Detailed study of nanoparticle surface charge and corona using PEG-based ligands

Pratik P. Goswami and Erin E. Carlson
Department of Chemistry, University of Minnesota, Minneapolis, MN

Nanoparticles can exhibit unique properties due to their small size and relatively high surface area. These properties have been incorporated into new technologies leading to diverse consumer products including cosmetics, drugs, fuel cells in electric cars etc. With widespread growth in nanoparticle use, it has become increasingly important to understand the implications of these materials to the environment. Two key properties of nanoparticles that can dictate their toxicity are as follows:

a. *Nanoparticle surface charge*: Surface ligands that display charge are known to alter the toxicity of nanoparticles. To understand this further, we have designed and synthesized PEG (polyethylene glycol) based ligands, which display varying charges on their end group. These compounds will enable us to probe how changes in ligand charge affect overall nanoparticle surface charge and density and to better understand the correlation of ligand charge and nanoparticle toxicity.

b. *Nanoparticle corona*: Nanoparticles capture proteins from their environment to form an outer layer, which is also known as the corona. Corona formation is dependent on the composition and shape of the nanoparticle, as well as the proteins present. This corona in turn can significantly change how the nanoparticles behave, such as alteration of their surface charge and incorporation into cells. A method to identify the corona, i.e. the constituent proteins on a nanoparticle, would be the first step in understanding how the corona impacts nanoparticle toxicity. We are developing a new strategy for facile exploration of nanoparticle coronas by synthesizing photoactivable ligands. This method envisions using a photoactivable capture unit (such as diazirine) embedded in the nanoparticle ligand. This functional group can be activated by UV light to form a covalent linkage with encompassing proteins in the nanoparticle corona. Once captured, these proteins can be identified and studied using mass spectrometry techniques.