
Molecular Motions, Surface Interactions, and Stacking Disorder in Kaolinite Intercalates

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Abstract: Intercalates of Georgia well-crystallized kaolinite with formamide, N-methylformamide (NMF), and dimethylsulfoxide (DMSO) were prepared at room temperature by dispersing the clay in the organic liquid. Several physical and chemical properties of the intercalated organic molecules and the clay, while intercalated and after de-intercalation, were examined using nuclear magnetic resonance (NMR), infrared (IR), and electron paramagnetic resonance spectroscopy (EPR), and specific heat (C_p) measurements. The chemical bonding between the inner-surface hydroxyls and the organic molecules, as indicated by IR, was strongest for DMSO and weakest for formamide. The distortion of the kaolinite layer, as shown by EPR, also was greatest for DMSO and least for formamide. NMR T_1 measurements indicated a relatively strong DMSO-kaolinite surface interaction that slowed down the methyl group reorientation comparable to that in bulk solid DMSO. T_1 measurements indicated a weaker interaction for NMF. De-intercalation by mild heating did not return the kaolinite to its original structural state as shown by EPR and C_p . The greatest disorder was found for the DMSO de-intercalate and the least for the formamide de-intercalate. These experiments show that for sufficiently strong bonding between the clay inner surface and the intercalating molecule, the structure of the clay is capable of distortion, which is partly temporary and partly permanent. The permanent changes probably involve the introduction of stacking faults.

Key Words: Dimethyl sulfoxide • Electron paramagnetic resonance • Formamide • Infrared spectroscopy • Intercalate • Kaolinite • N-methylformamide • Nuclear magnetic resonance • Specific heat

Clays and Clay Minerals; December 1986 v. 34; no. 6; p. 635-644; DOI: [10.1346/CCMN.1986.0340603](https://doi.org/10.1346/CCMN.1986.0340603)
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