Environmental applications and implications of nanotechnologies

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Since the launch of the U.S. National Nanotechnology Initiative (NNI) in 2000, research and development in nanotechnology innovation has come a long way worldwide. Based on the Web of Science database, the total SCI-indexed papers surged from 971 in 2000 to 13, 546 in 2014, and the momentum remains strong. One of the most active and productive research fields has been environmental applications and implications of nanomaterials and nanotechnologies. Environmental nanotechnologies have shown great potential to fundamentally change the conventional practices in environmental cleanup. While the development of innovative cleanup technologies continues to evolve, our understanding of the environmental implications/impacts associated with the booming applications of nanotechnologies in various fields has also deepened. The objectives of this special issue were to: 1) promote exchanges of ideas and information on the latest development of environmental nanotechnologies, 2) facilitate development of more cost-effective and “greener” cleanup technologies based on innovative nanomaterials and nanotechnologies, 3) address limitation and potential environmental impacts of nanotechnologies and nanomaterials, and 4) identify major knowledge gaps and research directions.

Due to the capacity limit, we can only include 20 papers in this issue from a large pool of high-quality submissions, including 14 research papers addressing applications, four papers on environmental impacts/implications, and two critical review papers. The applications are focused on adsorption, and redox or catalytic degradation of contaminants in water and potentially in soil. The nanomaterials encompass carbonaceous nanomaterials including carbon nanotubes, hydroxyapatite, metal oxides, zero-valent metals including iron, metal catalysts, iron-carbon composite microspheres, and TiO₂ nanotubes. The implication papers address interactions of carbonaceous materials with wastewater biomass, effects of zinc oxide on soil microorganisms, effects of nano-silicon on lead in rice cultivars, and toxicity of engineered TiO₂ nanoparticles, whereas the critical reviews thoroughly examine applications of nano-sized magnetite and hollow nanomaterials. While most of these works deal with water treatment, it appears that more research is needed to develop novel in situ nanotechnologies for remediation of soil and groundwater and to address impacts of nanoparticles in the subsurface on the biogeochemical conditions. As environmental nano-research continues to thrive, we hope this special issue will inspire even greater innovation and discoveries in the field.

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