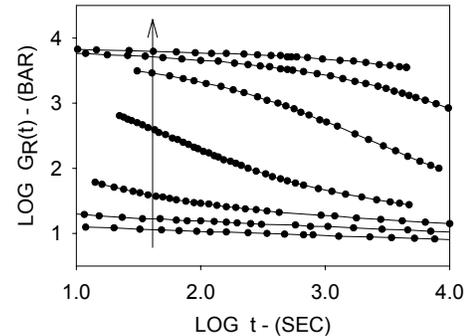


## 11. High Pressure Science

### Influence on High Pressure Polymer Dynamics and Coupling to Nanoscale Structure in Polymer Composites

At atmospheric pressure the mechanical response of a typical polymer binders utilized in viscoelastic composites, including polymer-nanoparticle composites and plastic bonded explosives (PBXs), is rubbery. However, the actual pressures present during mechanical loading of these materials can be extreme, on the order of kbars. At such high pressures, the entire polymer relaxation time spectrum is increased dramatically thereby shifting mechanical response toward the glassy regime, as shown in Fig. X. **Error! Bookmark not defined.** This shift in the polymer relaxation time spectrum with pressure can lead to a remarkable increase in the viscous dissipation rate during shock wave loading, producing local hot spots with temperature rises of order 1000°C. Furthermore, the shift of the effective glass transition temperature due to high pressures can couple strongly with the nanoscale confinement effects present in polymer-nanoparticle composites and in highly-filled (60%-95% solids) composites with larger (micron) sized particles, such as PBXs. The coupling between pressure and nanoscale confinement effects on the nanoscale dynamics of the polymer matrix in polymer-particle composites is essentially unexplored, due largely to the lack of experimental probes of polymer dynamics that can operate under high pressure with the appropriate spatial and temporal resolution. We anticipate that the application of dynamic neutron scattering to polymer-particle composites under high pressure will provide revolutionary advances in understanding the influence of pressure and nanoscale confinement on the dynamics of polymer matrices in polymer-particle composite materials critical to the design and processing of novel viscoelastic nanocomposites and shock-insensitive PBXs.



**Fig. X.** Effect of pressure (from 1 bar to 4.6 kbar, arrow indicates increasing pressure) on the relaxation modulus in shear of the elastomer Hypalon 40 at 298 K from Fillers and Tschoegl (see text).