Of the most significant uses of nanomaterial, zinc oxide and titanium dioxide have been common additives with a variety of applications (e.g., 70% of sunscreens: TiO$_2$; 30% of sunscreens: ZnO). However, fewer studies have been initiated on how these manufactured metal oxide nanomaterials are mobilized in aquatic and soil environments as well as any factors controlling for the transport of these nanomaterials. We recently studied the effect of coating materials (biodegradable polymers, such as carboxymethyl cellulose (CMC), guar gum, and xanthan gum, which are widely applied in textile, pharmaceutical, cosmetics industries, etc.) on two types (anatase and rutile) of TiO$_2$ nanoparticles on the mobilization in porous media.

Our preliminary batch experiments suggested that all the three types of coating materials made dry powder of TiO$_2$ nanoparticles dispersed in aqueous solution. The extent of dispersion was more significant in anatase with CMC while rutile nanoparticles remained more dispersed with guar and xanthan gum in 6 days based on the same (w/v) %. Particle size hydrodynamic diameter results showed that the true size of the particles in suspension was significantly different than the advertised size of the starting powders (10nm). This phenomenon, which is mainly due to aggregation of the particles (and to a certain extent, uncertainty in the manufacturing process) has also been reported by others. We observed that without these coating materials, TiO$_2$ nanoparticles were completely immobile in water saturated sand columns.

Enhanced mobilization of these nanomaterials implicates the potential to be greatly exposed in the environment as they are dispersed over significant distances, leading to increasing persistence in the environment. The biodegradable polymer coating materials would find their way in surface waters and soils as the metal oxide nanoparticles and could result in mobilizing the nanomaterials as a contaminant carrier.

The extent of transport of these metal oxide nanoparticles is dependent on particle size, coating materials, ionic strength, pH, cation types, contaminants, and the presence of metal contents. However, further studies are needed to investigate the detailed mechanism (e.g., adsorption, chemicomplexation, physical filtration, biochemical reactions) behind the various controlling factors.