Supporting Information

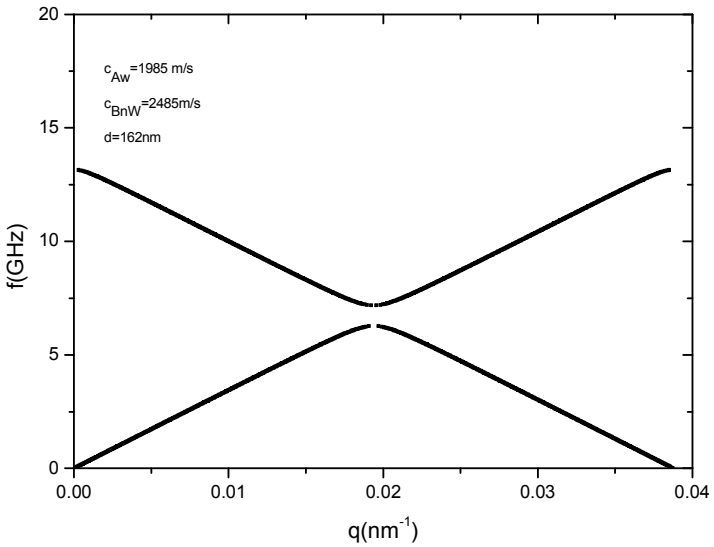

Figure S1: Theoretical phononic dispersion relation for BCP1250 with d1=90nm and d2=72nm and the lattice parameter d=d1+d2, ρ=1000kgm^{-3}, c_1=1985m/s, c_2=2485m/s.

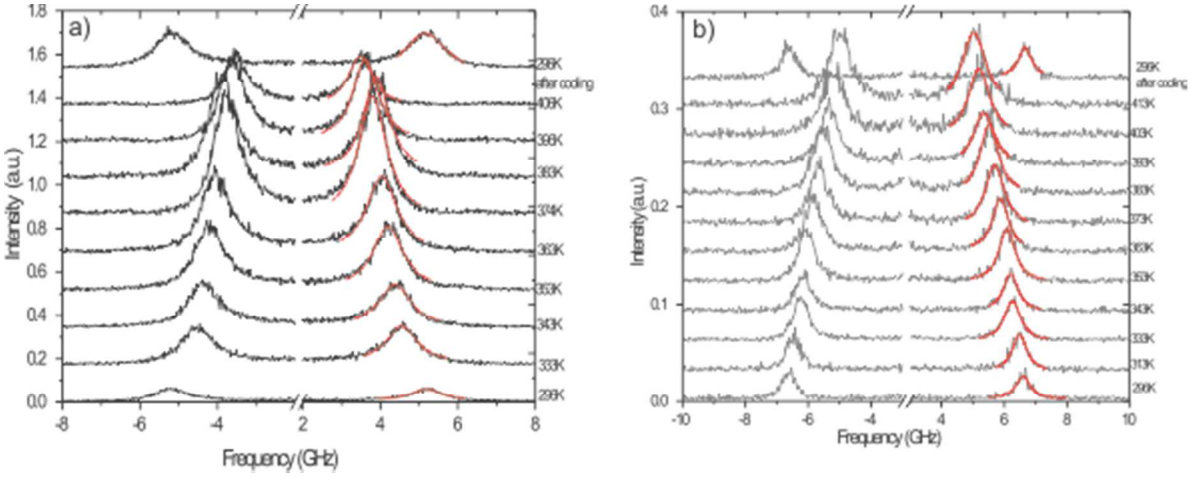

Figure S2: BLS spectra for a) alkyl (AW) and b) benzyl (BnW) homopolymers at $q = 0.0167\ \mathrm{nm}^{-1}$ at different temperatures below and above T_g (on heating). The spectra recorded with a free spectral range, FSR= 10GHz, are shifted for clarity. The glass transition can be studied by monitoring the change of the peak frequency with temperature. Note the agreement after cooling at RT in both homopolymers.

Table S1: Sound velocities and glass transition temperatures in the BCP's and the constituent homopolymers (AW and BnW) as obtained from the BLS study: c_L is the longitudinal sound velocity, $\gamma = c_L^{-1}(\partial c_L/\partial T)$ and T_g denotes the glass transition temperature.

Quantity	AW	BnW	BCP-480-5f BCP-570-5b	BCP-1250-5c
$c_L(T = 295K)(m/s)$	1960	2485	2150	2180
$T_g, (K)$	–	~347±5	~354±5/~**380**±5	~354±5
$\gamma(10^{-3}K^{-1})(\mathrm{T} > \mathrm{Tg})$	–	1.44	1.76	1.7
$\gamma(10^{-3}K^{-1})(\mathrm{T} < \mathrm{Tg})$	–	1.0	1.5	1.5

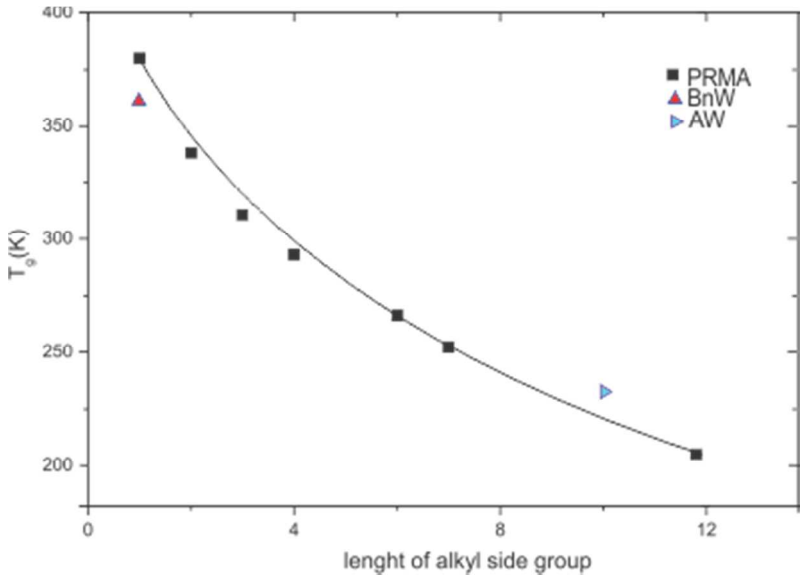

Figure S3. Glass transition temperature, T_g, in bulk poly(n-alkylmethacrylates) ranging from poly(methylmethacrylate) to poly(dodecylmethacrylates) and the two dendronized homopolymers AW and BnW vs the number of the carbon groups in the alkyl side group.

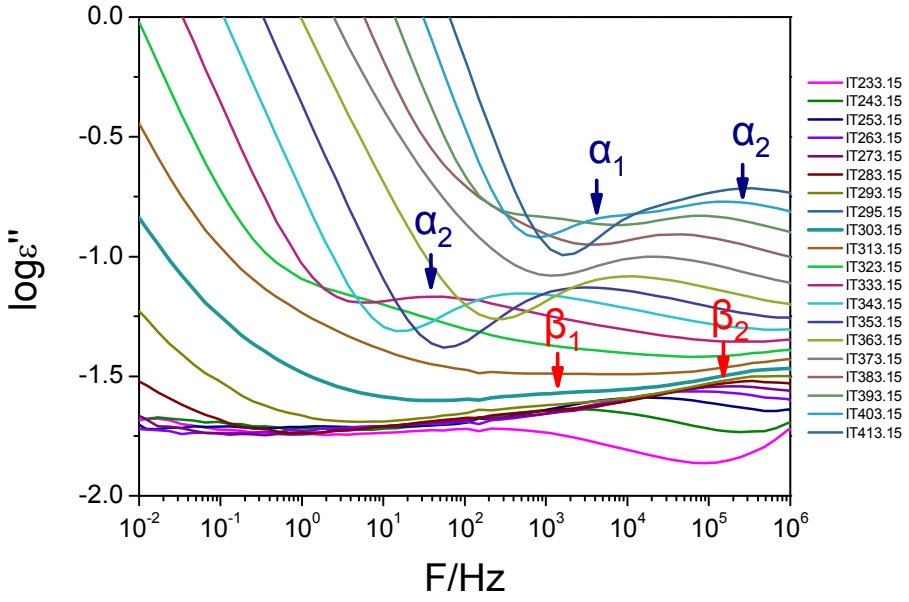

Figure S4. Dielectric loss curves of BCP-1390 at some selected temperatures as indicated. The different dynamic processes are indicated as α_1 and α_2, and β_1 and β_2.

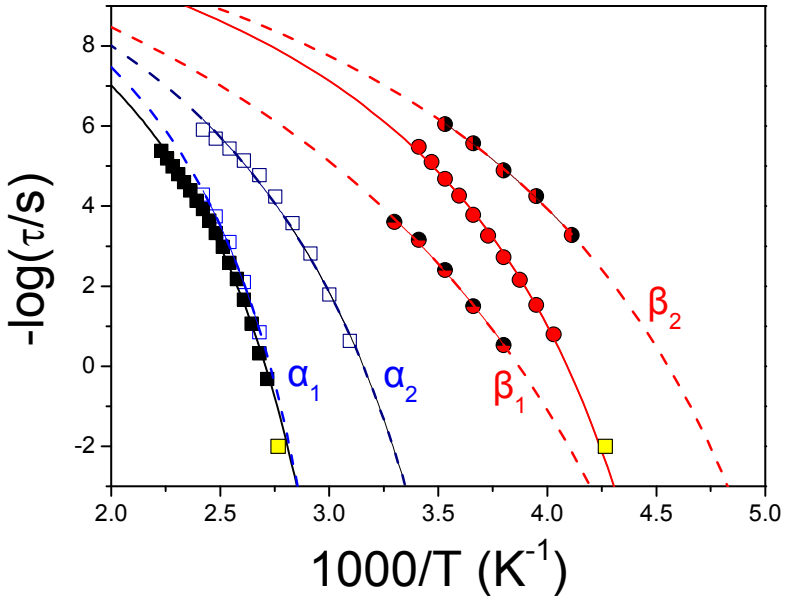

Figure S5. Arrhenius relaxation map of the multiple processes in BCP-1390. α_1 and α_2 have activation energies and relaxation times in the vicinity of BW segmental process whereas β_1 and β_2 have characteristics corresponding to AW-445 homopolymer. The copolymer glass temperatures from DSC are also shown with the yellow squares.