Modifications of Nanoparticles in the Environment: Implications for Bioavailability

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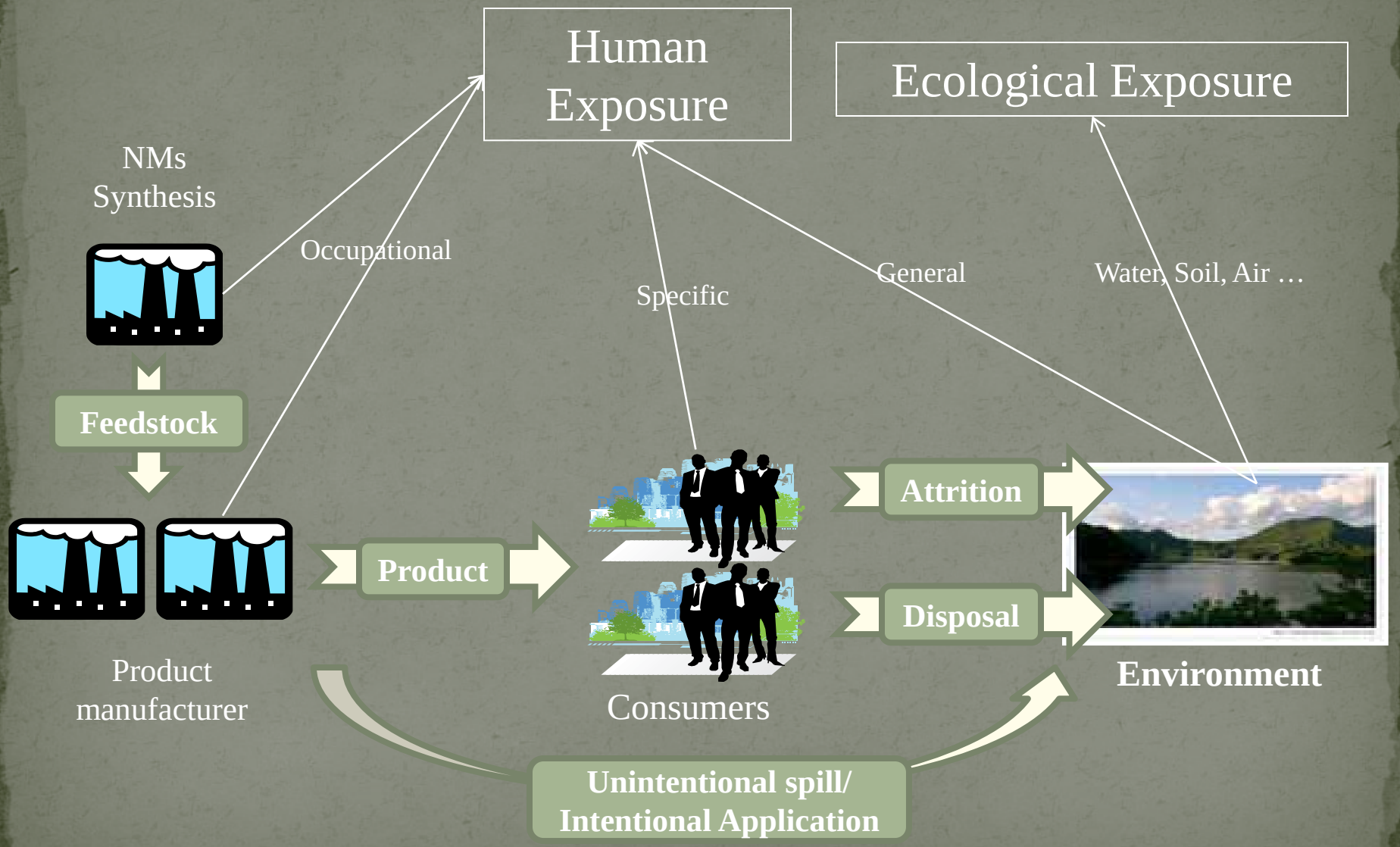
Nanomaterials in the Environment

- Entry
- Aging
- Fate
- Surface Modification
- Bioavailability

Release and Exposure of Nanoparticles



Kathleen Sellers, AMEC Inc.

Nanomaterials in the Environment: ENTRY

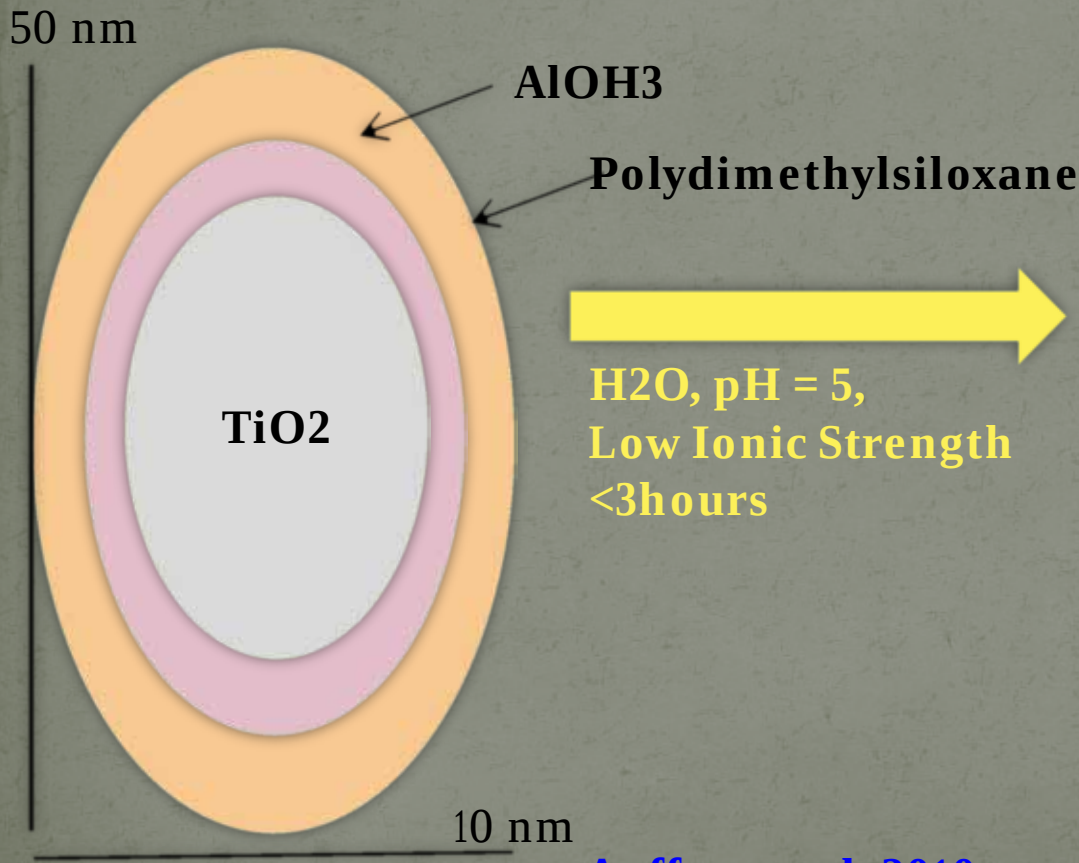
- Accidental Spill
- Direct Application
- Product Use
- Waste Discharge
- Leaching from Landfills
- Product Degradation

Nanomaterials in the Environment: AGING

- Degradation and Alteration of NP

Nanomaterials in the Environment: AGING

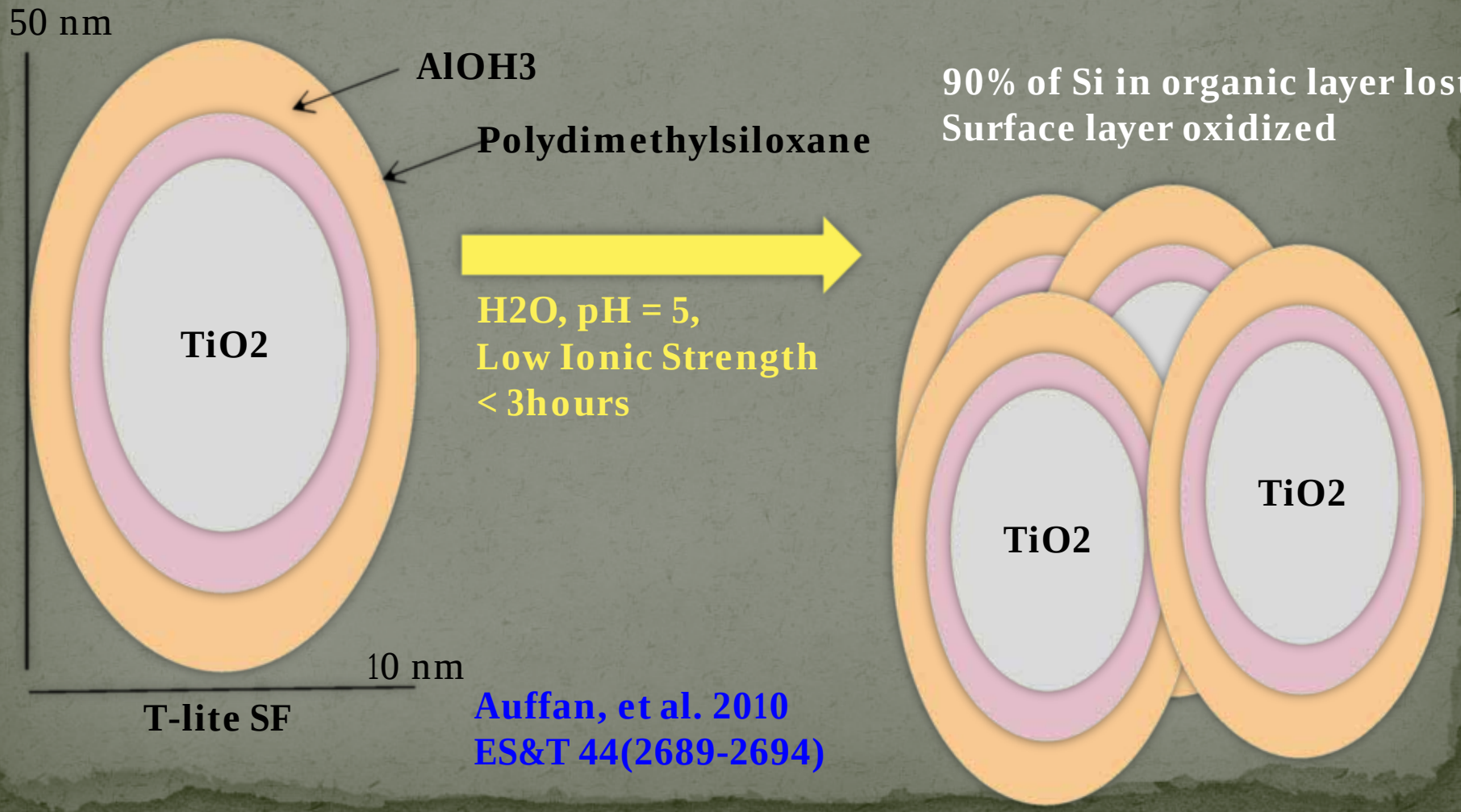
- Degradation and Alteration of NP



Auffan, et al. 2010
ES&T 44(2689-2694)

Nanomaterials in the Environment: AGING

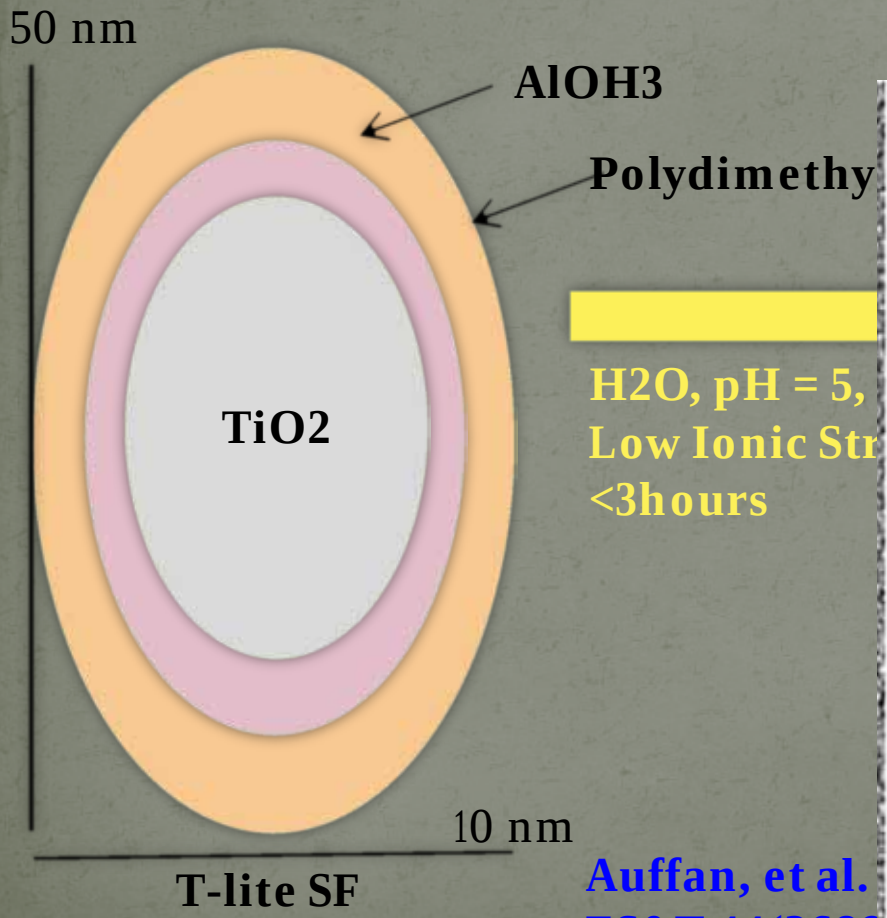
- Degradation and Alteration of NP



Auffan, et al. 2010
ES&T 44(2689-2694)

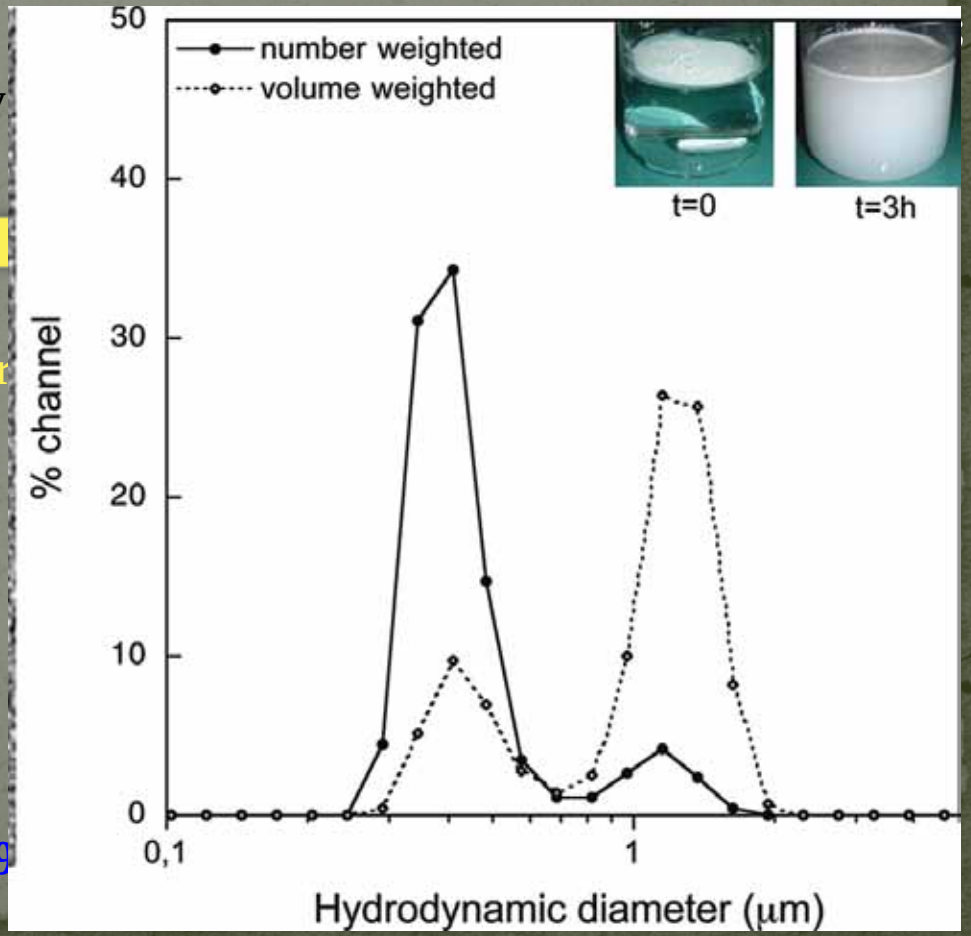
Nanomaterials in the Environment: AGING

- Degradation and Alteration of NP

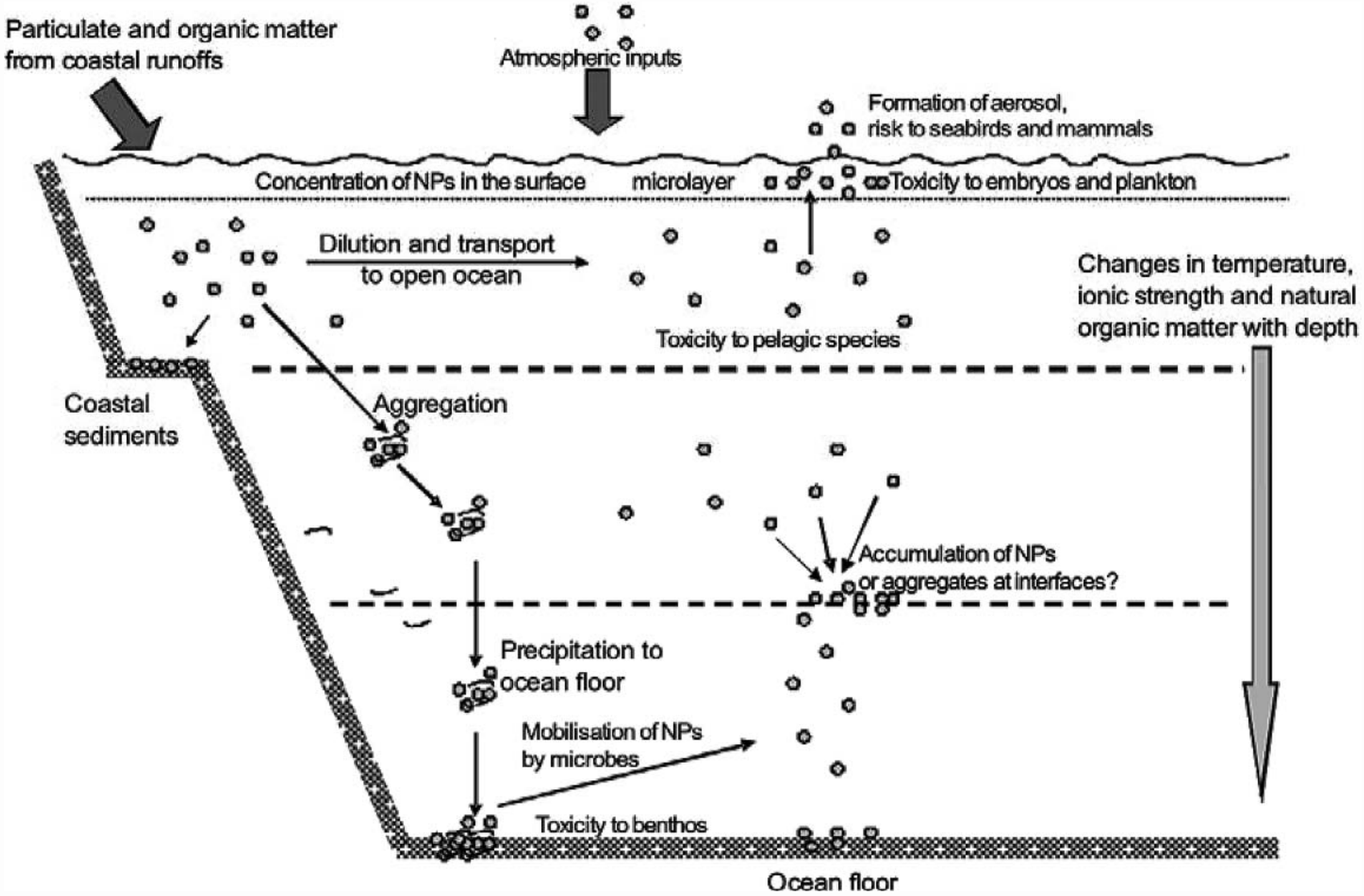


H2O, pH = 5,
Low Ionic Str
<3hours

Auffan, et al.
ES&T 44(2689



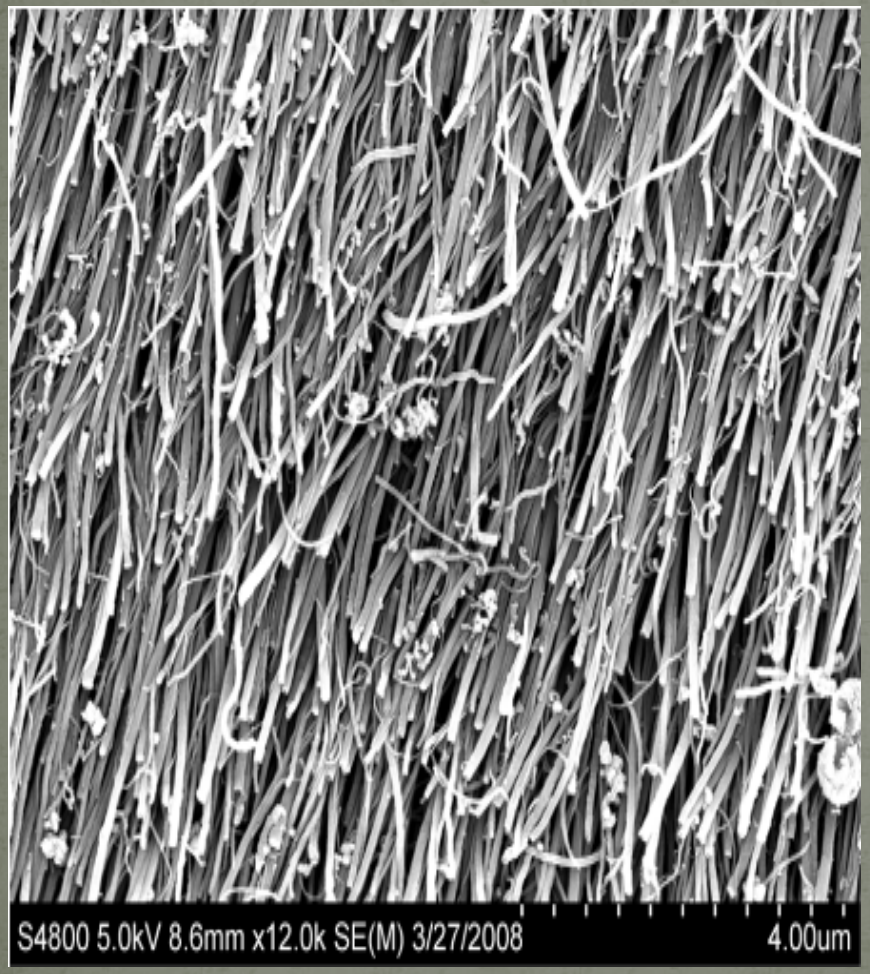
Nanomaterials in the Environment: FATE

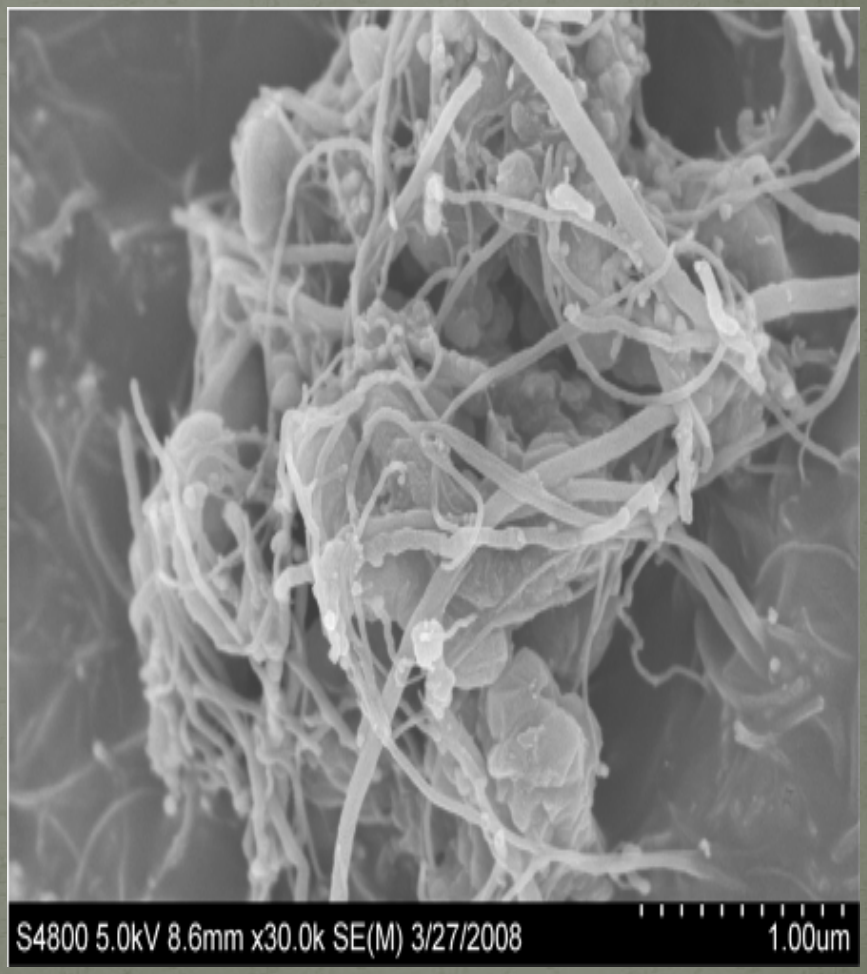


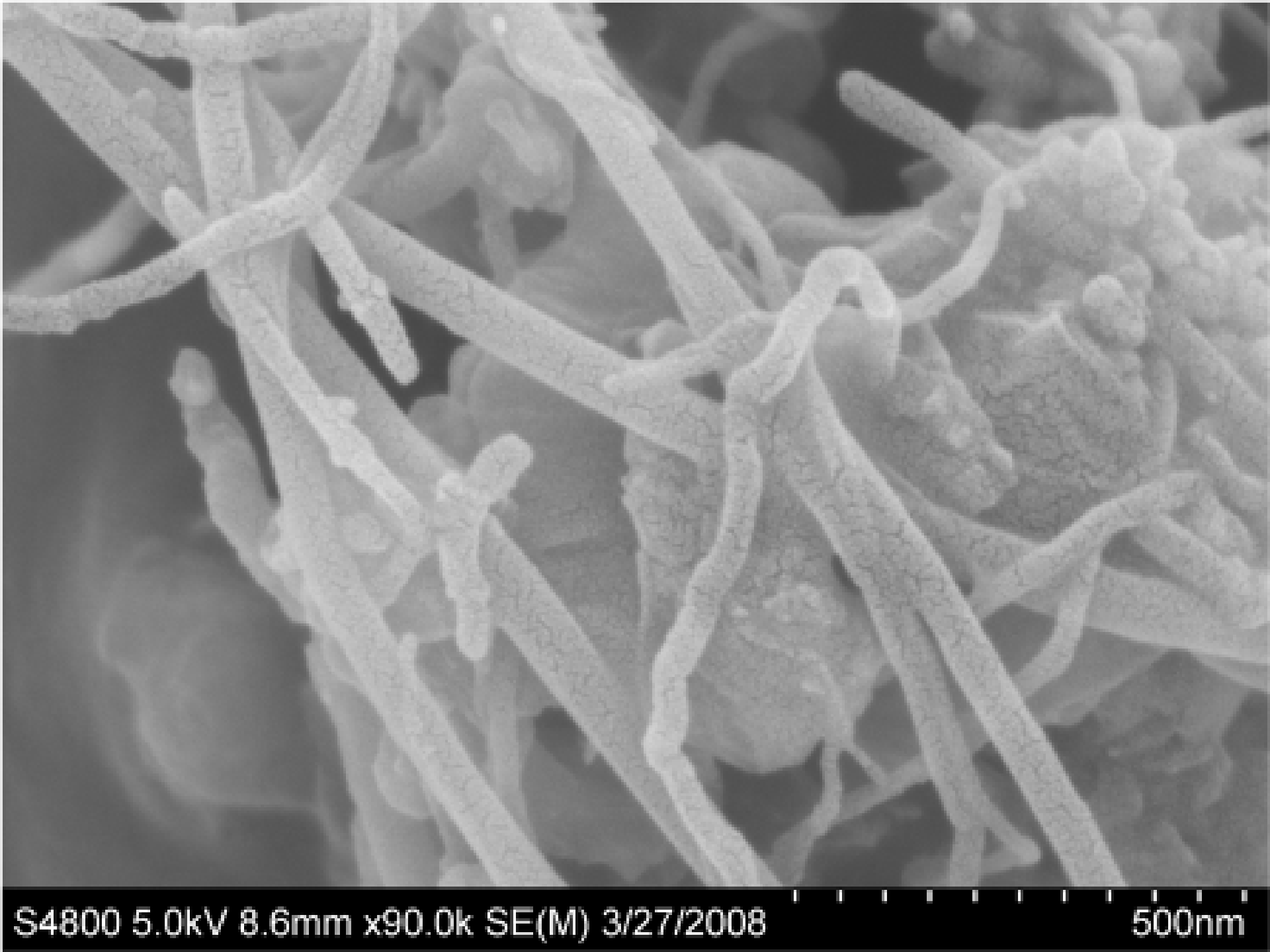
Nanomaterials in the Environment: SURFACE MODIFICATION

- Abiotic
  - Phot0-oxidation/hydrolysis
  - Adsorption of natural organics
  - Adsorption of contaminants
- Biotic
  - Macromolecules

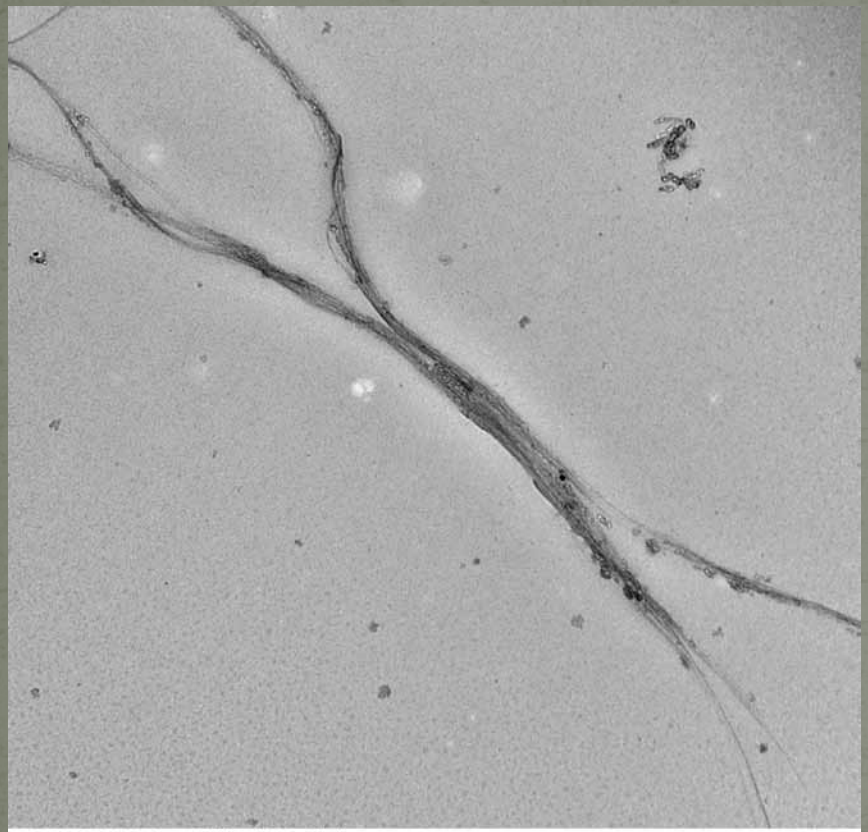
Surface Modification – NOM, MWNT

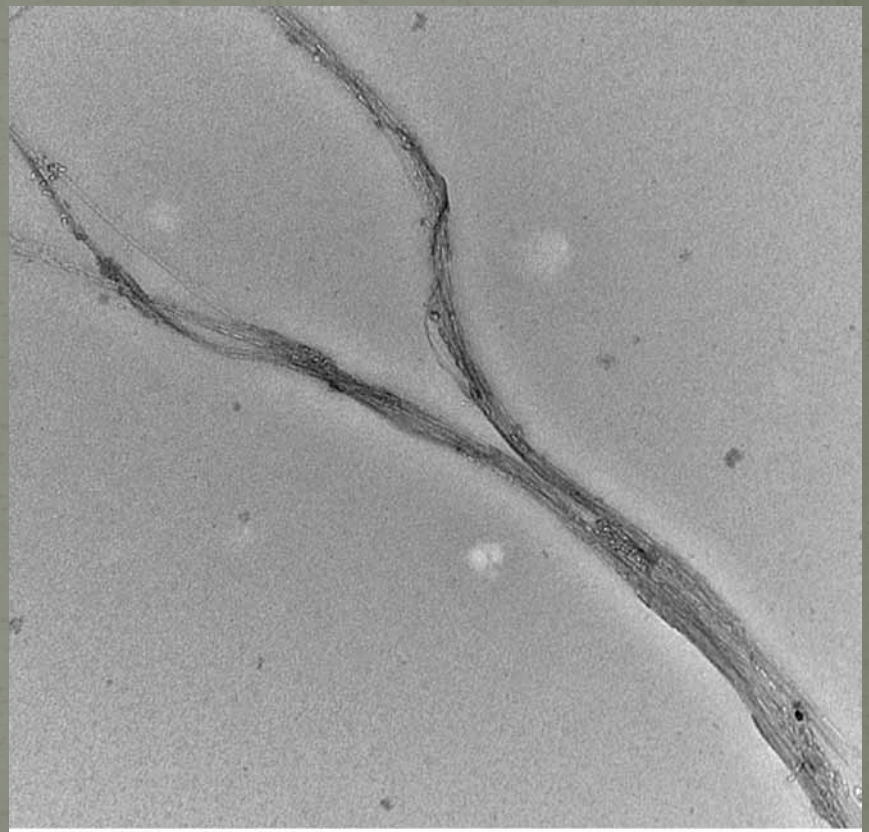





S4800 5.0kV 8.6mm x90.0k SE(M) 3/27/2008
500nm

OH-SWNT sonicated in 8% FBS

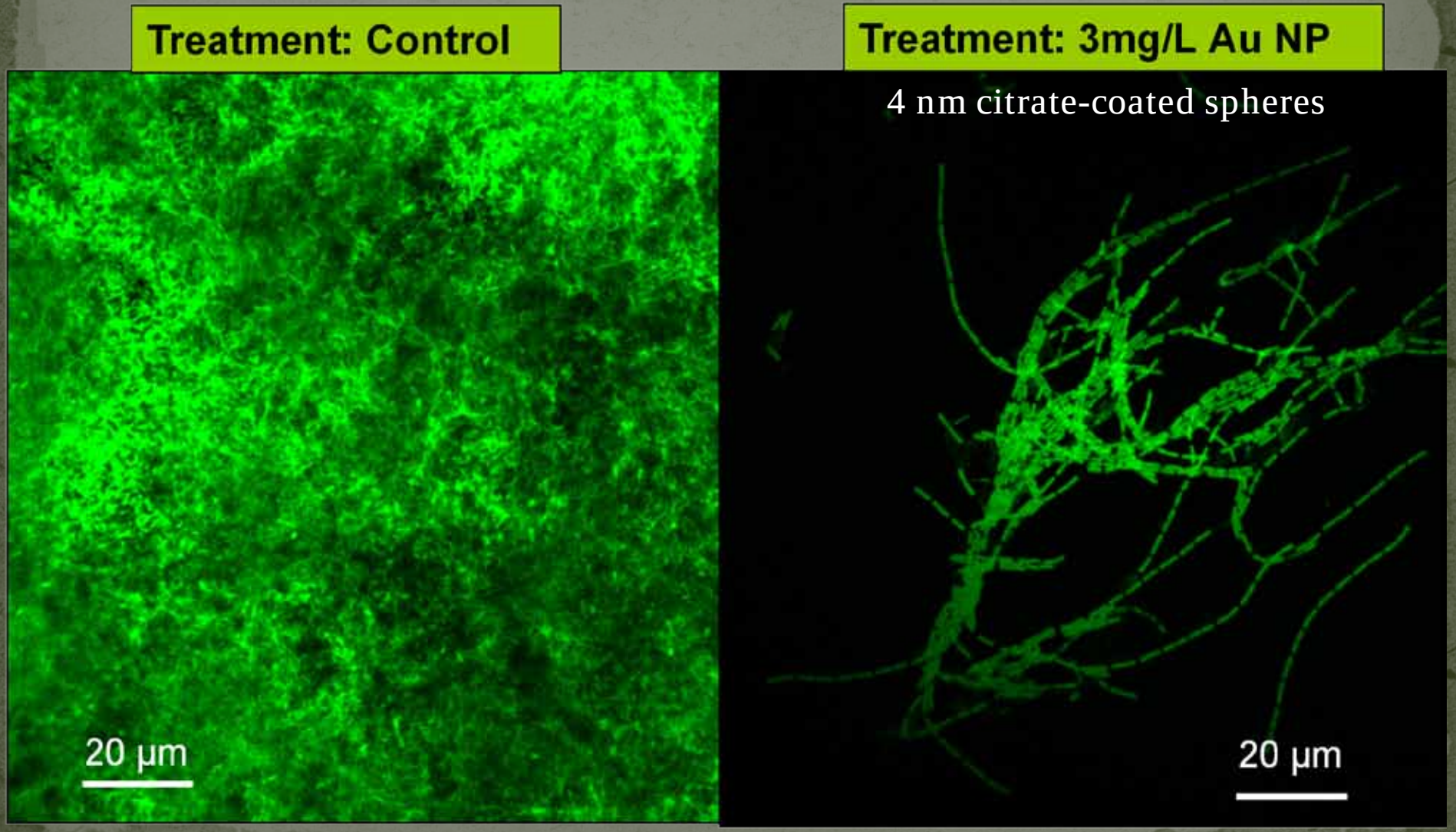




Nanomaterials in the Environment: BIOAVAILABILITY

- Physical Factors
  - Size
  - Shape (including aspect ratio)
- Chemical Factors
  - Core Chemistry
  - Surface Chemistry

Legionella sp. Biofilm

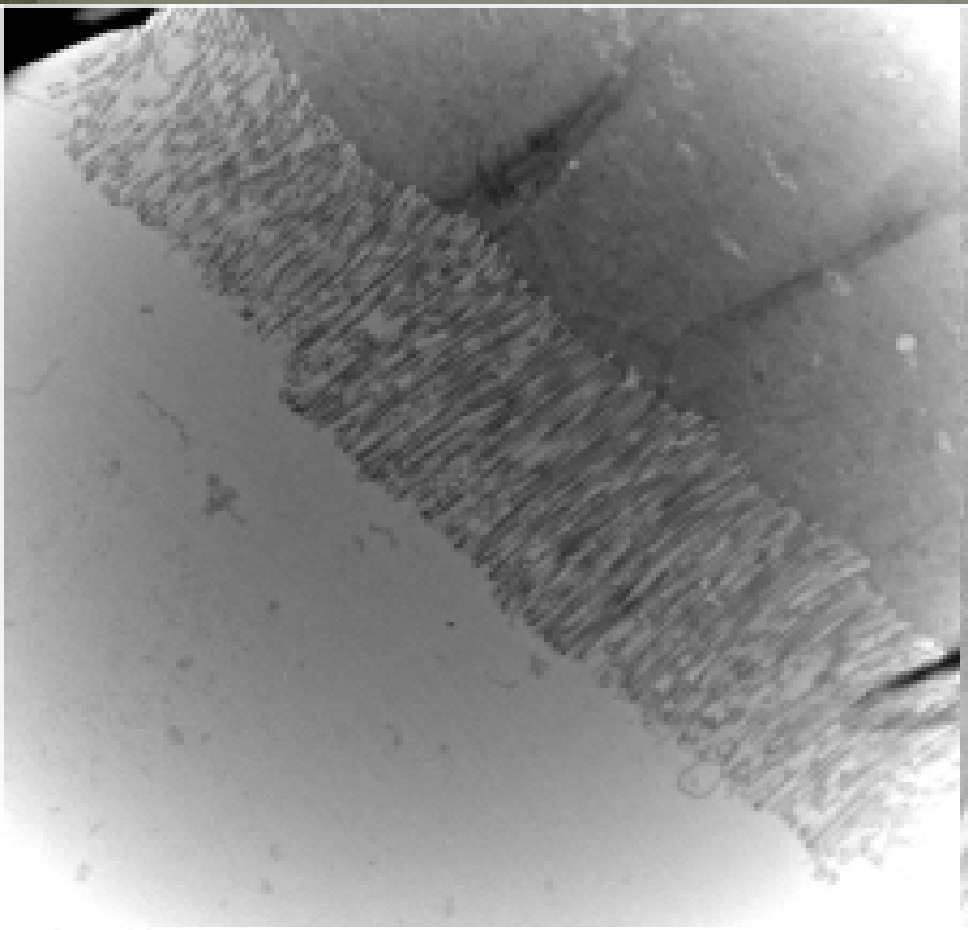


Nanomaterials in the Environment: BIOAVAILABILITY

- Surface Modified Carbon Nanotubes
  - NOM
  - Fetal Bovine Serum

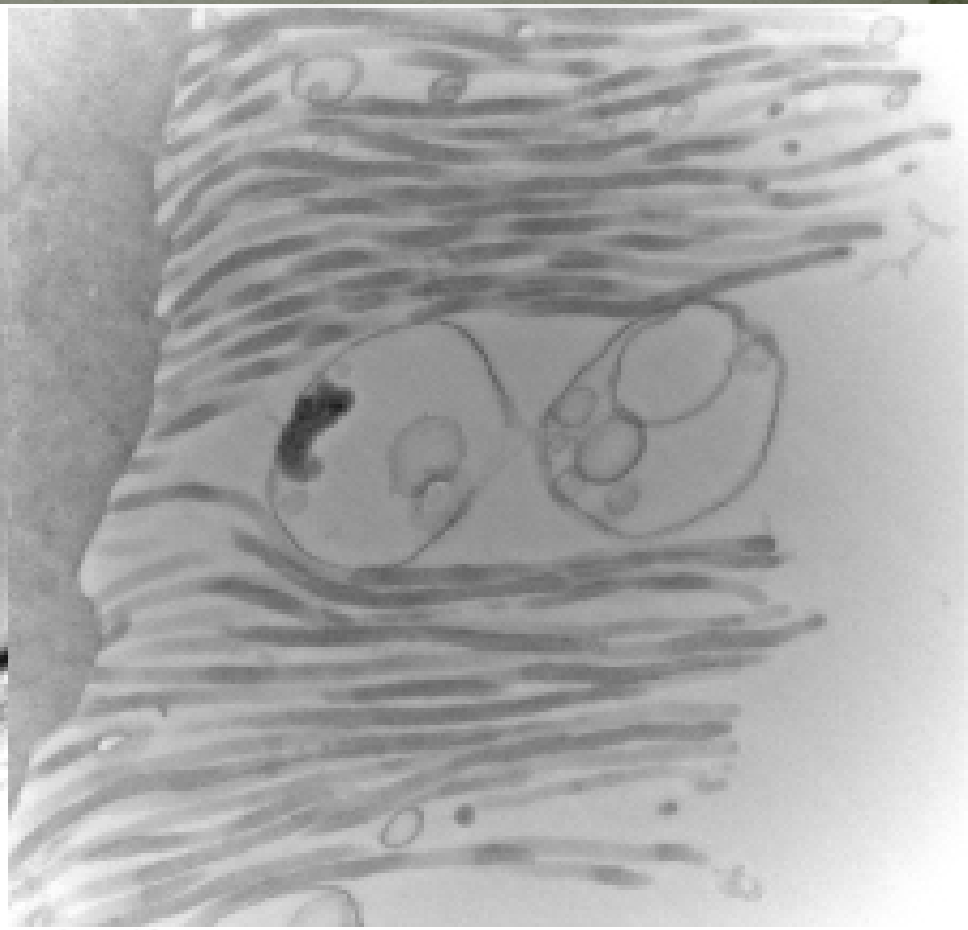
- Daphnia magna exposed to nanoparticle suspensions
  - Daphnids harvested, preserved, sectioned, stained
  - TEM of gut tracts

Control *Daphnia magna* gut tract



Ctrl03.tif
D. magna 96 hrs
Control Org
Print Mag: 2060x @ 51 mm
10:38 05/12/08

2 microns
HV=120kV
Direct Mag: 6000x
Clemson EM Center



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D. magna 96 hrs
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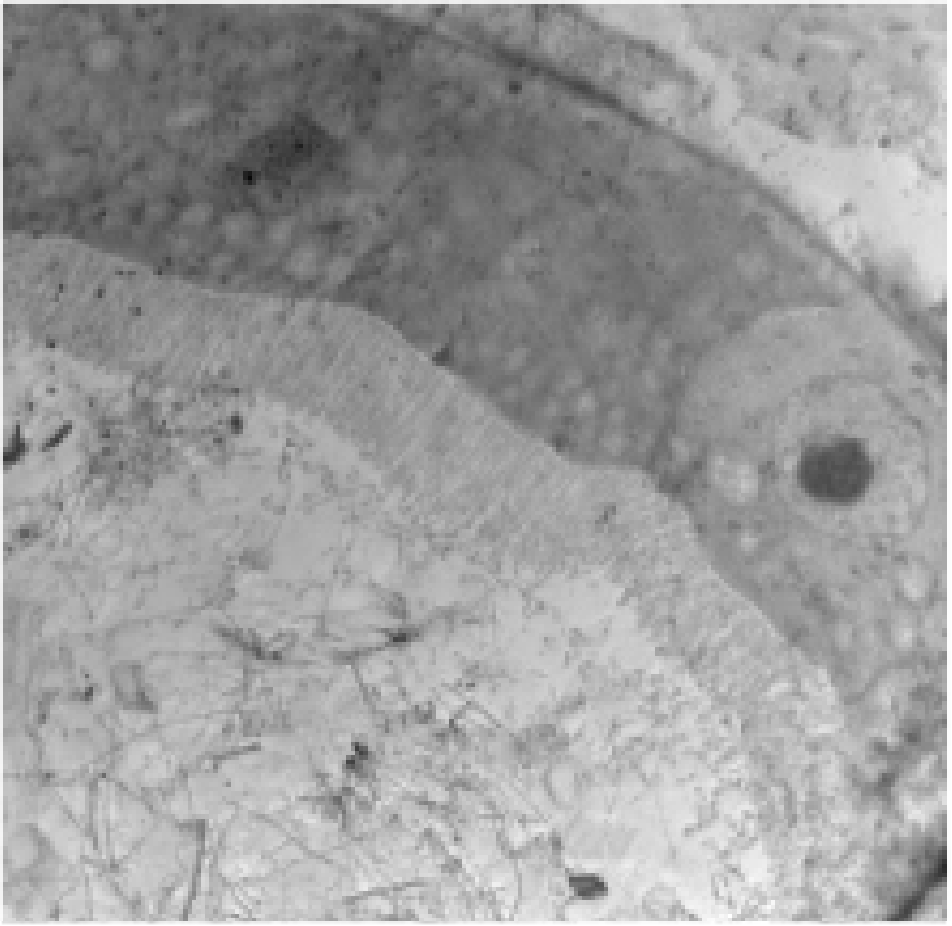
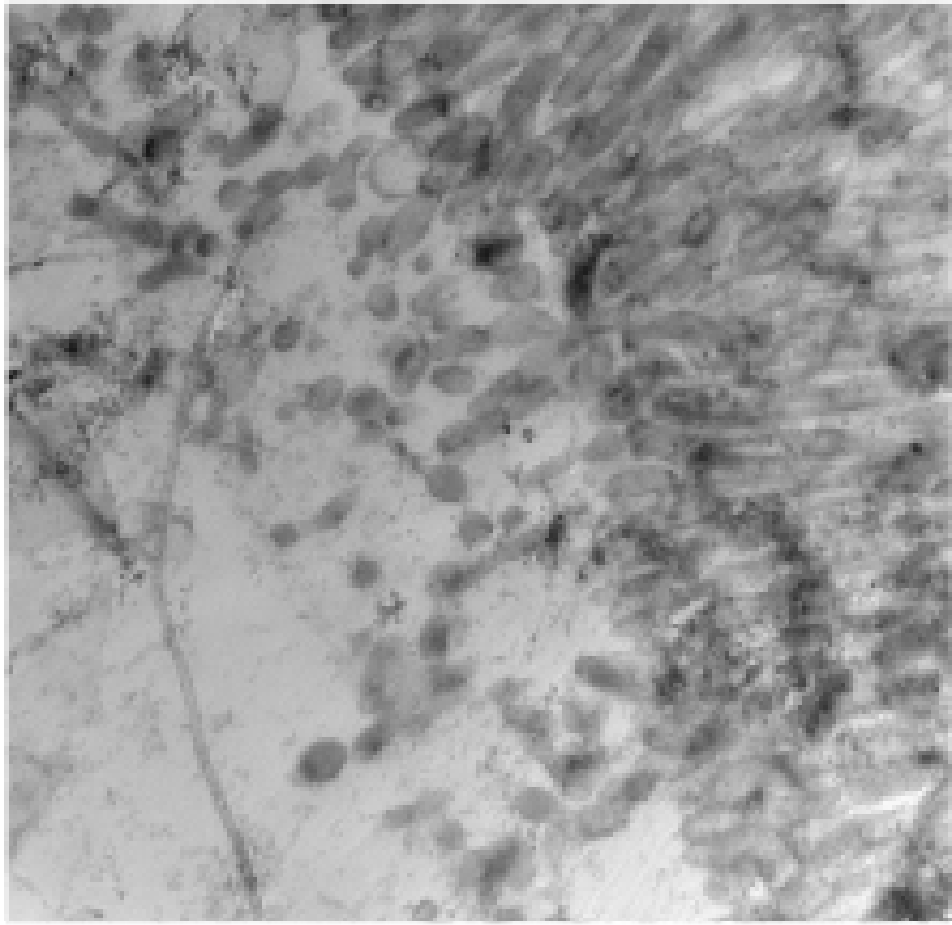
500 nm
HV=120kV
Direct Mag: 20000x
Clemson EM Center

NOM coated MWNT



DmagnaCiliaGut02.tif
Exposed D. magna .7 mg/L MWNT
Gut tract cilia
Print Mag: 2060x @ 51 mm
12:14 04/17/08

2 microns
HV=100kV
Direct Mag: 6000x
Clemson EM Center



DmagnaCiliaGut06highmag.tif
Exposed D. magna .7 mg/L MWNT
Gut tract cilia
Print Mag: 10300x @ 51 mm
12:29 04/17/08

500 nm
HV=100kV
Direct Mag: 30000x
Clemson EM Center

PEG Functionalized SWNT

PEG SWNTs D.tif
PEG-SWNTs D. magna
Print Mag: 6890x @ 51 mm
13:59 01/21/11
TEM Mode: Imaging

500 nm
HV=120kV
Direct Mag: 20000x
Clemson EM Center

PEG SWNTs D magna GA02.tif
PEG-SWNTs D. magna
Print Mag: 17200x @ 51 mm
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TEM Mode: Imaging

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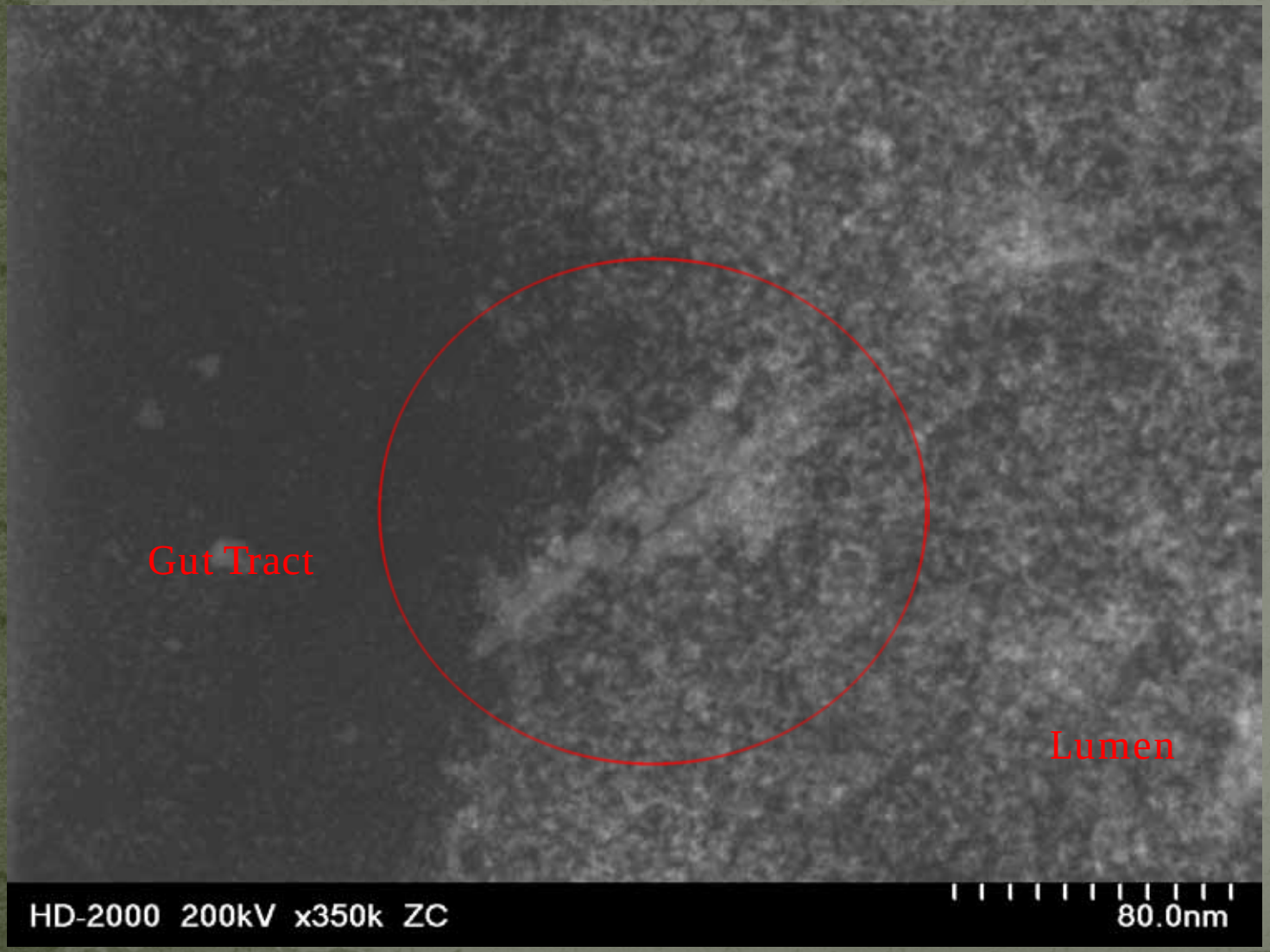
HV=120kV
Direct Mag: 50000x
Clemson EM Center

FBS coated OH-SWNT Images taken with HD 2000



This area is electron dense and has a uniformed "direction" to it, meaning it is long and slender much like a tube(s) would be.

FBS coated OH-SWNT
Images taken with HD 2000