Small Angle X-ray Scattering Studies of Colloidal Nanoparticles

Byeongdu Lee

X-ray scattering has been a key tool for materials science. Pertinent to nanoscale structure analysis is small angle x-ray scattering (SAXS) that measures x-ray diffraction or scattering off nanostructured sample typically in the scattering vector q less than 1 A^{-1}. While it has been considered imperative for colloid and polymer researches since its debut, recently it further gains much attention from other fields due to an advent of coherent x-ray sources and advances of synchrotron x-ray sources with high energy and high flux, coupled with high computing power. Improved control over nanoscale chemistries provide new opportunities in using SAXS for the field, and researchers are taking a full advantage of its power.[1-3]

For a decade or so, I have been developing SAXS theories and computational tools for studies of colloids and polymers.[1,4,5] They include calculations of form factor scattering from polyhedral particles and development of a powder diffraction theory for colloidal particle assemblies. In this talk, first, I will briefly overview the outcomes, followed by their use on revealing interactions between colloidal particles that are grafted with DNAs. The polyelectrolytes can provide both attractive and repulsive potentials, where the latter had often been neglected. [5] It, however, turns out that understanding the repulsive interaction is crucial to reproduce detailed structural features of the DNA-nanoparticle assemblies. Theoretical studies on the potentials will enable us better understanding the phase behaviors of DNA grafted nanoparticles and analogy with metal alloys or ionic salts.

1. H. Zhang, B. Lee, D. V. Talapin et al., **Nature**, 542, 328-331.
2. T. Li, A. J. Senesi, and B. Lee et al., ***Chem. Rev.***, 2016, 116 (18), pp 11128–11180.
3. M. N. O'Brien, M. R. Jones, B. Lee, C. A. Mirkin, **Nature Materials**, 2015, 14, 833.
4. S. G. Kwon, B. Lee, E. V. Shevchenko et al., **Nature Materials**, 2015, 14, 215–223.
5. R. J. Macfarlane, B. Lee, C. A. Mirkin et al., **Science**, 2011, 334, 6053, 204-208