Structures and rheology of polymers with long chain branching

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Polymers with low amount of long chain branching (LCB) exhibit very different properties from linear polymers. A lot of works have been done to understand the structures and rheology of LCB polymers, however, it is still difficult to characterize clearly the topological structures of polymer chains and the compositions of a LCB polymer if it is a mixture of different LCB polymers. Rheological methods have been shown to be a good choice for such problem due to the special relaxation process of branched chain on different topological structures. A topology map based on some experimental data has been suggested to account for the topology of polymers. In this work, such topology map will be extended and redrawn according to the predictions of the branch-on-branch molecular model, which supplies a possibility to determine the topological structures of pure polymers. Furthermore, the compositions and structures of a real product of reactive processing were analyzed. LCB poly(lactic acid) (PLA) was successfully prepared and the topological structure of these LCB generated from functional groups reactions as well as free radical reactions were investigated thoroughly by gel permeation chromatography and rheology with shear and elongation tests. Qualitative information on the branched structures could be readily obtained from linear viscoelasticity, nonlinear oscillatory shear experiments and strain hardening in elongational experiments. For quantitative information on chain structure, linear viscoelasticity combined with branch-on-branch (BOB) dynamic model was used to predict exact compositions and chain topology of the products, which were reasonably explained by the suggested mechanism of functional groups reaction.