

3-Dimensional Micro-Structural Study of Clay-LDHs Nano-Particle Complexation for Mineral Tailing Dewatering and Water Conservation

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To change clay particle behaviour in colloidal suspensions it is necessary to alter electrostatic charges on the mineral interfaces using oppositely charged colloidal particles like commonly synthesized Layered Double Hydroxides (LDHs). The LDHs are colloidal platelet like nano-particles and are positively charged to common clays. Such new materials composed of the oppositely charged particles may produce new nano materials whose behaviour will be determined by structure of clay-LDH complexes.

This research came with utilisation of new transmission X-ray microscopy (TXM) installed at beamline BL01B SWLS “X-ray Microscopy” NSRRC in Taiwan.



Figure 1. 3-D reconstruction of the Kaolinite stack from coarse fraction of Georgia kaolinite sample as seen within the aqueous solution. Stacking is visible as well as fine fraction of kaolinite and LDH particles adhered towards stack edges which are more clearly visible when picture is rotated. Dimension of cube is $\sim 2 \times 4 \mu\text{m}$.

The Birdwood kaolinite/LDH aggregates observed in the TXM are much more compact than observed before in pure Birdwood kaolinite suspension and similar to aggregates formed after treatment by positively charged surfactant. Kaolinite/LDH aggregates in water reveal complex structure of larger kaolinite platelets connected together by gelled nano-particles which are most probably LDH colloidal plates. Comparisons of the transmission electron microscope (TEM) and TXM techniques show similarities in particle morphology. The ability to study particles and aggregates in their natural aqueous environment and in 3-dimensions make this technique superior to the TEM technique.

In Figure 2B, three-dimensional arrangements of the

fine fraction of Birdwood kaolinite platelets can be seen with nano-particles of LDHs in-between fulfilling the role of a bonding medium between kaolinite platelets. In this micrograph, kaolinite platelets are oriented by edges towards larger crystal planar wall surfaces (edge to face orientation EF) which are remarkably different from micrographs of pure Observed aggregates in kaolinite-LDHs complexes are also less porous than these observed in pure kaolinite suspensions where chains of EE oriented platelets forms cellular-like structure.

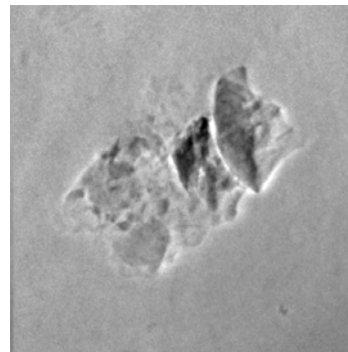


Figure 2. Birdwood kaolinite-LDHs complexed aggregate observed using TXM shows gelled LDHs nano-particles sandwiching in-between larger kaolinite platelets.

Aggregates, kaolinite platelets like observed in Fig. 2 are bonded with LDH nano-particles. These nano-particles form gelled structure between larger kaolinite platelets which can be recognisable by their pseudo-hexagonal symmetry. Such a gel, for the first time can be observed in the water environment in aid of TXM method only. This gel formed from LDH nano-particles between larger kaolinite platelets bonding all mineral phases into larger aggregates. This ability gives potential in commercial utilisation for encapsulate and retain larger molecules. It also can be used in water treatment as well as in fine particles aggregation for faster suspension dewatering and improve sedimentation.