Nonlinear Stress Relaxation Behavior of SiO2/(Acrylic Polymer/Epoxy) Suspensions

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Large deformation, nonlinear stress relaxation modulus G(t,γ) was examined for the SiO2 suspensions in a blend of acrylic polymer (AP) and epoxy (EP) with various SiO2 volume fractions (φ) at various temperatures (T). The AP/EP contained 70 vol% of EP. At φ ≤ 30 vol%, the SiO2/(AP/EP) suspensions behaved as a viscoelastic liquid, and the time-strain separability, G(t,γ) = G(t)h(γ), was applicable at long time. The h(γ) of the suspensions was more strongly dependent on γ than that of the matrix (AP/EP). At φ = 35 vol% and T = 100oC, and φ ≥ 40 vol%, the time-strain separability was not applicable. The suspensions exhibited a critical gel behavior at φ = 35 vol% and T = 100°C characterized with a power-law relationship between G(t) and t; G(t) ∝ t−n. The relaxation exponent n was estimated to be about 0.45, which was in good agreement with the result of linear dynamic viscoelasticity reported previously. This nonlinear stress relaxation behavior is attributable to strain-induced disruption of the network structure formed by the SiO2 particles therein.