Outline

Concerns – Why is this important?
Nanotechnology Workshop
   Gaps - Recommendations
European Union - Status
What’s out there right now?
Getting to the Core of Things
Summary - Acknowledgements
Concerns

Let’s put this into perspective:  (According to Wikipedia)

What is a Nano particle?
A particle is defined as a small object that behaves as a whole unit in terms of its transport and properties… Similar to Ultrafine particles, they are sized between 1 to 100 nanometers.

What is an Ultrafine Particle?
Particles in the nanoscale, less than 100 nanometers…There are two main divisions that categorize types of UFPs. UFPs can either be carbon-based or metallic, and then can be further subdivided by their magnetic properties.
# Sources of NPs and UFPs

## Anthropogenic

**Engineered**
- Carbon-based Nanotubes, Fullerenes
- Metal Oxides
- Quantum Dots
- Nanotubes
- Nanowires
- Dendrimers

**Incidental**
- Particles from:
  - Combustion
  - Industrial Processes
  - Vehicles
  - Construction

## Natural

- Particles from:
  - Plants, Trees
  - Oceans, other water bodies
  - Erosion
  - Dust
Concerns

There are numerous health effects

• Pulmonary inflammation
• Early interstitial lung fibrosis and granulomas
• Asbestos-like pathogenicity
• Translocation from respiratory tract
  – Oxidative damage in human blood serum
  – Inflammatory and pro-clotting effects in blood
Concerns

What is it that causes these symptoms?

– Size
– Shape
– Composition
– Solubility
– Crystalline structure
– Charge
– Surface characteristic
– Attached functional groups
– Agglomeration
– Impurities
Nanotechnology Workshop

March 3-4, 2009: EPA and Battelle Hosted a Workshop on Monitoring

Technology Needs and Gaps
Implications and Drivers Discussion
Technology Needs Discussion
Path Forward/Actions

EPA – OAQPS’ Goal:
– What are the technology gaps and needs?
– What will it take to fill those gaps?
– What do we present to EPA management?
Nanotechnology Workshop Findings

A literature search should be performed to identify all available types of NP air measuring devices.

The Agency needs to define whether NPs should be classified as a subset of UFPs or classified independently.

Technology that has been developed for UFPs should be investigated as the “springboard” to launch technology development for NPs. The ability to collect and “count” UFPs is a mature technology.

UFPs and NPs should be regulated in the same manner.

A collaborative group should be formed from different organizations to lead an effort to identify the best available air monitoring.
Nanotechnology Workshop Findings

Individual Particle Techniques

- Electron Microscopy (SPM, SEM, TEM)
- Electron Diffraction

Ensemble Techniques

- Photon based Spectroscopy (FT-IR, NMR)
- X-ray (scattering, spectroscopy)
- Mass Spectrometry
- Reverse Chromatography

Metrology Standards

- 3-D Characterization Standards
- Dispersion and Distribution
- Interfacial Interactions
- Interphase Properties

March 2-3, 2009
European Union UFP’s

• In 2005 the EU adopted the “Thematic Strategy on Air Pollution” - part of the “Clean Air for Europe (CAFE)” program

• EU established a starting point for particle number based limits for emission of UFP’s from light duty vehicles with diesel engines

• $6 \times 10^{11}$ particles/km - phased in - 2010 to 2012
EU-Life UFIPOLNET Project

Objectives

Design a new UFP monitor for air quality networks

- Affordable (initial cost & total cost of ownership)
- Easy to install, use and maintain
- Easy to integrate into existing station data acquisition
- Well suited for continuous monitoring

Four European sites with different particle characteristics were chosen:

- Street Canyon in Stockholm, Sweden (very high PM concentration)
- Street tunnel entrance in Prague, Czech Republic (medium PM concentration)
- Street intersection in Dresden, Germany (medium PM concentration)
- Urban park in Augsburg, Germany (urban background)
EU TSI UPFs Instrument

Sampling system of UFP 330 implemented at all 4 stations (Hillemann/Wehner)
NY UFPs instrument

TSI 3031 Features and Benefits

- Long-term, unattended operation
- Low start-up and operating costs
- No working fluids; no radioactive source
- Convenient data management with remote access via the Internet
- Continuous measurements every 10 minutes
- Optional environmental sampling system
NY UFP Data

Diurnal Profile Long Island, NY  6/24 -30/09
Aerodyne Research, Inc.- Aerosol Chemical Speciation Monitor (ACSM)

Size: 19”D x 21”W x 33”H

Weight: 140 lbs

Power: 300W

AC power; 120/240 VAC, 50/60hz
What's out there? - ACSM
What’s out there? - ACSM

- Continuous monitoring of non-refractory aerosol composition (40-1000 nm) by thermal particle vaporization aerosol mass spectrometry (0-200 amu).
  
  Sulfate, Nitrate, Chloride, Ammonium, Organics.

- Builds on ARI Q and ToF AMS concepts
  
  lower cost, lower sensitivity.

- Designed for long term unattended operation.

- Data acquisition and control via Ethernet connectivity, basic laptop computer is sufficient
Getting to the Core of Things

UFPs/NPs can be the core of fine/coarse particles

UFP/NPs are generally emitted, not coalesced, fine particles are.

UFPs/NPs can get many different layers and grow over extended time.
Getting to the Core of Things
Getting to the Core of Things
CCN-Soot Particle Experiments

Source

nascent soot particles hydrophobic

Atmospheric processing oxidation, coating etc.

Hydrophilic particles

Indirect effect

Oxidation by OH

SMPS

CCN counter

AMS
Summary

• There is a growing concern about NP/UFPs
• From the Workshop many issues were expressed
• There’s a plethora of ways to identify/quantify NP/UFP
• EU has already instituted a standard and network –Using particle counting
• Instruments, like the TSI 3031/ACSM look promising
• UFPs/NP are at the core of many different monitoring issues: Global Warming, fine and coarse particles
• We need to be able to strip away the fine particles to see what’s underneath – Paul Davidotis: Boston College
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