

CRYSTALLISATION OF BRANCHED POLYETHYLENE ON LINEAR POLYETHYLENES

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Previous studies were carried out into the crystallisation of branched polyethylene (BPE) on linear polyethylene (LPE)^{1,2}. Puig showed in BPE/LPE blends that lamellae of BPE were able to grow from a surface of preexisting LPE crystals on isothermal treatment, conditions under which pure BPE remained molten. The amount of BPE crystals formed during the isothermal treatment was a function of the LPE content and the temperature treatment¹. Loos et al. showed that the oriented crystallization of linear low-density polyethylene on high-density polyethylene took place with an adoption of the HDPE crystal thickness at the interface and a continuous thinning of the LLDPE lamellae in the interface². In this work, we investigated the LPE molecular weight effect into the crystallisation of BPE at high temperatures.

The polyethylenes used in this study were a commercial branched polyethylene PN220 ($M_w = 208000$ g/mol, $M_w/M_n = 8.2$) and three linear polyethylenes (LPE), a commercial BP HD6070 ($M_w = 72000$ g/mol, $M_w/M_n = 6$) and two LPE purchased from NIST, 1483 ($M_w = 32000$ g/mol, $M_w/M_n = 1.1$) and 1484a ($M_w = 120000$ g/mol, $M_w/M_n = 1.2$). 1% LPE/ 99% PN220 blends were prepared by dissolving the two polymers in xylene 1% (w/v) at $\sim 150^\circ\text{C}$ and precipitating the mixture into cold acetone. After filtering, the blends were dried in a vacuum oven at 50°C for 2 days. The pure PN220 and the blends were put into a thermostatic silicone oil bath at 160°C for 30 minutes, the temperature of the bath was then decreased to 122°C and held for 48 hours for the crystallisation of LPE only. Finally, samples were transferred to a silicone oil bath using various temperatures: 117°C , 116°C , 115°C and 114°C . Samples were left at those temperatures for up to 96 hours before quenching to below room temperature. The thermal behavior of the materials was recorded in a differential scanning calorimeter, Perkin Elmer DSC-7, and the lamellar morphology was revealed using a transmission electron microscope, JEOL JEM 1220 operated at 100 kV. Samples were treated with chlorosulphonic acid, embedded in an epoxy resin, and sectioned using a Leica Ultracut at room temperature.

The largest crystallisation of the PN220 due to the presence of LPE lamellae took place at 114°C. At all temperatures, the PN220/HD6070 blend showed the largest crystallisation of PN220 (Fig. 1), as revealed by the largest heat of fusion of the intermediate melting peak in curve 2 (Fig. 1(b)). Fig. 2 shows the various lamellar morphologies. Lamellar branching in Figs 2(b) and 2(c) is clearly observed, the BPE segments nucleate onto the LPE lamellae surfaces to form crystals.

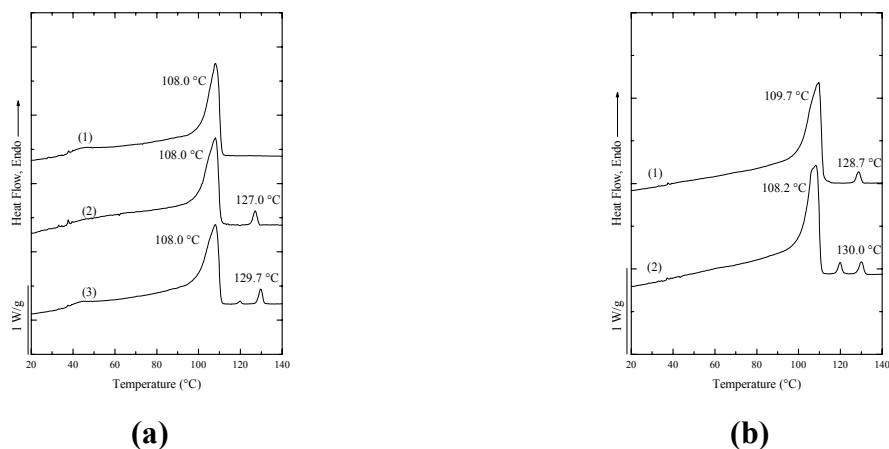


Fig.1 DSC traces from materials quenched after various isothermal treatments. (b) (1) PN220 held at 122°C and 114°C, (2) PN220/1483 crystallized at 122°C, (3) PN220/1483 crystallized at 122°C and 114°C. (b) (1) PN220/HD6070 crystallized at 122°C, (2) PN220/HD6070 crystallized at 122°C and 114°C.

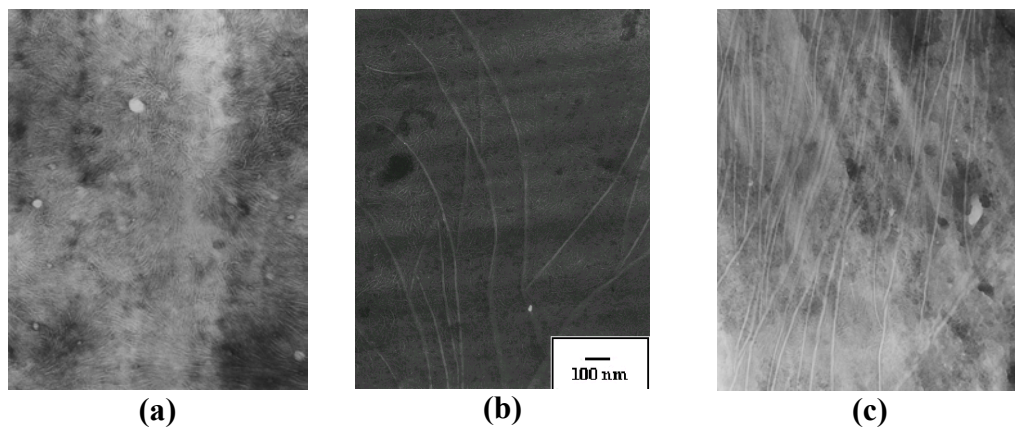


Fig. 2 Transmission electron micrographs showing the PE section after chlorosulphonation. (a) PN220 held at 122°C and 114°C. (b) PN220/1483 crystallized at 122°C and 114°C. (c) PN220/HD6070 crystallized at 122°C and 114°C.

(1) Puig CC, *Polym. Bull.*, **36** (1996) 361.

(2) Loos J, Katzenberg F, Petermann J, *J. Mat. Sci.*, **32** (1997) 1551.