Temperature Effects in a Self-Exfoliating Nanocomposite

H, Henning Winter University of Massachusetts Amherst

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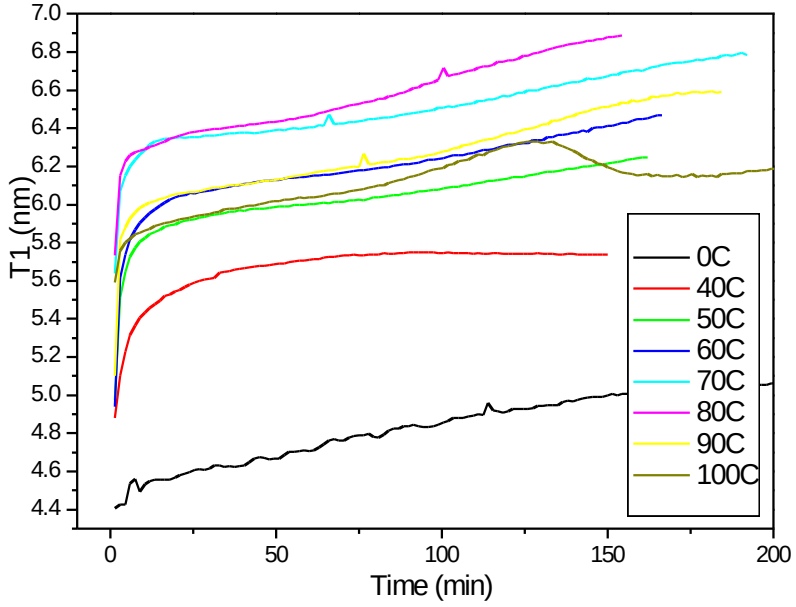

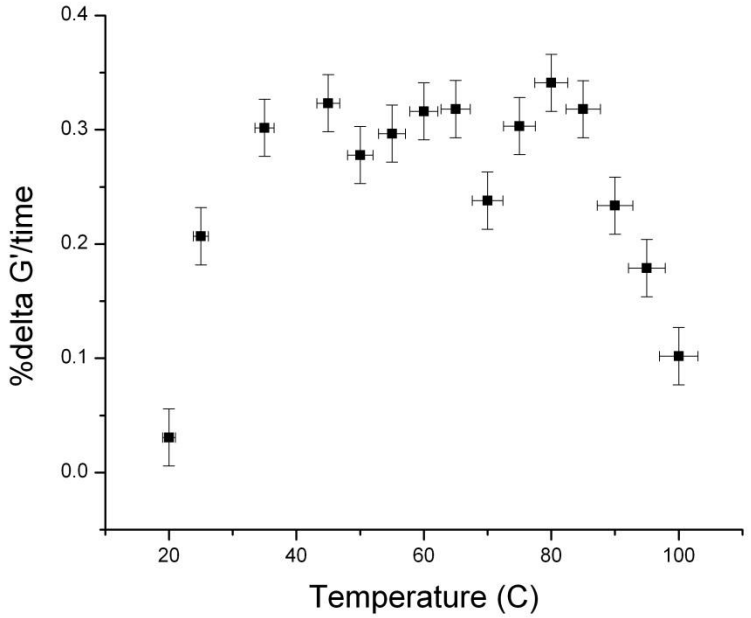

This experimental study focuses on nanocomposites with layered silicate (stack of nm-thick organo-clay sheets), such as montmorillonite, as the reinforcing component of a polymer (end-functionalized polybutadiene). The experiments are guided by a newly proposed exfoliation mechanism which consists of three steps. Novel is especially the first step: the proposed pulling of anchored, telechelic ("sticky") macromolecules on the outer surface of clay particles. The macromolecules form a polymer brush. The second step is the swelling of the clay particles to a new quasi-equilibrium state in which the outer brush force, due to the tethered macromolecules, is balanced by the inner cohesion forces between the sheets in the stack. The third and final step is diffusion and pressure driven flow of matrix molecules into the expanded clay galleries to the point that they fully exfoliate. In confirmation of the proposed exfoliation mechanism, the first figure shows the rapid increase of the spacing between clay sheets (T1) as a function of time and temperature obtained by SAXS. The second figure shows the maximum scaled rate of change in the storage modulus as a function of temperature obtained by time resolved mechanical spectroscopy. Both show a strong temperature dependence with maximum values around 80ºC and sharp drops at lower and higher temperatures.