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Poster abstract

P.28 **Creep behaviour of bimodal polyethylene**

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Slow crack propagation limits the life span of many polyolefin applications. The deformation resistance of the highly drawn fibrils bridging the cracks determines the propagation speed. Correlations of slow crack growth resistance with creep rate deceleration factor (CRDF) and strain hardening modulus (Gp) have been observed previously in polyethylene [1, p. 409-411]. The molecular origin of these correlations however has not been clarified.

The resistance of a material against slow crack propagation is improved by a high number of tie molecules (long molecules interconnecting the crystals) [2]. This is promoted by both an optimised degree of short chain branching and a high backbone chain length. This results in very high molecular weight polymers, which drastically limits their processability. Therefore a low molecular weight fraction is added, acting like a low viscosity 'solvent' during processing. In this work, bimodal polyethylenes are studied in which the backbone chain length and the branch content of the high molecular weight fraction are varied.

In figure 1, HM and LM stand for high and low molecular weight and HB and LB stand for higher (11.5-14.3/1000C) and lower (5.0-7.7/1000C) branch content respectively. For all materials, the CRDF drops dramatically below a stress of 40 to 60 MPa. The creep mechanism appears only to be activated at a certain stress, the value of which is similar for all the materials studied. Above this stress, HMHB has a lower CRDF than the other materials. Figure 2 shows that for the HM materials, Gp is higher over the studied strain rate range. From both tests, one would conclude that HMHB has the highest resistance against slow crack propagation, which would be expected from its molecular architecture. However, HMLB shows a different ranking between the two tests, with a Gp similar to that of HMHB but a CRDF similar to the LM samples. This raises the question of which test is a better representation of the molecular mechanisms behind slow crack propagation.

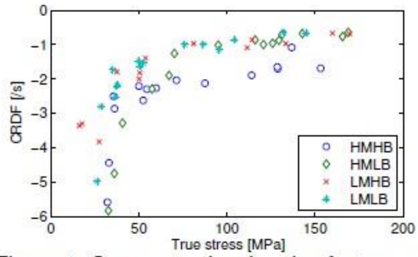

Figure 1: Creep rate deceleration factor as a function of applied stress at 80°C

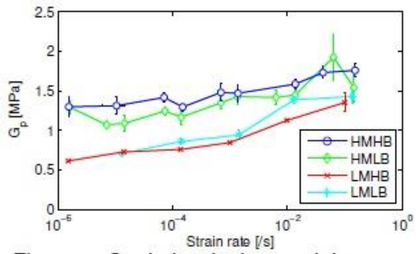

Figure 2: Strain hardening modulus as a function of strain rate at 80°C

Future work will study changes in crystal structure in the different materials during creep and strain hardening tests to establish the different mechanisms present. Crack opening displacement tests will also be done to investigate the correlation with CRDF and Gp.

[1] I.M. Ward and J. Sweeney. Mechanical properties of solid polymers. John Wiley & Sons, 2013
[2] R.A.C. Deblieck, D.J.M. van Beek, K. Remerie, and I.M. Ward. Polymer, 52:2979 –2990, 2011