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Observing the Twinkling Fractal Nature of the Glass Transition JOSEPH STANZIONE III, Department of Chemical Engineering, RICHARD WOOL, University of Delaware, KENNETH STRAWHECKER, ARL, Aberdeen MD — The main idea underlying the Twinkling Fractal Theory (TFT) of the glass transition is the development of dynamic percolating solid fractal structures near T_g , which are in dynamic equilibrium with the surrounding liquid. Solid and liquid clusters interchange at a frequency ω_{TF} , which is controlled by the population of intermolecular oscillators in excited energy levels in accord with the Orbach vibrational density of states for a particular fractal cluster $g(\omega) \sim \omega^{d_f-1}$, where the fracton dimension $d_f = 4/3$. To an observer, these clusters would appear to be “*twinkling*.” A time-lapse tapping-mode atomic force microscopy (AFM) technique has been developed in order to experimentally confirm such phenomena. The *twinkling* behavior of amorphous, atactic polystyrene with $M_W = 194,000$ g/mol, PDI = 1.07 (GPC) and $T_g = 375$ K (DSC-heating rate of 3 K/min) has been captured above (383 K), below (358 K), and well below (298 K) its T_g . Two-dimensional space images reveal fractal dimensions consistent with the TFT. The *twinkling* behavior was analyzed using a statistical autocorrelation function in conjunction with the apparent stretched exponential Kohlrausch-Williams-Watts relaxation function.

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