Experimental perspective on supercooled liquids and glasses (molecular and atomic systems)

- Dynamics
- Thermodynamics
- Structure
- Glass properties
- Transformation kinetics
- Glasses near the bottom of the potential energy landscape (vapor-deposited glasses)
Dynamics in SCLs depend strongly on temperature


Lunkenheimer et al., in Structural Glasses and Supercooled Liquids: Edited by Peter G. Wolynes and Vassiliy Lubchenko. 2012

Lu et al. / Acta Materialia 51 (2003) 3429–3443
Strong and fragile glassformers

- Strong limit = Arrhenius
- Structure is strong or fragile (with respect to temperature)
- Kinetic fragility “m”
Relaxation times from different techniques that measure SCL dynamics often show good agreement:

- $\alpha$ relaxation: dielectric relaxation, dynamic Kerr effect, light scattering, NMR, probe rotation
- $\beta$ relaxation: dielectric relaxation, partial probe reorientation


- $\alpha$ relaxation: Comparison of dielectric relaxation and heat capacity spectroscopy for glycerol, propylene glycol, salol, and o-terphenyl/o-phenylphenol.
Dynamics in SCLs continued: Self-diffusion has a weaker temperature-dependence

Molar volume data from Plazek and Magill, JCP 1966
Kauzmann entropy crisis

Ediger and Harrowell, JCP 137, 080901 (2012)

Tatsumi, et al. PRL 109, 045701 (2012);
Kauzmann entropy crisis and the potential energy landscape

Are simulated systems good mimics of experimental glassformers?

<table>
<thead>
<tr>
<th>TABLE I. Parameters related to glass transitions.</th>
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<tr>
<td>$T_g$ (K)</td>
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<tr>
<td>$T_K$ (K)</td>
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<tr>
<td>$T_g/T_K - 1$</td>
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<td>$T_b/T_m - 1$</td>
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<td>$S_{res}$ (JK$^{-1}$ mol$^{-1}$)</td>
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<td>$z^*(0)$</td>
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Tatsumi et al. PRL 109. 045701 (2012)
Structure of supercooled liquids and glasses: Can you find the origin of slow dynamics

Propylene glycol
Leheny et al., JCP 1996
Structure of supercooled liquids and glasses: Can you find $T_g$?

Metallic glasses show correlation between temperature-dependent structural evolution and fragility

Mauro et al., Nature Comm. (2014)
Deep connections between thermodynamics and dynamics?
