Nanoparticles in Water
What’s Coming Down the Pipe?

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Nanotechnology 101

I have no idea what you're talking about...

...so here's a bunny with a pancake on its head.
Nanotechnology 101

- Engineered nanoparticles (i.e., anthropogenic)
- One axis <= 100 nm
- An enabler
- Quantum mechanics
- Novel properties (hang on, we’ll get there)
Where is it?

- Sunscreens
- Clothing
- Sports equipment
- Medical
- Agriculture
- 1,600+ nano-enabled products
- Increasingly everywhere
The bad news...

OH, THE HUGE MANATEE!
(Mis)behavior

- Persistent in surface waters
- Pass through controls
- Not removed (mostly) by treatment systems
- Kill or inactivate beneficial bacteria
- Harmful effects on living organisms
- Unexpected interactions in nature
How much?

• Hundreds of thousands of tons/year manufactured
• Releases during production, use, and disposal
• Pathways into water
The search

• Mostly unregulated
• Could your laboratory detect in water:
  o Nanoscale silver?
  o Nanoscale titanium dioxide?
  o Carbon nanotubes or buckyballs?
• Different techniques for different characteristics
• Are you looking for it?
• Should you be?
• Is a new method needed?
# Techniques

<table>
<thead>
<tr>
<th>Technique</th>
<th>Nano-object Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Concentration</td>
</tr>
<tr>
<td>Atomic Force Microscopy</td>
<td>✓  ✓</td>
</tr>
<tr>
<td>Brunauer-Emmett-Teller</td>
<td>✓</td>
</tr>
<tr>
<td>Condensation Particle Counter</td>
<td>✓</td>
</tr>
<tr>
<td>Differential Electric Mobility Analyzing System</td>
<td>✓  ✓  ✓</td>
</tr>
<tr>
<td>Differential Scanning Calorimetry</td>
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</tr>
<tr>
<td>Dynamic Light Scattering</td>
<td>✓  ✓  ✓</td>
</tr>
<tr>
<td>Electron Back-Scatter Diffraction</td>
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<tr>
<td>Electron Energy Loss Spectroscopy</td>
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</tr>
<tr>
<td>Fluorescence Spectroscopy</td>
<td>✓  ✓</td>
</tr>
<tr>
<td>Fourier Transform Infrared Spectroscopy/Imaging</td>
<td></td>
</tr>
<tr>
<td>Induced Grating Method</td>
<td>✓  ✓</td>
</tr>
<tr>
<td>Inductively Coupled Plasma – Mass Spectrometry and Single Particle ICP-MS</td>
<td>✓  ✓  ✓</td>
</tr>
</tbody>
</table>

Adapted from Perkin Elmer's: *Nanotechnology and Engineered Nanoparticles: A Primer*
Now, the good news
Now, the good news

- Groundwater remediation
- Kill or inactivate bacteria (sound familiar?)
- Imaging enhancement
- Filter technology
- Efficient fertilizer delivery
- Field devices
- Decreased sample size and prep time
Questions? (and thanks!)
References

• Are nanoparticles a threat to our drinking water?  
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• Evaluating Nanoparticle Breakthrough during Drinking Water Treatment  
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  http://pubs.acs.org/doi/abs/10.1021/es304023p

• The Project on Emerging Nanotechnologies: Consumer Product Inventory  
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• Nanotechnology and Engineered Nanoparticles: A Primer  
  http://shop.perkinelmer.com/Content/Manuals/GDE_NanotechnologyPrimer.pdf

• Forthcoming nanotechnology white paper from ELSC