Characterization of hybrid nanoparticles synthesized in supercritical water with analytical centrifugation

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Analytical centrifugation (AC) (LUMiSizer, Germany) with *in situ* space and time-resolved extinction profiles (STEP) technology [1] was used to obtain sedimentation profiles for hybrid nanoparticles (HNPs) synthesized with supercritical water [2] for purposes of characterizing particle interactions and dispersion stability needed for design of separators (Fig. 1). CeO_2 HNPs synthesized in supercritical water can be well-dispersed in cyclohexane, whereas for the same HNPs in acetone (antisolvent), the velocity of the settling front can be estimated to be about 13.8 μm/s.

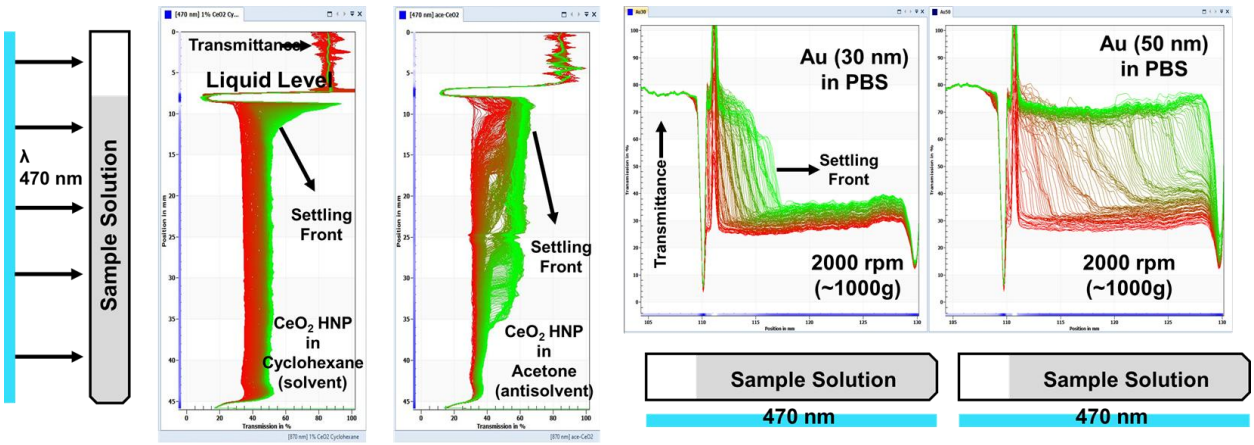

Figure 1. Dispersion characteristics of nanoparticles: (left) natural sedimentation of decanoic acid modified CeO_2 in cyclohexane solvent and in acetone anti-solvent; (right) STEP sedimentation of 30 nm and 50 nm gold nanoparticles at 2000 rpm (~1000*g*). Red curve marks t = 0, green curve marks t = t_final.

Commercially-available Au NPs in aqueous phosphate-buffered solution (PBS) had typical mono-disperse sedimentation profiles, whereas TiO_2 NPs of 25 nm and 100 nm sizes had profiles that showed strong particle interactions and hydrogen bond networks. For TiO_2 of a given NP size, low concentrations (0.1 wt%) had faster moving settling fronts than high concentrations (0.5 wt%). For TiO_2 NPs at a given concentration (*e.g.* 0.1 wt%), 25 nm particle sizes had faster moving settling fronts than 100 nm particle sizes. SiO_2 NPs were also studied with AC and numerical simulations. Different trends in HNPs for mixed-solvents and simulation models for estimating dispersion stability for HNP separations will be discussed at the conference in an online presentation.

[1] D. Lerche, KONA Powder and Particle Journal 36 (2019) 156–186.
[2] M. Taguchi, N. Yamamoto, D. Hojo, S. Takami, T. Adschiri, T. Funazukuri, T. Naka, , RSC Advances 4 (2014) 49605-49613.