

Rheological and mechanical properties of polystyrene with hydrogen bonding

Wendi Wang, Jeppe Madsen, Anne L. Skov, Ole Hassager, Qian Huang

Danish Polymer Center, Department of Chemical and Biochemical Engineering, Technical University of Denmark, Building 227, 2800 Kgs. Lyngby, Denmark

Recent work [1] shows that polystyrene can become flexible at room temperature by stretching the melt at a rate faster than the inverse Rouse time, followed by rapid quenching below the glass transition temperature (T_g). Long-lasting flexibility and good humidity resistance, combined with other advantages such as light weight and interference immunity, make this flexible polystyrene a good candidate for plastic optical fibers (POFs). However, improvements are required to prevent cracks during filament bending.

In the present work, we investigate if crack prevention can be achieved by introducing hydrogen bonding (carboxylic acid groups) into the backbone. The rheological and mechanical properties of polystyrenes with different acid group contents are studied and compared to the corresponding pure polystyrene sample. Linear viscoelastic (LVE) measurements have experimentally confirmed that all the tested samples have a similar number of entanglements per chain (Z), suggesting that the acid groups do not form (or weakly form) hydrogen bonds at temperatures above T_g . This is further confirmed by non-linear extensional behavior measured by stretching the samples in uniaxial extensional flow. However, different mechanical properties at room temperature have been observed, which may be explained by the Haward and Thackray model.[2] Finally, to further improve mechanical properties of polystyrene based polymers, different types of polystyrene ionomer will be employed for future studies.

[1] Huang et al., *ACS Macro Lett.* 7, 1126–1130 (2018)

[2] Meijer and Govaert, *Prog. Polym. Sci.* 30, 915–938 (2005)