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Observation of Anomalous Viscosity in Entangled Polymer Films near the Glass Transition ZHANG JIANG, Dept. of Physics, University of California at San Diego & Advanced Photon Source, ANL, M. K. MUKHOPADHYAY, SUNIL K. SINHA, Dept. of Physics, University of California at San Diego, SURESH NARAYANAN, Advanced Photon Source, ANL, LAURENCE B. LURIO, Dept. of Physics, Northern Illinois University, SANGHOON SONG, HYUNJUNG KIM, Dept. of Physics & Interdisciplinary Program of Intergrated Biotechnology, Sogang University, Korea — We have studied the viscous relaxation of surface waves on molten polystyrene films of various molecular weights (M_W) using x-ray photon correlation spectroscopy. The relaxation time has been measured as a function of wave vector from high temperatures down to near the bulk glass transition temperature (T_g). We find a transition from a single exponential regime through a stretched exponential to another single exponential regime as the temperature decreases to T_g where the effective viscosity saturates at that of chains with critical molecular weight for entanglement. These results are interpreted in terms of the freezing-out of relaxation modes involving full chains and large segments until only fluctuations of chain segments of critical entanglement length survive. We also find no evidence for a low-viscosity surface layer near T_g.

Hyunjung Kim
Dept. of Physics & Interdisciplinary Program of Intergrated Biotechnology, Sogang University, Korea

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