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Probing the role of surface chemical features in nanoparticle-biofilm interactions

Recent advances in nanotechnology have increased awareness and concern of nanomaterials exerting potentially negative impacts on the environment and public health. “Nanomaterials” refer to particles that are in the 1 to 100 nanometer size range, where 1 nanometer is one billionth of a meter. For reference, the upper end of this range is only one thousandth the diameter of a strand of hair. Nanomaterials enter the environment naturally (e.g., from fires and volcanoes) but most of the concerns from the general public are about anthropogenic sources (e.g., nanoparticles are being used in electronics, sunscreen, and drug delivery). In fact, in a recent 2012 report by the National Academy of Science, scientists have voiced the increasing need for research on the environmental health and safety of engineered nanomaterials.

Engineered nanomaterials may enter the environment through several means; however, once released, they are highly likely to come into contact with various surfaces. Most environmental surfaces are coated with biofilms, which are “sticky” matrices of bacterial cells and extracellular polymeric substances (EPS) secreted from cells. The chemical complexity and stickiness of biofilms often result in nanomaterial deposition onto such surfaces, thus providing a sink for engineered nanomaterials released into the environment. However, there is only very limited knowledge on what dictates the deposition of nanomaterials onto biofilm-coated surfaces. In this proposed study, the PI hypothesizes that the surface chemical features of both the biofilm and the nanoparticles play important roles in the interaction. Specifically, the chemical composition and distribution of the biofilm such as proteins, polysaccharides, and lipids, as well as the surface organic coating of the nanoparticles are expected to significantly affect the nanoparticles deposition characteristics.

These hypotheses will be tested on lead sulfide nanoparticles that are currently being engineered as quantum dots for use in semiconductors and also exist in the natural environment as the mineral, galena. Ultimately, the results from this study will provide a predictive framework for the deposition patterns of nanoparticles onto environmental surfaces to be used in the environmental risk assessment of engineered nanomaterials.