The Effect of Added Polymers on *n*-Butylammonium Vermiculite Swelling

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Abstract: A 4-component clay-polymer-salt-water system was studied by neutron scattering. The clay-salt-water system consisted of *n*-butylammonium vermiculite, *n*-butylammonium chloride and heavy water, and the volume fraction of clay in the system was held constant, at $r = 0.01$. Three polymers in the molecular weight range 10,000 to 30,000 were studied, poly(vinyl methyl ether) (PVME), poly(ethylene oxide) (PEO) and poly(acrylic acid) (PAA), at a polymer volume fraction of $\nu = 0.01$. The addition of PAA suppressed the clay swelling, irrespective of the salt concentration, *c*. The addition of the neutral polymers had no effect on the phase transition temperature, T_c, between the gel and tactoid phases of the system, its value remaining at 14 °C for $c = 0.1$ *M* and 30 °C for $c = 0.01$ *M*. At $c = 0.01$ *M*, the neutral polymers also had a negligible effect on the lattice constant *d* along the swelling axis of the clay colloid, but at $c = 0.1$ *M*, the *d*-value was significantly lower than in the system without added polymer. For a PVME sample of molecular weight 18,000, both *d* and T_c were measured as a function of ν, for volume fractions between 0 and 0.04. The addition of polymer, up to $\nu = 0.04$, had no effect on T_c. However, even for ν values as low as 0.001, the vermiculite layers in the gel phase were more parallel and more regularly spaced than in the system without added polymer. In the gel phase, *d* decreased exponentially as a function of ν, from 12 nm at $\nu = 0$ to 8 nm at $\nu = 0.04$. In the tactoid phase, at $T > 14$ °C the *d*-value in the crystalline regions was equal to 1.94 nm at $\nu = 0$ and $\nu = 0.04$, showing that the spacing between the vermiculite layers is not affected by the added polymer when they are collapsed by an increase in temperature. The addition of a PVME sample of molecular weight 110,000, at $\nu = 0.001$, had no noticeable effect on either *d* or T_c.

Key Words: Interlayer Spacings • Neutron Diffraction • Osmotic Swelling • Phase Transitions • Polymers • Vermiculite Gels

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