Nanomaterials and Their Environmental Applications

Dr. Jason K. Holt
Chief Technology Officer, NanOasis
jason.holt@nanoasisinc.com

I'll begin this presentation with an overview of nanomaterials and many of the exciting applications they enable. Nanomaterials are broadly defined as natural or synthetic materials having at least one dimension less than 0.1 micron. On this size scale, materials exhibit numerous properties not seen in conventional bulk materials. For example, nanowires and nanotubes can allow ballistic (scatterless) electron transport, enabling possible next-generation microprocessors that beat the performance of silicon. Nanoparticles, on the other hand, exhibit unique optical properties (a consequence of quantum confinement) that make them useful as light emitting diodes and contrast agents for medical imaging.

Next, I'll discuss emergent environmental applications in this field, with particular focus on the novel fluid properties of one-dimensional nanomaterials. Here I will draw examples from both industry and academia. For example, spatial confinement within nanotubes leads to significant enhancements in water flow compared to other materials. Harnessing this effect on a large-scale could lead to next-generation membranes that reduce energy requirements for desalination (a key current bottleneck) by 30-50%. Other novel properties of nanomaterials are their atomic precision and high surface area-to-volume ratios. In an application such as oxygen separation, traditionally done by energy-intensive cryogenic processes, nanocomposite membranes could offer a much lower energy, high-selectivity alternative.

I'll then move on to discuss some of the key challenges in the area of nanofluidic membrane separations. These include the deaggregation and alignment of the consistuent nanomaterials, as well as the development of diagnostics for measuring flow on these length scales. I'll focus on some of the solutions that we and other colleagues have arrived at to address these challenges.

To conclude, I'll address future challenges for this field and some of obstacles that remain to commercializing some of the highlighted technologies. The goal of this presentation is to highlight that, while nanomaterials carry with them unique risks that must be studied and mitigated, there are numerous beneficial environmental applications that warrant continued investigation.