



Experiment title: Combination of high spatial and high time resolution in the study of crystallization kinetics during drawing and annealing of poly(ethyleneterephthalate) copolymers (PET)

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Local contact(s):

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Report:

Understanding the mechanism of strain induced crystallization in homopolymers and copolymers is fundamentally important for industrial polymer processing. Strain induced crystallization enables high orientation to be obtained by preventing chain slippage. It is also stabilises orientation after draw and prevents shrinkage above T_g .

In the present study, we have been investigating the effect strain induced crystallization rate by statistically distributed comonomers within PET as function of:

- draw ratio
- draw rate
- draw temperature

The comonomers used in these studies were:

- Isophthalic acid (IPA)
- Diethylene glycol (DEG)
- Cyclohexane dimethanol (CHDM)

Samples were drawn at temperatures from 90°C to 125°C with draw rates from 281% min^{-1} to 72000% min^{-1} . The draw ratio were varied from 1.8 to 4.0. In each experiment 124 diffraction patterns were recorded using a Photonic Science CCD camera linked to an i860 based Synoptics frame grabber with an exposure time of 40 msec. For each draw ratio, crystallization rate was determined by using the techniques reported previously [1].

The development of orientation ($\langle P_2 \cos(\theta) \rangle$) was followed by analysing azimuthal **scans** of successive frames at a reciprocal space distance of 0.28 \AA^{-1} [2]. From this analysis, the $\langle P_2 \cos(\theta) \rangle$ at the end of draw were determined. The variation of crystallization rate as a function of $\langle P_2 \cos(\theta) \rangle$ at the end of the draw for PET and PET with 10% IPA are shown in figure 1.

It can be seen from the figure 1:

- The rate of crystallisation is reduced by incorporation of IPA comonomer in to PET
- The critical orientation value **is** increased by incorporation of IPA comonomer
- For a given final orientation at the end of draw, the crystallisation rate **is** reduced by half by incorporation of IPA comonomer

The results from DEG and CHDM were also shows a reduced crystallisation rate compared to unmodified PET.

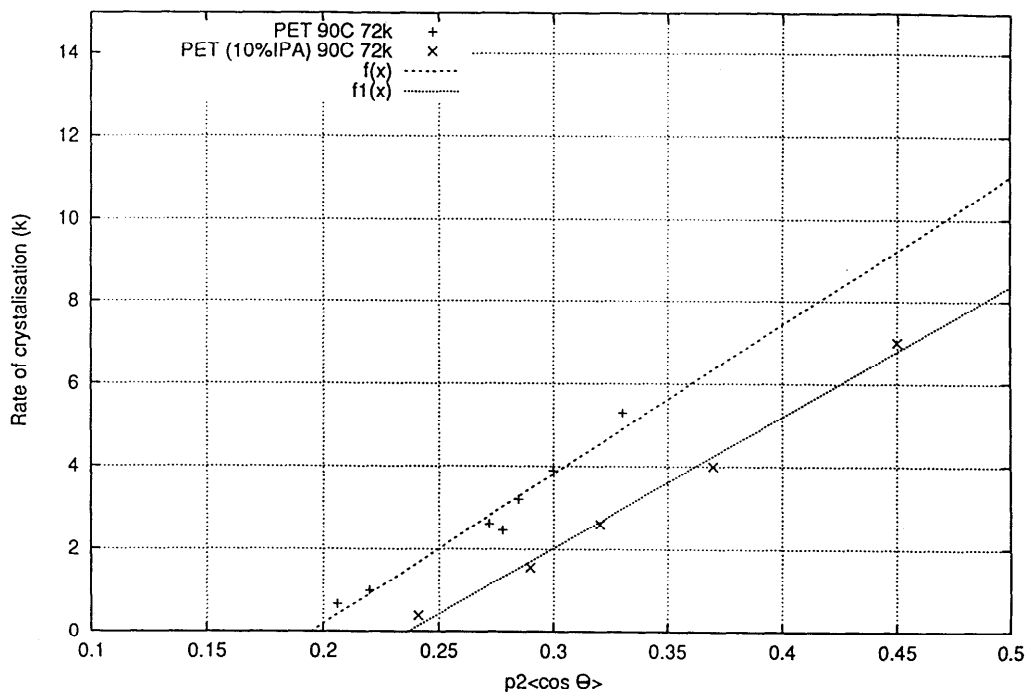


Figure 1 Variation of crystallization rate with the $\langle P_2 \cos(\theta) \rangle$ at the end of draw for PET and PET modified with 10% IPA. The samples were drawn at 90°C with a rate of $72000\% \text{ min}^{-1}$

References

- [1] Blundell, D.J., MacKerron, D.H., Fuller, W., Mahendrasingam, A., Martin, C., Oldman, R.J., Rule, R.J. and Riekel, C., *Polymer*, (1996), 37, 3303-3311.
- [2] Mahendrasingam, A., Martin, C., Fuller, W., Blundell, D.J., Oldman, R.J., Harvie, J.L., MacKerron, D.H., Riekel, C. and Engstrom, P., submitted to *Polymer*