Abstract for AICHE Conference Undergraduates Student Poster Competition

Due to their very small size, nanomaterials can be used for versatile applications. Numerous nanomaterials have found uses in the catalytic, photonic, mechanical, biomedical and electrical industries. They are used every day in the production of commercialized products such as sunscreen, composites, catalysts, electronics and medical devices. However, their small size can also be detrimental since it grants them the ability to cross brain-blood and cellular barriers and thus affect cellular functions. Recent publications have shed light on the mechanisms of cellular responses to exposure to bioactive nanoparticles. For example, silver nanoparticles have widely documented cytotoxic properties that are mediated, in part, by oxidative stress.

The mechanisms by which nanomaterials induce cellular toxicity are complex, as nanomaterials exhibit a wide range of physical and chemical properties. These variable properties are based on their core material and their interactions with extra/intra–cellular proteins which adsorb and desorb from their surface. The functionality and consequently the toxicity of these nanomaterials are affected by factors such size, surface chemistry, cell type and environmental factors such as temperature. Current literature includes research assessing the toxicity of nanomaterials based on size, surface chemistry and cell type.

Our work focuses on characterizing nanoparticle-cell interactions using particles with variable surface chemistry. Silver nanoparticles were coated with a thermo-responsive copolymer of the formula MeO_2MA_x-co-OEGMAy. This thermo-responsive copolymer exhibits a variable Lower Critical Solution temperature (LCST) which is dependent on the composition of the more hydrophobic monomer MeO_2MA or the more hydrophilic monomer OEGMA. The resulting coated Silver nanoparticles exhibited a temperature dependent aggregation with the critical aggregation temperatures increasing with the co-polymer composition of OEGMA. Most notably, polymer coated silver nanoparticles particles with OEGMA composition around 5% aggregated at 37 degrees Celsius.

Using absorbance based cytotoxicity assays, we evaluated the toxicity of free copolymers solutions and silver nanoparticles coated with thermo-responsive polymers containing 80, 90 and 95% of MeO_2MA. The nanoparticle concentration was varied ranging from 0 to 6 nM. Free polymers in solution did not initiate potent cytotoxic responses at concentrations used for nanoparticle coating (< 1 mg/mL). Uncoated silver nanoparticles exhibited a dose and time-dependent cytotoxicity with 100% cytotoxicity attained at a particle concentration of 6 nM under 12 hours. Similarly, the polymer coated particles exhibited a dose-dependent cytotoxicity with a 100% cytotoxicity reached under 6 nM for an OEGMA composition of 5%. The cytotoxicity also increased with decreasing OEGMA composition. We also correlated cellular uptake of polymer coated silver nanoparticles with their cytotoxicity by quantifying partitioning of nanoparticles between the cellular monolayer and the supernatant media as a function of OEGMA composition.

Our future experiments will investigate molecular mechanisms of cytotoxicity, gene regulation and ROS generation.