MECHANICAL & INDUSTRIAL ENGINEERING COLLOQUIUM: ME 794 002

The Effects of Electronic Structures of Metallic Nanoparticles on Photogeneration of Reactive Oxygen Species and Antibacterial Activity

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Abstract:

Oxidative stress induced by reactive oxygen species (ROS) is one of the most important antibacterial mechanisms of engineered nanoparticles (NPs). To elucidate the ROS-generation mechanisms, we investigated the electronic structure (i.e., the band gaps, valence and conduction band positions) on the ROS production kinetics of selected metallic nanoparticles including metals and metal oxides under room light and UV irradiation (365 nm). The results show that different metal oxides had distinct photogenerated ROS kinetics under the same environmental conditions. Particularly, TiO_2 nanoparticles and ZnO nanoparticles generated three types of ROS (superoxide radical, hydroxyl radical, and singlet oxygen), whereas other metal oxides generated only one or two types or did not generate any type of ROS. Similar observations were achieved for metal NPs (e.g., AgNPs, AuNPs, NiNPs). The ROS-generation was found to be influenced by the electronic structures of semiconductor-type NPs such as metal oxides and SiNPs, whereas the ROS generation on metal NPs was more likely affected by surface plasmon resonance (SPR). Lastly, a linear relationship between oxidative stress (expressed as the average ROS concentration) and the viability of *E. coli* cells was established (R^2=0.84). This relation will facilitate the quantitative evaluation of oxidative stress and toxic potential of engineered nanomaterials. Overall, the reported findings lay the groundwork for unraveling the ROS photogeneration mechanisms and antibacterial activities of metallic NPs.

About the Speaker:

Dr. Wen Zhang is an assistant professor of New Jersey Institute of Technology's Newark College of Engineering. Wen graduated from Georgia Institute of Technology with PhD in Environmental Engineering in 2011. He received master degree and bachelor degree from Tongji and Tsinghua Universities respectively in 2007 and 2004. His research interest is developing innovative solutions for simultaneous wastewater treatment and renewable energy recovery with nanotechnology and environmental biotechnology to address the grand challenges associated with sustainability and energy-water nexus.

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