetic Polymers
- Polymer Nanocomposites
- Organic Electronics
- Quantitative Microstructural Analysis

VAMAS Accomplishments

- **Work has led to 85 national, regional or international standards**
- **~30 VAMAS reports**
- **Five ISO Technology Trends Assessments**
- **~600 publications resulting from VAMAS work**

Nanoparticles: Many Shapes, Many Chemistries



Not all nanoparticles are the same

"To measure is to know," Lord Kelvin

But what should we measure?

Will these measurements ensure the safety of nanoparticles?

Crystalline Silica Toxicity

"Despite the substantial volume of research since the early 1950's on the pathogenicity of quartz-induced diseases, the exact mechanism of action of crystalline silica is still debatable and inconclusive."

D.Dutta and B.M. Moudgil, Kona-Powder and Particle, 25, 76 (2007)

Toxicity Depends on Crystal Structure

In order of toxicity

Amorphous - Mostly Inert

Quartz

Tridymite

Cristobalite – Most toxic

Why?

Possible Mechanisms

After considerable, Researchers have concluded

- **Effects of free radicals on freshly fractured surfaces**
- **Toxicity depends on surface characteristics, but not on particle size. (Warheit et.al., Toxico Sci., 95, 270 (2007)**
- **No single measurement can be made to determine the safety of such particles**

- The complexity of nanoparticle reactions causes great difficulty in establishing definitive test methods
- Most likely premature to create regulations based on methods that yield uncertain results

Summary

- **Nanoparticles are variable in chemistry, structure, and geometry, and will undergo complex reactions with human tissue.**
- **No one measurement can be used to determine the safety of such particles.**
- **The uncertainty in measurements must also be taken into account.**