

# Active ring melts and topological glasses

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I will give a flash introduction to polymer physics and subsequently talk about computational investigation of dense polymeric systems where the topology of the polymer chains governs the material properties in- and out-of-equilibrium.

A prominent example of such a system is the melt of nonconcatenated and unknotted ring polymers, which has been fascinating for a number of reasons. For example, the equilibrium state has the same mean conformational properties as the (linear) chromosomes of higher eukaryotes [1] and the system exhibits interesting rheological behavior: close to equilibrium a power-law stress relaxation with the absence of a rubbery plateau [2] but also a strong extensional viscosity thickening [3]. It turns out that all these effects are the consequence of the topological constraints of different kinds.

Besides the constraints of no linking and no knots, the rings can restrict each other by threading - a ring entering another's ring opening [4]. It has been a long-standing conjecture that the threadings (topological in nature) of sufficiently long rings can form a hierarchical percolating network that would impede the mutual rings' motion to the extent of a glassy state (aka the topological glass conjecture) [5]. Despite the efforts, such a state has not been directly observed in simulations or experiments, maybe due to the insufficient threading in equilibrium at the accessible ring lengths. But can we manipulate the threadings to generate a topological glass or tune the response at will?

Using externally driven or active blocks (modelled as a stronger-than-thermal fluctuations) on the polymers, we can alter the ring dynamics and shift the prevalence of certain threading entanglements to generate a novel type of glass. This Active Topological Glass [6, 7] differs from ordinary polymeric glasses in many properties and exhibits the counter-intuitive behavior of a slow-down as a consequence of the energy input.

The opposite dynamic behavior can be achieved for equilibrium rings with torsional stiffness. The competition of the torsion and bending generates supercoiled conformations that reduce the threadings, and linear entanglements, thereby exhibiting a speed-up [8].

## References

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