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Shear-Induced Crystallization of PB-1 at Processing-relevant Conditions

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The crystallization kinetics of semi-crystalline polymers is significantly enhanced under imposed deformation. An investigation of shear-induced crystallization in high shear rate regime is of particular interest because it can be directly compared to real processing conditions. An earlier paper by Hadinata et al. (accepted for J. Rheol (2004)*) studied shear-induced crystallization of polybutene-1 (PB-1) samples having different molecular weight distribution, at crystallization temperatures from 99 - 107 °C and using relatively low shear rates (10^{-4} - 0.3 s^{-1}). The paper proposed a normalization procedure through which the curve of crystallization onset time (t_{on}) vs. shear rate ($\dot{\gamma}$) can be made temperature-invariant, and the influence of molecular weight distribution accounted for. The current study expands the range of shear rates up to 500 s^{-1} and examines the validity of the temperature-invariant curve in this range. For this purpose, three types of devices were employed: A plate-plate rotational rheometer, a Couette-type viscometer, and a capillary rheometer. It was found that the results from plate-plate rheometer and Couette-type viscometer agree with each other and this facilitates the extension of the curve. The data points obtained from the capillary rheometer, however, are shifted from this curve. Possible explanations and limitations behind this finding will be addressed. The results from shear-induced crystallization experiments are supplemented by initial results from elongational flow-induced crystallization experiments using an oil-bath rheometer.

* Hadinata, C., Gabriel, C., Ruellmann, M., and Laun, M., "Comparison of shear-induced crystallization behavior of PB-1 samples with different molecular weight distribution," accepted J. Rheol, 25 October 2004.