Nano-Sized Particles in the Environment: Fate, Transport and Potential Impacts to Ecosystem Health

Bridging NanoEHS Research Efforts: A Joint US-EU Workshop

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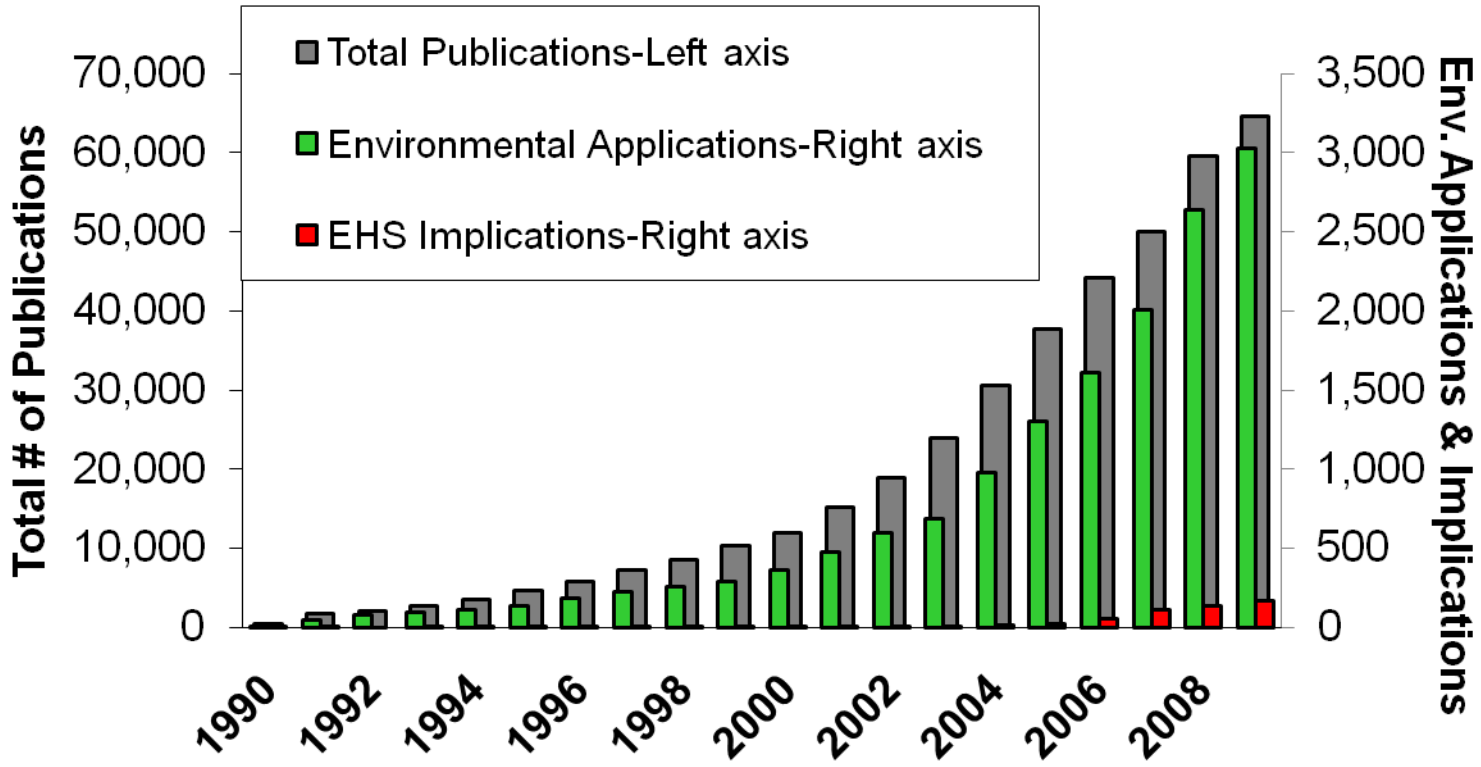
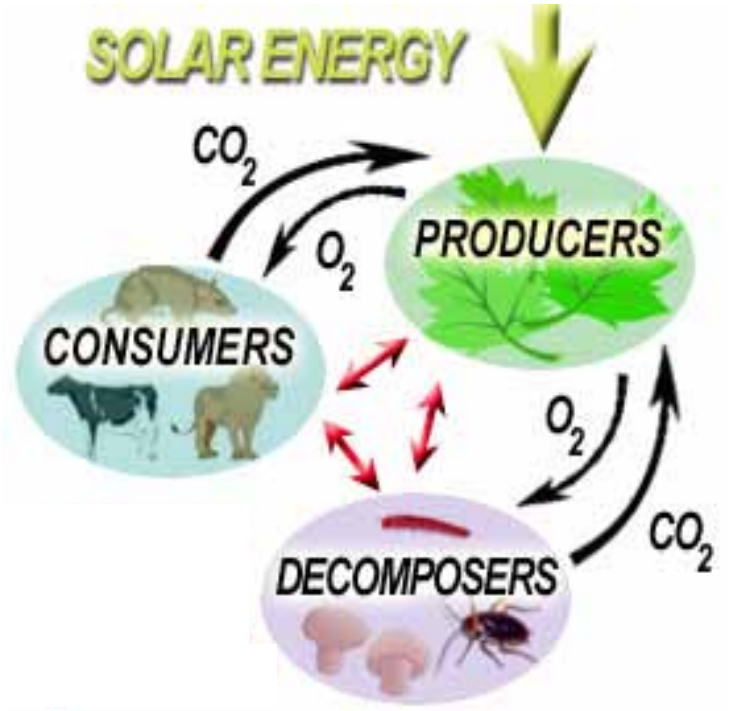
Growth of Nano-Related Publications
(3-year doubling time)



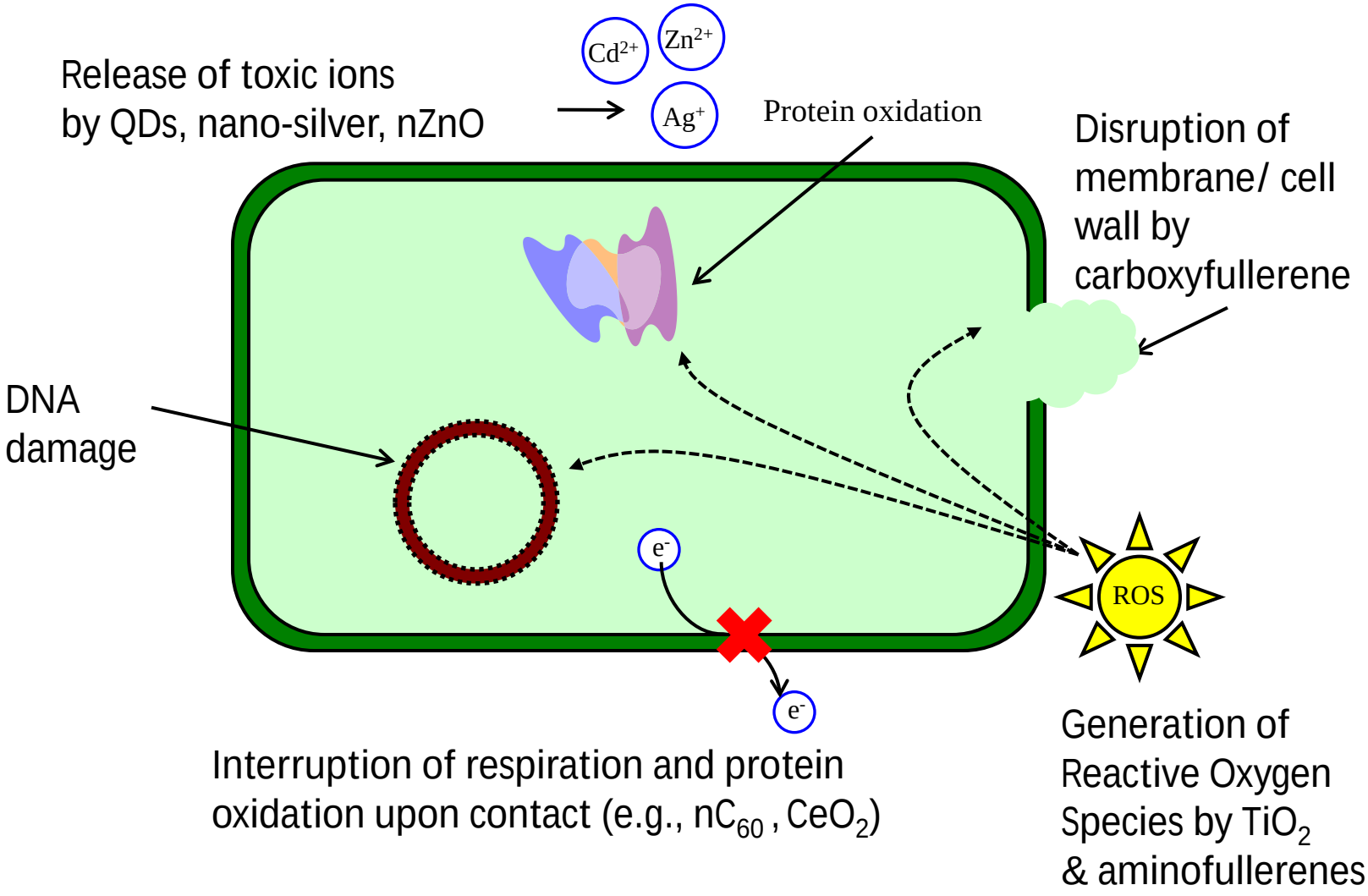
Source: Web of Science

Microbial-nanoparticle Interactions to Inform Risk Assessment

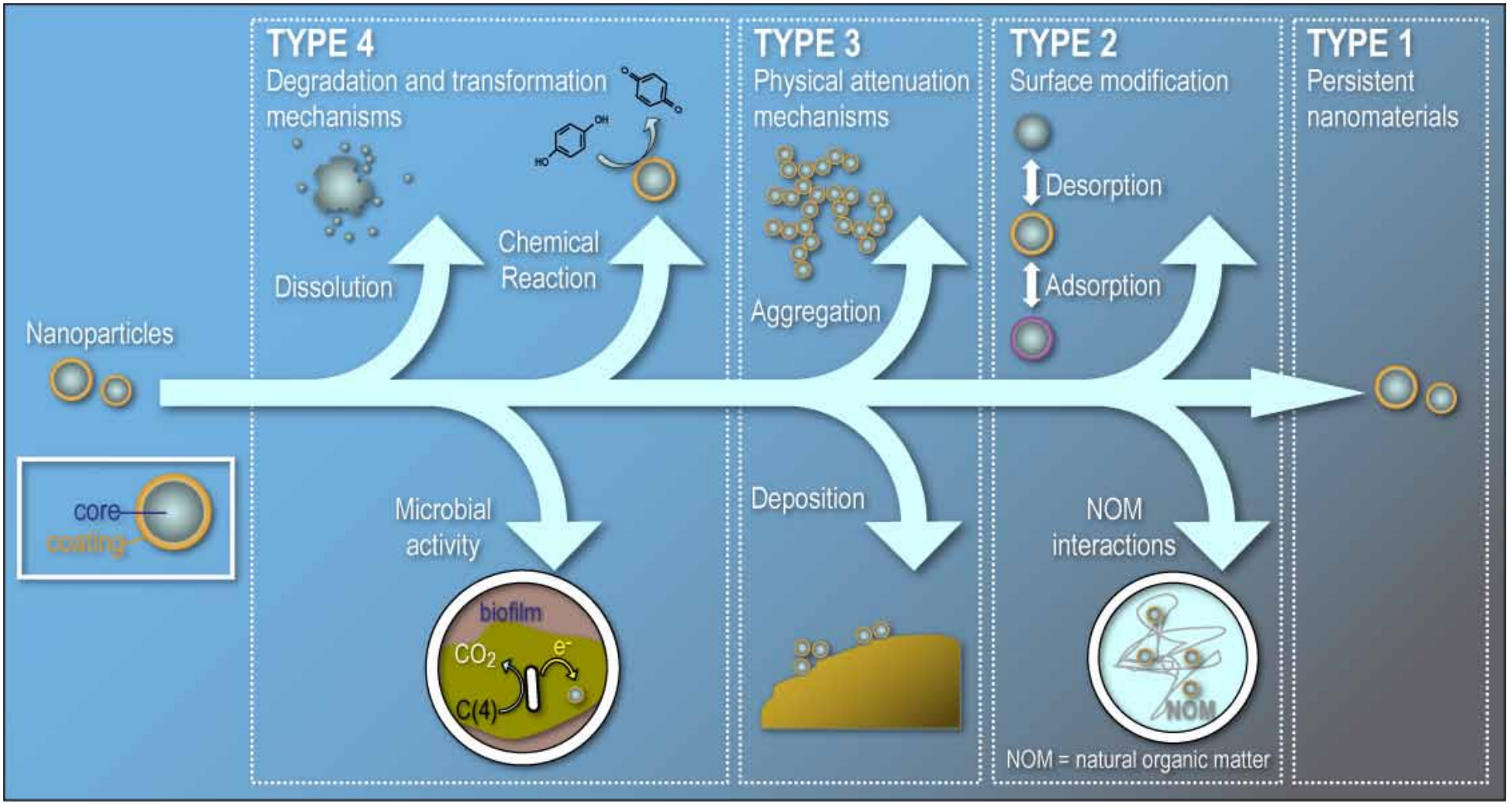


- Bacteria are at the foundation of all ecosystems, and carry out many ecosystem services
- Disposal/discharge can disrupt primary productivity, nutrient cycles, biodegradation, agriculture, etc.
- Antibacterial activity may be fast-screening indicator of toxicity to higher level organisms (*microbial sentinels*?)

Bacterial Toxicity Mechanisms

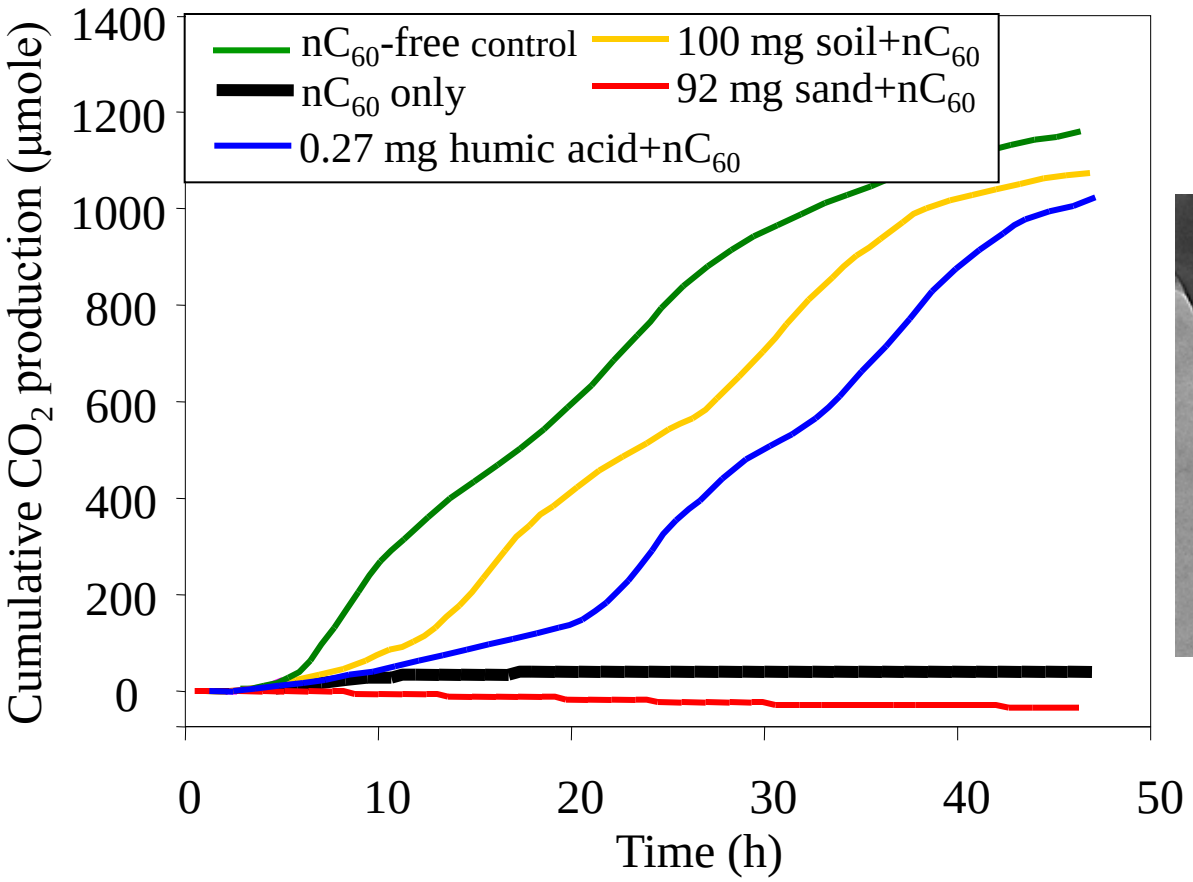


Nanoparticle Modifications in the Environment

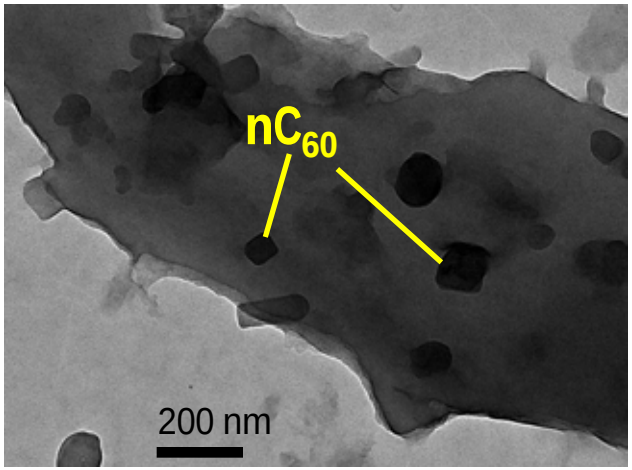


Alvarez P.J.J., V. Colvin, J. Lead and V. Stone (2009). Research Priorities to Advance Eco-Responsible Nanotechnology. ACS Nano 3(7): 1616-1619.

NOM reduces bioavailability & toxicity of nC_{60}



nC_{60} trapped by humic colloids

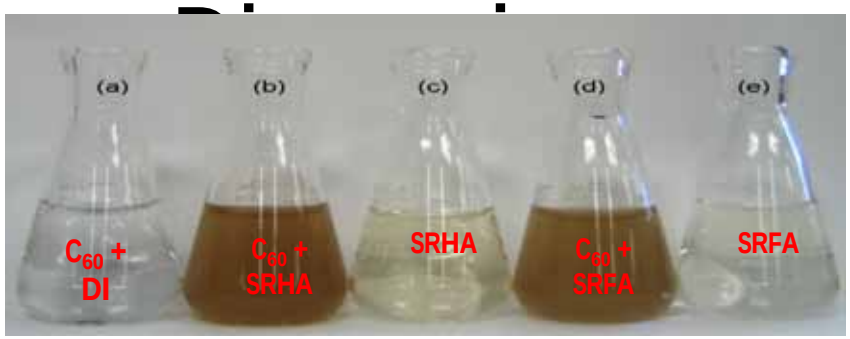


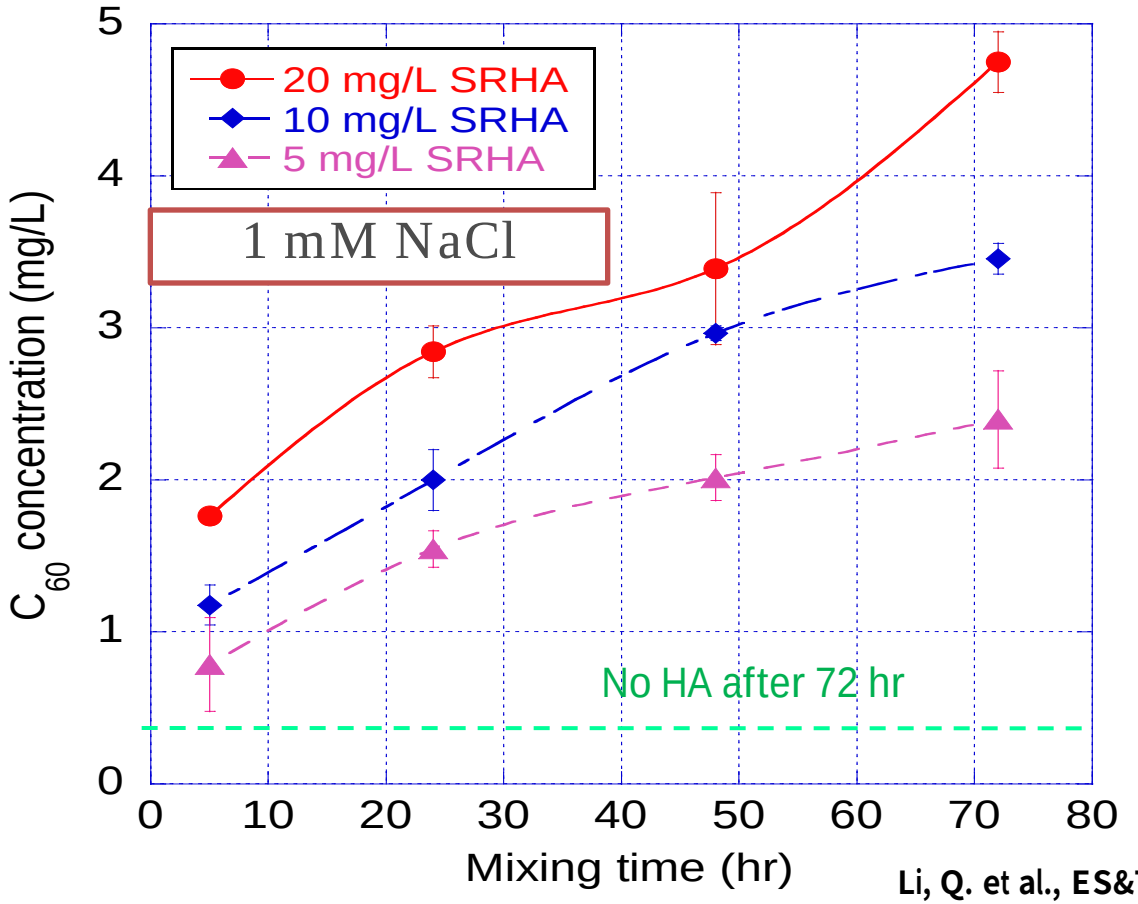
Humic acid concentrations as low as 0.1 mg/L eliminated toxicity

Li, D., Lyon D.Y., Q. Li, and P.J.J. Alvarez (2008). Environ. Toxicol. Chem. 27(9):1888-1894

Dissolved NOM Enhances C_{60}

- *Dispersed C_{60} was measured as dissolved TOC*

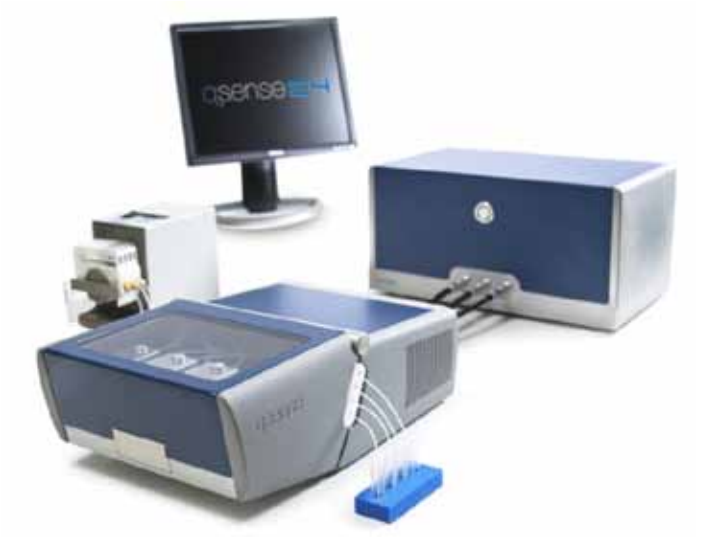


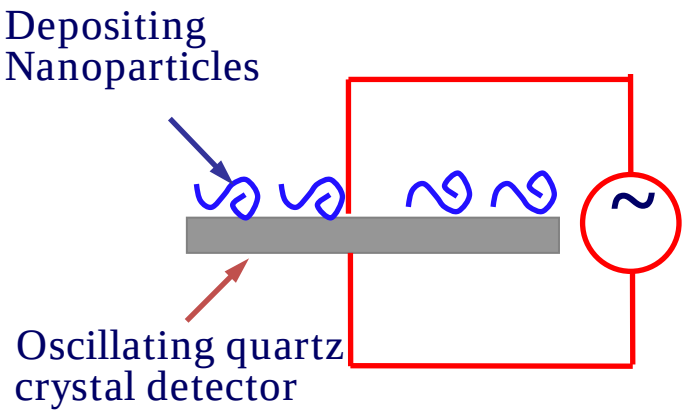


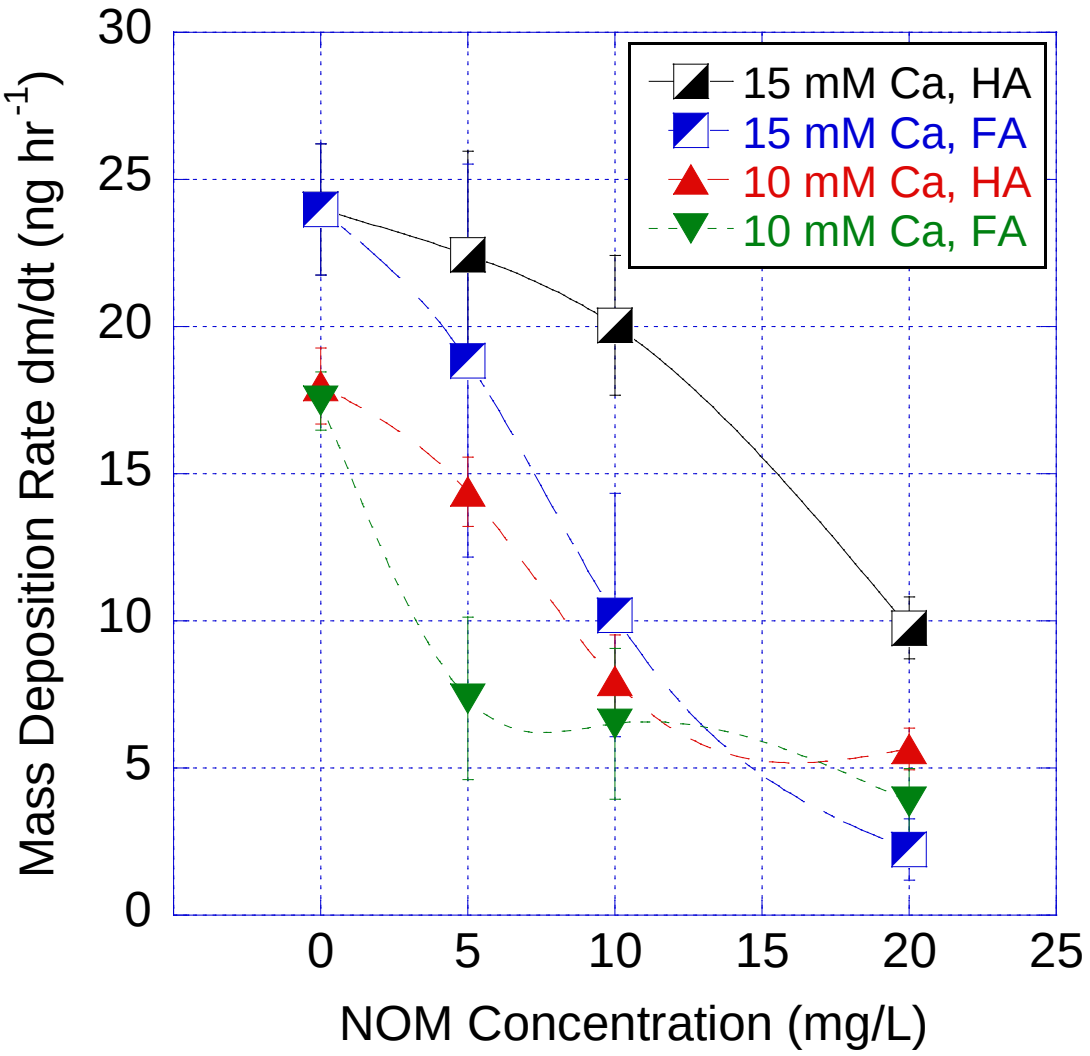
Li, Q. et al., ES&T, 2009, 43(10): 3574-3579.

Dissolved NOM Decreases nC_{60} Deposition onto a Quartz Surface, Increases Mobility in Water

Quartz Crystal Micro Balance



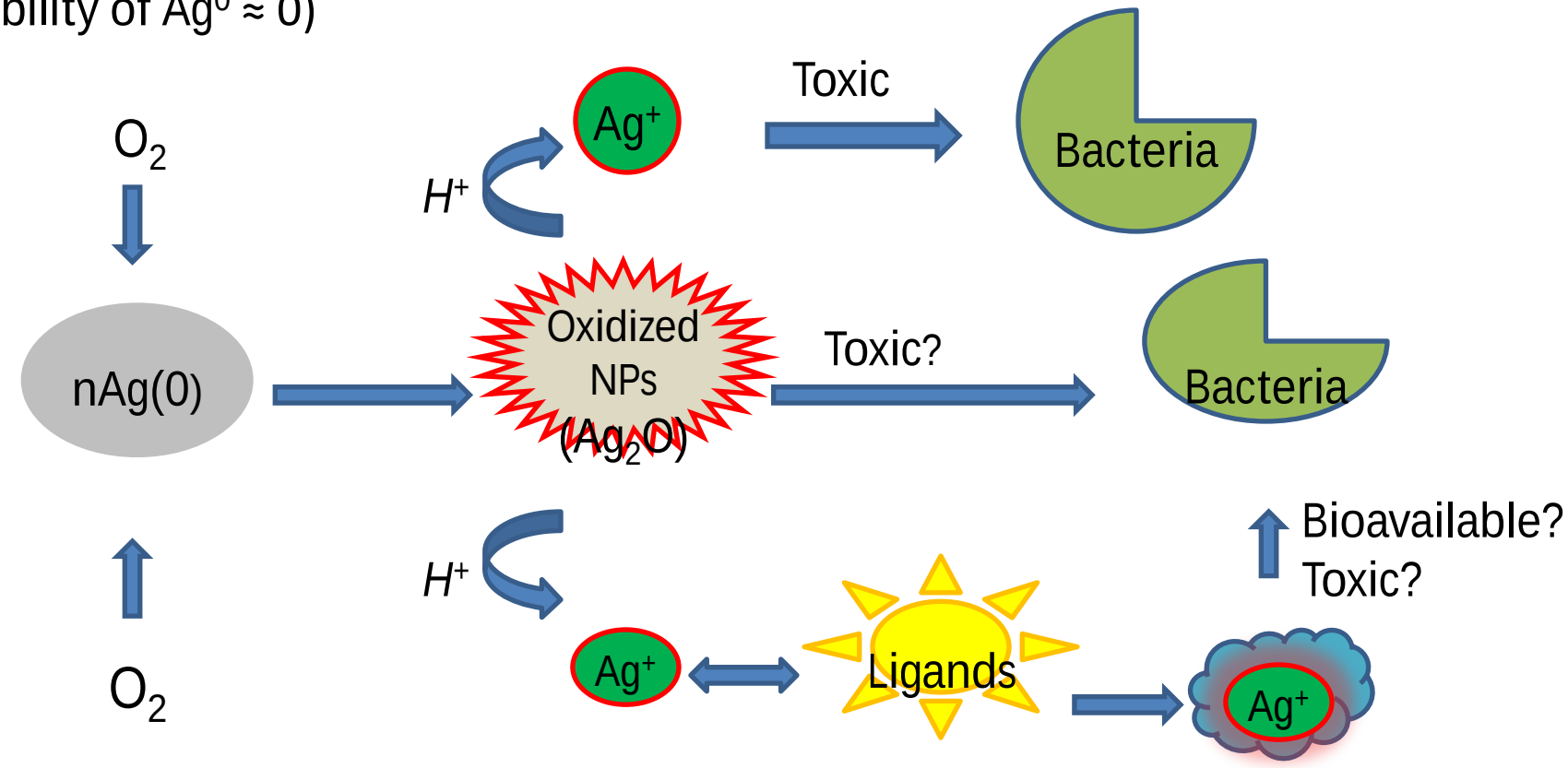




Bioavailability and Toxicity: nAg Example

Ag^+ is released only if nAg(0) is oxidized: $4Ag^0 + O_2 + 4H^+ \leftrightarrow 4Ag^+ + 2H_2O$

(Solubility of $Ag^0 \approx 0$)



Nanomaterials: **B**ioavailability and **E**nvironmental **E**xposure (funded by USEPA & NERC)

Cl^-, S^{2-}, Cysteine, CO_3^{2-}, HCO_3^-, SO_4^{2-}, PO_4^{3-}

Complexation?
Precipitation?

Risk = Hazard × Exposure

Hazard, but no exposure

Exposure but no hazard

Hazard as well as exposure

Synthetic Nanoparticles in Natural Water

Example

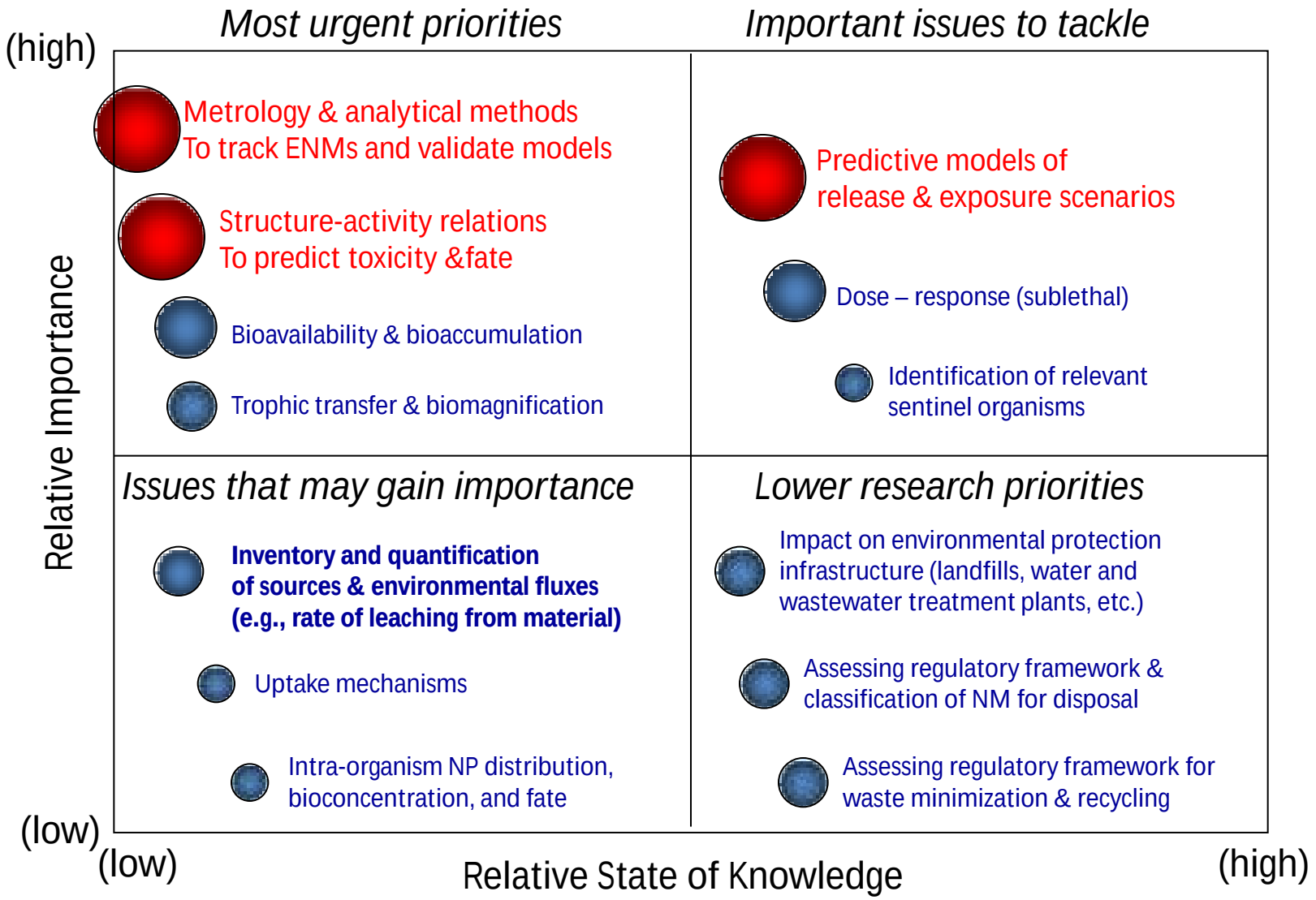
$1.5 \cdot 10^3$ manufactured nanoparticles/ml

10^8 natural nanoparticles/ml (erosion, eruptions, combustion, etc)

International Workshop on Priorities to Advance the Eco-Responsible Design and Disposal of ENMs (Rice University, March 9-10, 2009)

What critical knowledge gaps and opportunities exist to inform and advance the design of environmentally benign ENMs and the management of wastes containing them?

Towards Ecoresponsible Nanotechnology



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