

**Lok Pokhrel** Evaluation of Aquatic Toxicity of Nanoscale Silver, Zinc Oxide, Titanium Dioxide and Cadmium Selenide Quantum Dots, and Their Ionic Particulates to the MetPLATE™ Bioassay

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Current understanding on potential toxicity upon exposure of aquatic microorganisms to engineered nanoparticles (NP) is limited for risk assessment and management. Rapid screening test such as MetPLATE™ bioassay is envisioned as a promising tool for screening potential toxicity of NPs to aquatic microorganisms. We tested five types of NPs (citrate-nAg, PVP-nAg, nZnO, nTiO<sub>2</sub>, and nCdSe Quantum Dots) using MetPLATE™ bioassay. MetPLATE™ bioassay is a simple, rapid and cost effective test that uses a mutant strain of Escherichia coli assay - the enzymatic activity of which is measured as the percentage inhibition compared to the untreated negative control. Toxicity of NPs was also compared with their corresponding dissolved ionic chemicals. The physicochemical properties of the NPs were characterized using dynamic light scattering (DLS), UV-Vis Spectrophotometry, Inductively Coupled Plasma-Mass Spectrometry (ICP-MS), and electron microscopy. Results showed that ionic Ag, Zn, and Cd were highly toxic than their corresponding NPs suspensions to the MetPLATE bacteria. However, both nano- and ionic-particulates of TiO<sub>2</sub> were not toxic at concentration as high as 2.5 g/L. Moreover, fractionating nAg using 10 KD polysulfone hollow fiber membranes allowed us to distinguish nAg-specific toxicity from dissolved Ag ions toxicity. We found that ionic-Ag toxicity was 16X and 2.25X more toxic than clean citrate-nAg and polyvinylpyrrolidone-nAg, respectively. As the dilution and bioassay matrix constituted moderately hard water, the NPs stability was evaluated as a measure of particle size distributions (PSD) using DLS method. The observed nanotoxicity is explained based on the particle size distributions (PSD), zeta potential values, and sedimentation of the particles in the suspensions. Although we found that the tested NPs are relatively less toxic than their ionic forms, we caveat to disposing NPs into the receiving waters as physicochemical properties of NPs may change with changeable water chemistry which may alter NPs toxicity.

**Mehrnoosh Behrooz** Acid Mine Drainage in Ore Knob Mine Tailings Pile– Impacts on Ore Knob Watershed

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Ore Knob Branch and Peak Creek within the New River Basin are classified as 'Not Supporting' due to discharge of acid mine drainage with high iron, sulfate, and low pH from a former copper/zinc mine located near Ore Knob. When the mine was active in the 1950s-60s, waste tailings were discharged into the Ore Knob watershed filling the valley bottom, forming a 9 ha, 21 m pile with high levels of iron, copper and zinc sulfides. Oxygen rapidly diffuses through the tailings pile surface, oxidizing the iron sulfide minerals (primarily pyrite and pyrrhotite) and producing large amounts of dissolved Fe<sup>2+</sup>, SO<sub>4</sub><sup>2-</sup>, and acidity. These pollutants are carried to the water table with infiltrating rainwater, and eventually discharge to Ore Knob Branch through a series of seeps on the downstream embankment face. Surface water has been periodically monitored at seven locations in the Ore Knob Branch and Peak Creek watersheds from March 2007 to August 2008. Surface water discharging from the tailings pile contains extremely high concentrations of ferrous iron (Fe<sup>2+</sup>), sulfate (SO<sub>4</sub>) and acidity. As this water migrates downstream along Ore Knob Branch, the pH decreases to 3.1, due to oxidation of Fe<sup>2+</sup> to Fe(OH)<sub>3</sub> and H<sup>+</sup>. A loading analysis indicates that approximately 403,000 Kg/yr of SO<sub>4</sub>, 106,000 Kg/yr of Fe<sup>2+</sup> and 242,000 Kg/yr of acidity are released to Ore Knob Branch from the tailings pile. Groundwater monitoring results indicates low iron concentration (12 mg/l) in the most upstream monitoring well compared with high iron concentration (1770 mg/l) in the most downstream wells showing the effect of tailings pile on pollutant generation. Most of the SO<sub>4</sub>, Fe<sup>2+</sup> and acidity are produced by oxidation of iron sulfides immediately below the tailings pile surface.