Identification of Suitable Substrate for Assessing Personal Exposure to Nanoparticles by Transmission Electron Microscopy

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Background

Nanoparticles (<100 nm diameter) are shown to be particularly toxic when inhaled. Adverse health effects are more strongly related to particle number or surface area than mass concentration. Sampling methods to assess personal exposure to number or surface area concentration are unavailable.

Sample analysis by transmission electron microscopy (TEM) would allow distinction between engineered and incidental nanoparticles. This ability may be critical in assessing workplace inhalation hazards.

An appropriate deposition surface compatible with TEM analysis is needed for incorporation into novel personal samplers that our group and others are developing.

Objective

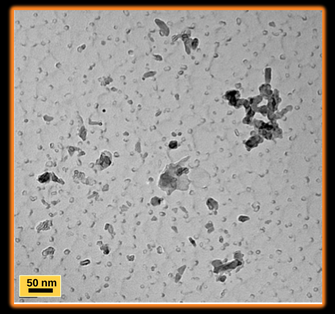
Identify an appropriate deposition surface for analysis of nanoparticles by TEM

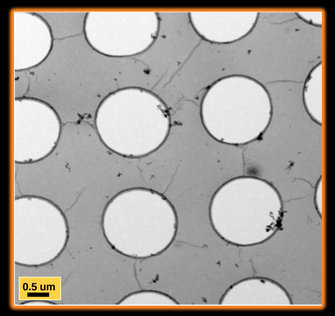
Methods

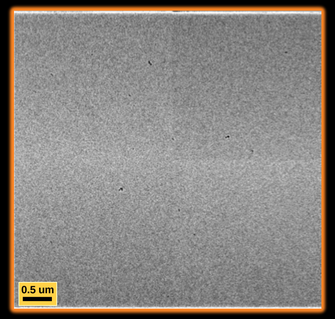
- Collect particles on various substrates
- Image particles byTEM
- Size particles with ImageJ software
- Compare size distribution to real time equipment output (SMPS)

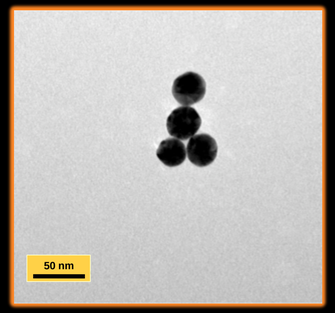
Implications

- TEM analysis allows
  1) sizing and counting of nanoparticles
  2) distinction between engineered and incidental nanoparticles
- Distinction is critical to assess workplace health effects
- Deposition substrate is crucial for development of passive and filter samplers
- Novel sampling methods will help assess personal exposure to number or surface area concentration

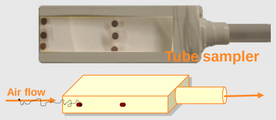








Results

Particles	Collection Process & Sampling Media	Expected mean diameter	Measured mean diameter	Standard Deviation	Pros and Cons
Occupational aerosol from facility that produces lithium titanate nanomaterial	Collected on Mixed Cellulose Ester filter Direct-transfer method used to collapse filter onto carbon coated formvar on TEM grid	20 nm – 2 um	Not Calculated	Not Calculated	Background noise makes it difficult to clearly size particles using computer software
Diesel particles from an electric generator in exposure chamber	Airflow passed around and through carbon coated holey –formvar TEM grid mounted on filter U. Mathis et al. / Atmospheric Environment 38 (2004) 4347–4355	50 nm	52.32 nm	4.29 nm	Greater particle collection than tube sampler Holes useful to increase deposition with active filter sampling Large holes in background pose problem for sizing software
Diesel particles from an electric generator in exposure chamber	Airflow passed over carbon coated formvar on TEM grid; particles deposit by diffusion 	50 nm	53.21 nm	7.3 nm	Lower collection because no flow through film Clean background Sizing consistent with real time equipment
Gold nanoparticles dried from solution droplet	Drop of solution evaporated onto carbon coated formvar on TEM grid 	30 ± 4 nm	33.29 nm	3.05 nm	Clean background Optimal particle/background contrast useful to evaluate substrates

Conclusions

- **Carbon coated formvar TEM grid provides clearest background**
- **Clear background optimal for digital processing and sizing**
- **Tube sampler shows promise for depositing nanoparticles**

Future Research

- **Perform rigorous test of deposition substrates**
- **Incorporate substrate optimal for imaging into tube sampling method for nanoparticles**
- **Use method to distinguish airborne engineered nanomaterials from incidental nanoparticles**

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