**Molecular mechanics for all polymer glasses: Is there a common framework**

**to unify with melt rheology?**

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**Abstract**

Polymer glasses have little mechanical strength when their molecular weight is low. Unlike the window glass, it is the networking of the covalently-bonded chains that makes polymers strong in their glassy state. Regarding ductility of such glasses, one common statement is that the "entanglement density" determines whether a polymer is brittle or ductile. Polystyrene is brittle because of its low entanglement density. However, a physicist's question is not why PS is brittle and bisphenol A polycarbonate is ductile. The question is why the brittle PMMA turns ductile above 60 oC and pressurization makes PS ductile even at room temperature. In absence of a predictive microscopic theory that captures the key characteristics of polymer glasses, there is no satisfactory explanation concerning the brittle-ductile transition in glassy polymers. We have recently started to venture into the field of mechanical behavior of polymer glasses, having achieved sufficient understanding of the same materials above the glass transition temperature Tg, namely having established a conceptual and phenomenological foundation for nonlinear rheology of entangled polymer. In this talk we will discuss a picture of hybrid structure for polymer glasses under large deformation, made of (a) a primary structure due to short-ranged inter-segmental attractions and (b) a network of load-bearing strands owing to chain uncrossability. In this theoretical framework, all the chemical differences as well as effects of pre-deformation above Tg and mechanical "rejuvenation" can be accounted for in terms of the structure and properties of the chain network relative to that of the primary structure, and universal mechanical behavior can be explored. Specifically, we will discuss how the chain network plays an essential role to influence all aspects of large deformation of polymer glasses including strain localization after yielding and mechanical failure.

\*: [www.uakron.edu/rheology/](http://www.uakron.edu/rheology/)