Argonne research unveiling the secrets of nanoparticle haloing

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A glass of milk, a gallon of paint, and a bottle of salad dressing all look to the naked eye like liquids. But when viewed under a microscope these everyday liquids, called "colloids," actually contain small globules or particles that stay suspended in solution.

Colloids require a delicate balance of opposing forces for them to be stable: attractive forces must be matched by repulsive ones. A new colloidal stabilization method characterized by scientists at the U.S. Department of Energy's (DOE) Argonne National Laboratory may give scientists a new way to control the stability of some colloidal suspensions.

In this approach, known as nanoparticle haloing, highly charged nanoparticles and negligibly charged colloidal microspheres are mixed together in solution. The nanoparticles self-organize around the microspheres to form a halo-like structure that stabilizes the solution. This new pathway to produce materials would not be possible through traditional routes.

The structure of the halo – the key to understanding this kind of stable colloid – has remained a mystery because the nanoparticles that form it are more than 100 times smaller than the microspheres that they surround.

By using x-rays produced by Argonne's Advanced Photon Source (APS), Argonne scientists, in collaboration with researchers from the University

of Illinois at Urbana-Champaign, were able to finally discover the structure of the nanoparticle halo.

The researchers used the ultra-small-angle x-ray scattering (USAXS) instrument at the APS to discover that nanoparticles form a loosely organized layer a small distance from the surface of the microspheres. This discovery suggests a weak attraction between nanoparticle and microsphere, corroborating earlier theoretical predictions that the halo can form only in such an environment.

"Because we have established a methodology to determine the structure of nanoparticle halo, it opens a window to the systematic study of the entire nanoparticle-microsphere phase diagram for this type of novel colloidal stabilization mechanism," said Argonne's Fan Zhang, a coauthor on the Langmuir paper.

Source: Argonne National Laboratory