The production of polyethylene films through flow induced crystallization

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INTRODUCTION

Recently Coombes and Keller[1,2] presented a novel method for growing highly oriented polyethylene films from flowing solutions. The method follows the successful experiments by Pennings and coworkers[3] with fibre forming and also makes use of a Couette apparatus.

The aim of this note is to present first results obtained with a different technique already suggested[4].

EXPERIMENTAL

As schematically shown in *Figure 1* a rotating disk is pressed against a stationary plate and the two disks are immersed in the crystallizing solution. The rotating disk has a slot which allows fresh solution to be fed continuously to the gap where the flow-induced crystallization takes place.

The apparatus used in this investigation had a rotating disk made out of brass which was not critical for inducing orientation in the solution.

With regard to the stationary plate the best results were expected with a microscopically fibrillar surface morphology, according to the results already obtained in references 1 and 2. Therefore a stationary plate of sandblasted wood was used.

The morphological features of the samples have been studied, after thoroughly washing the samples in hot xylene, by a Scanning Electron Microscopy model ISI 100.

The solution was a high molecular weight HD-Polyethylene in xylene at a concentration of 5 g/l. The results reported in the following pertain to a run conducted at a rotor speed of about 200 r.p.m. and at a temperature of 112°C. As for the temperature the test was actually performed firstly maintaining, for some time, the solution at 130°C and then quickly dropping it to the chosen value.

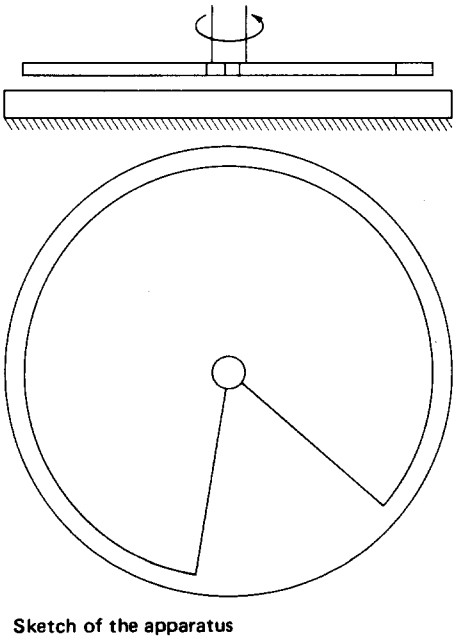

Figure 1 Sketch of the apparatus

RESULTS AND DISCUSSION

The fibrous nature of the produced film was revealed under the scanning electron microscope. More precisely the micrograph of the lower part of the film, i.e. the one attached to the stationary plate, is shown in *Figure 2*. On the right side of the figure one may observe the fine fibrils constituting the larger fibrils shown on the left: the 'shish-kebab' type of structure is evident although no attempt has been so far made to find out the best working conditions.

Figure 3 shows the micrograph of the upper part of the

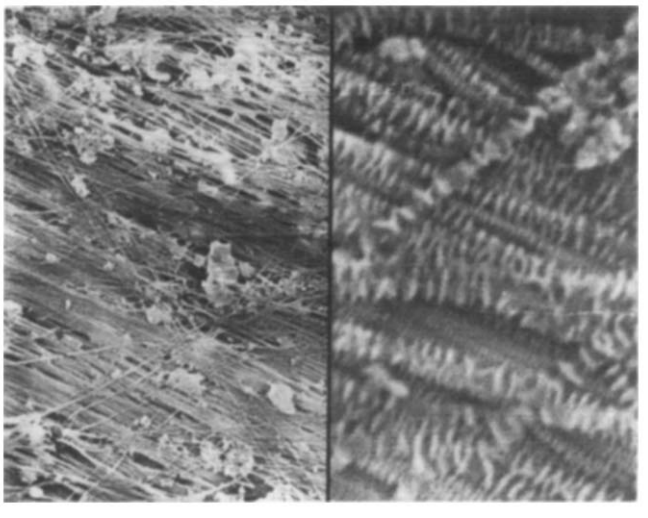

Figure 2 Micrograph of the lower part of the grown film

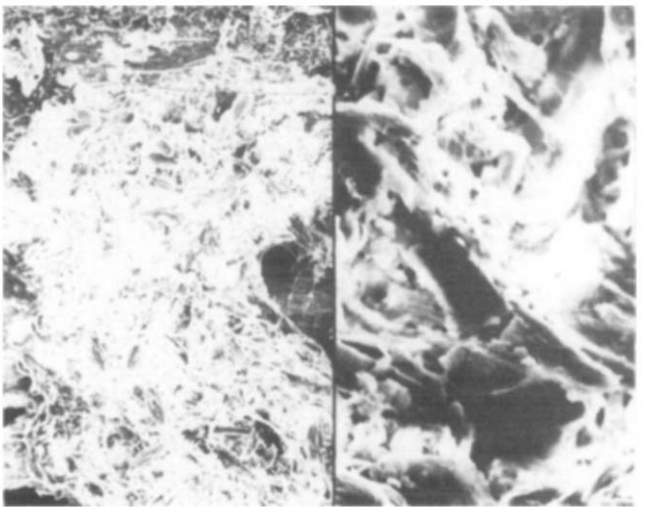

Figure 3 Micrograph of the upper part of the grown film

film: it is evident that further crystallization occurred after stopping the flow. And in fact the usual lamellar type of structure may be seen with no obvious indication of orientation.

Finally, *Figure 4* shows a wide angle X-ray pattern of the above film. Of course such data have the shortcomings of the lamellar overgrowth already mentioned; the expected orientation in the tangential direction is therefore not evident. They reveal, however, like the films reported by Coombes and Keller[1] the existence of the monoclinic crystalline form of the polyethylene beyond the usual orthorombic form. This seems a peculiarity of the flow induced crystalline fibres and films in the sense that the appearance of such a form was previously observed only as a consequence of mechanical operations[5].

In conclusion the method presented here is promising in the view of obtaining high modulus polymer films from dilute solutions.

The technique has been shown to be successful but its optimization has not even been investigated neither with regard to the experimental conditions nor to any other polymer.

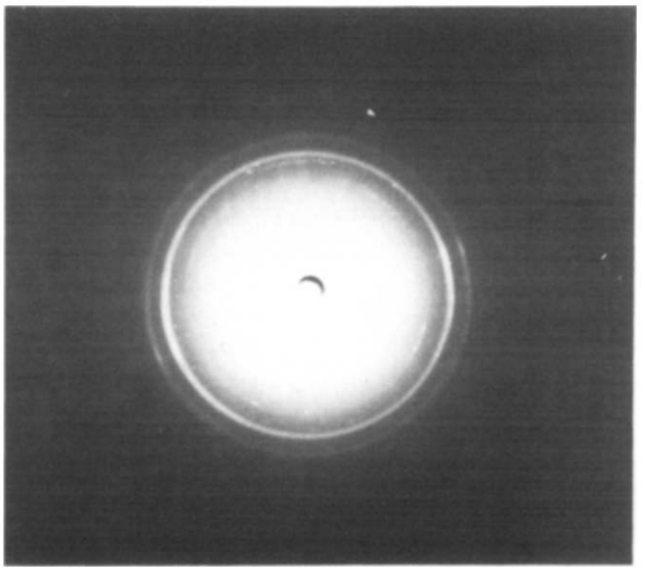

Figure 4 Wide angle X-ray pattern of the grown film

REFERENCES

1 Coombes, A. and Keller, A. *J. Polym. Sci. Polym. Phys. Edn.* 1979, **17**, 1637

2 Coombes, A., Cannon, C. G. and Keller, A. *J. Polym. Sci. Polym. Phys. Edn.* 1979, **17**, 1957

3 Pennings, A. J., Zwijnemburg, A. and Lageneen, R. *Kolloid Zn. Z. Polym.* 1973, **251**, 500

4 Acierno, D., La Mantia, F. P. and Marrucci, G. *Polym. Eng. Sci. 1978*, **18**, 817

5 Hay, I. L. and Keller, A. *J. Polym. Sci., Polym. Symp.* 1970, **30**, 289