# Particle Orientation in Synthetic Clay Gels

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## Introduction

Colloidal suspensions of clay particles in aqueous solutions make ideal model systems for the study of interactions between hard disk-shaped particles, due to the ease in tuning their electrostatic repulsion with the concentration of the salt. Numerous gel and sol phases are possible, along with the possibility of liquid crystalline ordering, although evidence for the latter in clay colloids has been ambiguous so far.

## Methods and Materials

We have studied Na fluorohectorite, a synthetic layered clay that exhibits gravity-induced phase separation when dispersed in NaCl solutions, as evident by well-defined strata identifiable by eye. The samples were studied by transmission of 19-keV x-rays through glass tubes, with the momentum transfer both parallel and normal to the strata, as shown in the inset of Fig. 1. By comparing intensities of Bragg peaks for these two scattering geometries, we aim to identify particle reorientation that might accompany liquid crystalline ordering.

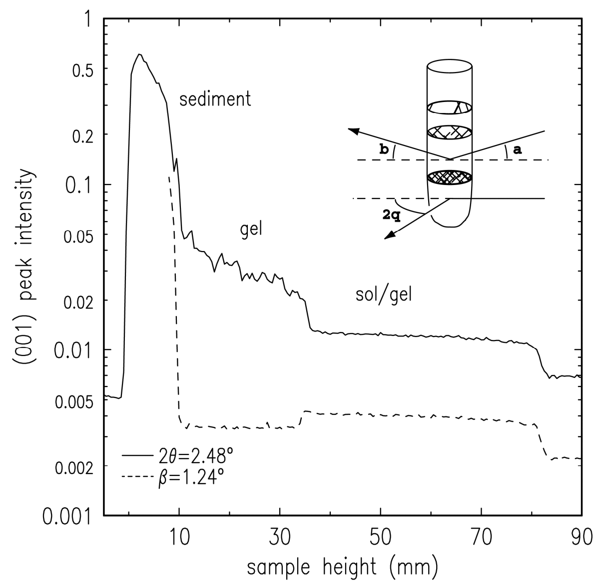


*FIG. 1. (001) peak intensity for a sample with 2.985 wt% Na fluorohectorite in 1 mM NaCl. Solid line: horizontal momentum transfer. Dashed line: vertical momentum transfer. Inset: scattering geometry through clay gel strata.*

## Results and Discussion

Figure 1 shows (001) peak intensities for the two scattering orientations. This peak is normal to the platelet face. Solid lines therefore correspond to populations of vertical platelets (those standing "on edge" in the solution), while the dashed line refers to scattering from horizontal particles (those "lying flat"). Both intensities drop sharply going from the dense sediment (below 10 mm in the tube) to the gel phase above. At the boundary at 34 mm, however, an overall drop in density is accompanied by an increase in the scattering from horizontal particles. This proves that particle orientations differ in the two phases, a prerequisite for a nematic-isotropic phase transition.

A Williamson-Hall plot of (001), (002), and (003) peak widths for selected phases shows a roughly linear dependence of Lorentzian width versus sin(θ). (See Fig. 2.) This indicates that both particle size and strain contribute to the peak widths.[1] Further structural refinements are underway, and are expected to reveal new information about the detailed morphology of these clay gel phases.

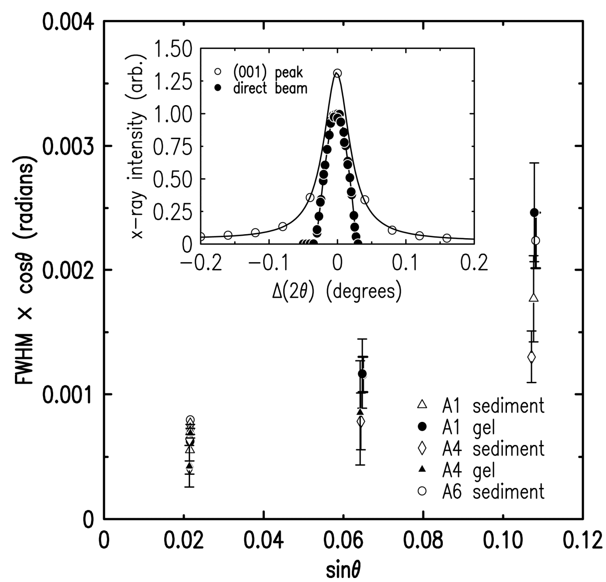


*FIG. 2. Williamson-Hall plot for several dense clay gel phases. Inset: (001) peak with Lorentzian fit (open circles) and direct beam (closed circles). Peaks were uncorrected for resolution broadening.*

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## References

[1] G. K. Williamson and W. H. Hall, Acta Metall. Mater. **1**, 22 (1953).