

New approach for predicting transient strain-hardening of linear polymer melts in non-linear extensional flow

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While linear rheology of polymers is well understood and predicted, their behavior in non-linear regime remains a matter of discussion, even at a fundamental level. Because this topic is of great interest for industrial applications where this regime is often met, many studies addressed this issue.

The Pom-Pom model^[1] is one of the most common models to predict the viscosity of polymers in non-linear flows. However, it does not enable to predict steady viscosity at high deformation rates (see figure 1).

Therefore, several models attempt to predict the level of strain hardening reached by linear monodisperse polymer melts by introducing additional parameters (finite extensionability^[2]) or mechanisms (such as monomeric friction^[3]) that have to be taken into account with the ones acting in linear regime.

In this work, we explored another way to predict the level of strain hardening of monodisperse polymer melts in extensional flow based on the Pom-Pom model. By considering the role of the different Rouse modes in stretch relaxation, we show that it is possible to well capture the transient viscosity of linear polymers without considering additional modifications compared to the basic Tube Model mechanisms.

[1] McLeish and Larson, J. Rheol. 42, 81 (1998); doi: 10.1122/1.550933

[2] Wagner et. al., J. Rheol. 49,6, 1317-1327 (2005); doi: 10.1122/1.2048741

[3] Yaoita & al, Macromolecules, 45, 2773–2782 (2012); doi : 10.1021/ma202525v

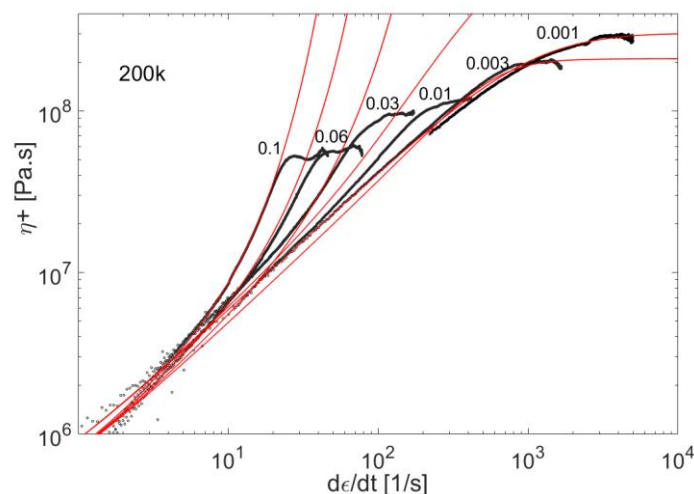


Figure 1 : Experimental (black) and predicted (red – by Pom-Pom model) transient strain hardening of monodisperse PS200k melt