

## The Swelling of Polyester in Dichloroacetic Acid

It has been reported by Tucker and Murray<sup>1</sup> that the treatment of poly(ethylene terephthalate) filaments with *n*-propylamine solutions produces disc-like structures with a central core. The core of these discs can be removed by the use of ultrasonic radiation which also splits the discs in the direction of the fiber axis. Such unusual features of polyester fibers have not been previously reported.

As an indication that such features may be generally characteristic of swollen polyester filaments rather than specific to the system examined by Tucker and Murray, the results of some recent swelling experiments carried out at the Shirley Institute may be of interest.

Partially oriented yarn (POY) (268 dtex/30 fil. Viscosuisse polyester) was passed over the heater of a texturing machine at different temperatures (195°, 200°, 205°, 210°C) without false twist being applied. During these experiments the draw ratio was maintained at 1.62, and the speed of throughput was 200 m/min. Small samples of these yarns were swollen in a series of aqueous solutions of dichloroacetic acid containing 83%, 84%, and 85% (v/v) dichloroacetic acid. After allowing swelling to take place for 15 min at room temperature, the swollen fibers were mounted in the dichloroacetic acid solution on a microscope slide and examined with phase-contrast microscopy. Photomicrographs were taken of typical results.

These photomicrographs revealed several interesting features. In some critical concentrations of dichloroacetic acid in the range of 82%–85% (v/v) the filaments in the yarn were seen to swell to markedly different degrees, some highly swollen and some hardly swollen at all. These differences were attributed to the different heat treatments the various filaments had received due to their different relative position in the yarn during passage over the heater. The highly swollen portions showed clearly the disc structures reported by Tucker and Murray, but in addition there was evidence of an external skin which had what appeared to be a serrated seam along it. A typical photograph is shown Figure 1.

The disc effects were first thought to be artifacts produced by diffraction effects; but if the concentration of the acid was gradually raised, separated discs were produced that had a central core similar to that reported by Tucker and Murray (Fig. 2). Owing to the poor contrast in the system it was found difficult to produce clear photographs of the effect, but it was observed with different yarns on a number of occasions. Furthermore, similar observations were made with textured yarns where false twist (61 t.p.i.) had been applied during heating.

In Table I are given the dimensions of the fibers swollen in different concentrations of dichloroacetic acid as obtained by the use of a projection microscope. Where two values are given, the lower value is for the slightly swollen filaments and the upper value is for the highly swollen filaments from the same specimen in the particular concentration of acid. All values are the mean of 50 determinations.

It will be seen that as the temperature of heat treatment is raised the degree of swelling in a par-

TABLE I  
The Swelling of Polyester Filaments in Dichloroacetic Acid

Acid in water, % (v/v)	Width, microns			
	195°C <sup>a</sup>	200°C	205°C	210°C
0 (water)	11.8	15.0	15.0	15.7
50	15.0	15.0	17.6	17.0
70	15.7	19.6	19.0	19.6
80	22.2	27.5	23.5	22.2
81	27.5	24.2	25.5	24.2
82	32.0/99.3	27.5	28.1	22.9
83	134.6	31.4/116.3	26.8	25.5
84	168.0	138.6	29.4/105.2	26.8
85	113.1	135.9	30.7/118.3	25.5

<sup>a</sup> Sample preparation temperature.

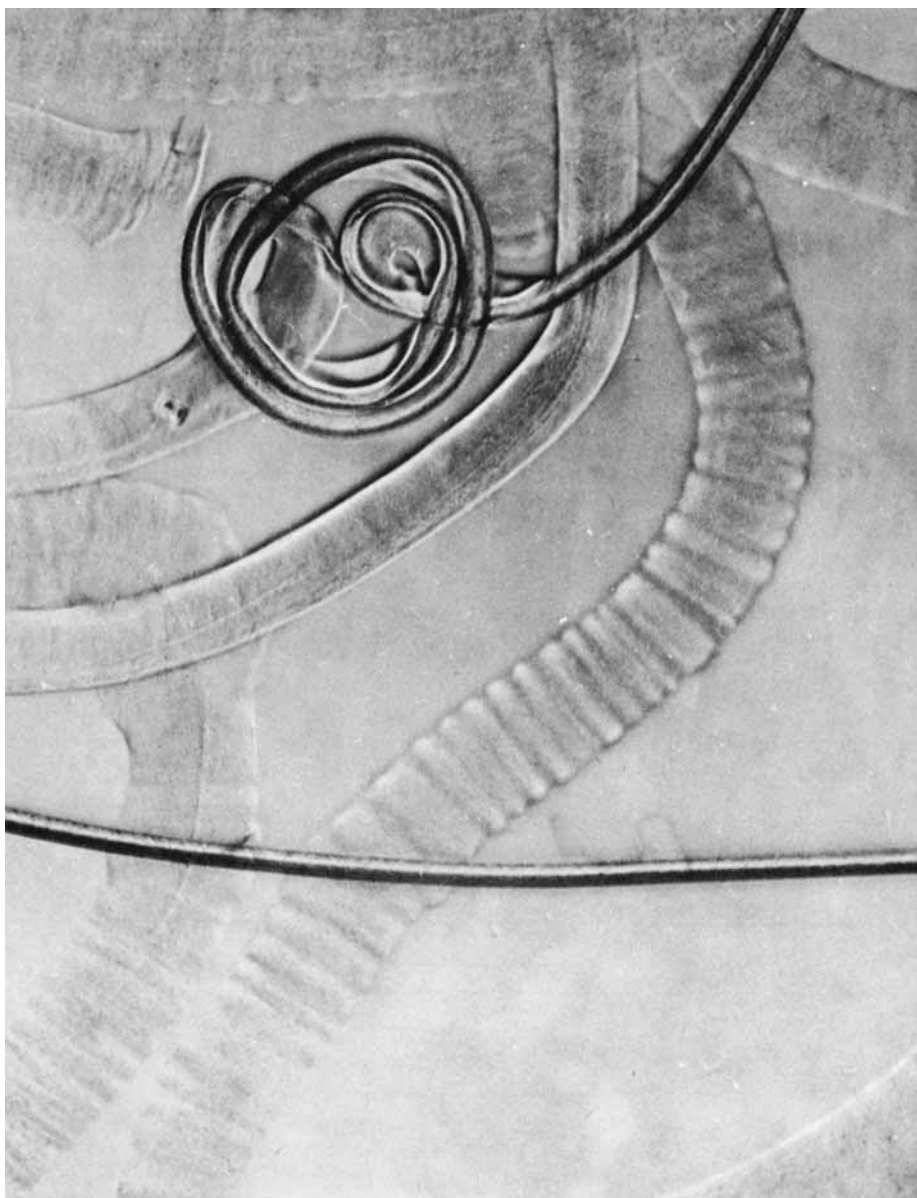


Fig. 1. Photomicrograph ( $\times 120$ ) of polyester yarn heated to  $205^{\circ}\text{C}$  in a texturing machine (no false twist) and swollen in 84% (v/v) dichloroacetic acid/water solution.



Fig. 2. Photomicrograph ( $\times 120$ ) of polyester yarn heated to  $200^{\circ}\text{C}$  in a texturing machine (no false twist) and swollen in 83% (v/v) dichloroacetic acid/water solution.

ticular concentration of acid is reduced; this is no doubt some consequence of the annealing process brought about by the action of heat. The study of the swelling of polyester with aqueous dichloroacetic acid thus throws light on heat-setting effects and has also revealed unusual features of morphology that now require explanation.

#### References

1. P. Tucker and R. Murray, *Proc. Ann. Meet. Electron Microsc. Soc. Am.* **33**, 82-83 (1975).

J. O. WARWICKER

Shirley Institute  
Manchester M20 8RX, England

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