STUDIES ON THE MANUFACTURE OF HIGH TECHNOLOGY FIBERS

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1. INTRODUCTION

Some functional and high technology fibers are developed successfully by the authors, through studies on the melt spinning of polymer blends and the ununiform structure of fibre cross section for single polymer spinning. The conclusion of our studies are as follows.

Reological behaviour and compatibility for polymer blend spinning can be controlled by seeking polymers composition, blend ratio and(or) using agent of adjusting rheological behaviour; besides, the special spinning parameters are suitable to above. The blend spinning fibres are made with good spinnability and processability(contain high speed spining and its processing) on common single screw spinning machine. The feature and property of these blend spinning fibres can exceed that of every components for blend polymers.

For single polymer spinning fibres, the special ununiform structure of fibre cross section can be formed by controlling spinning condition. So that this study can obtain the unexpected results in the development of SHINGOSEN.

The characteristic of development for these new synthetic fibres is using common spinning and processing apparatus. But, the adjusting rheological behaviour and processing method demand the highest level technique. Therefore, these developments above naturally belong to the area of high technology.

2. THE MANUFACTURE OF HIGH TENACITY AND HIGH INITIAL YOUNG'S MODULUS FIBRES BY SPINNING OF PET/PEET BLENDS

PET (polyethylene terephthalate) and PEET (polyethylene—1,2—diphenoxyethane-p,p'-dicarboxylate blends are all crystalline polymers. The PET is a good fibre material. The PEET, in contrast to PET, crystallizes relatively easily. PEET fibres have also comparatively high tenacity and Young's modulus. The viscority of PET/PEET melt blends, the oriented crystallization and necking phenomenain in the spinline, all can be controlled. If this blend spinning fibres structure can be controlled, the fibre modification and the industrial application of blend fibres will be realized.

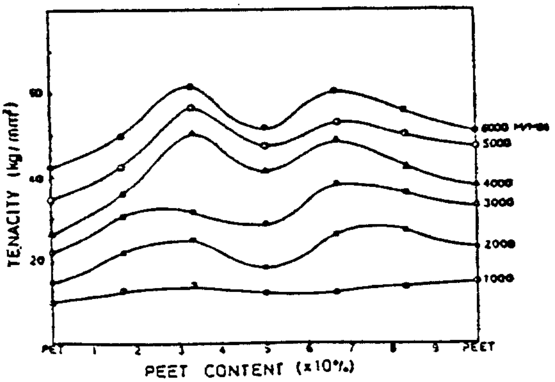

Fig. 1

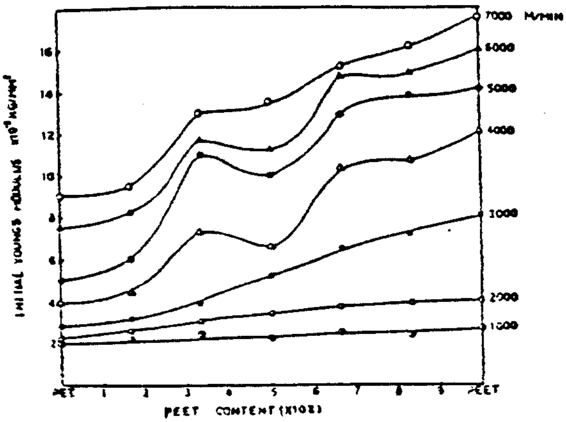

Fig. 2

The relation between tenacity and blend ratio of PET/PEET blend fibres at various take-up speed is shown as Figure 1. It is similar to the relation between initial Young's modulus and blend ratio of PET/PEET blend spinning fibres (Fig. 2). The tenacity of 67/33, 33/67 (PET/PEET) blend spinning fibres were larger than that of single polymers

PET, PEET, at high take-up speeds. Because of in high speed spinning of PET/PEET blends, the thinning fibrils(island phase) were formed, and the sea-island fibre structure shows a netlike form. This suggests that, it is possible, the mechanical properties of PET/PEET blend fibres change to strong.

3. INDUSTRIAL DEVELOPMENT OF A NEW ANTISTATIC POLYESTER FIBER

The antistatic polyester fibre developed by the authors has a sea-island struture by blend spinning of antistatic agent PR-86 made by ourself (content 0.4-1.2%, China patent C.P. 86106302.3) with PET pellets on common single screw spinning machine. The surface electric charge density of antistatic polyester fabric is lower than $5\mu C/M^2$(washing 50 times, measuring condition: RH30-40%, 20-25℃)

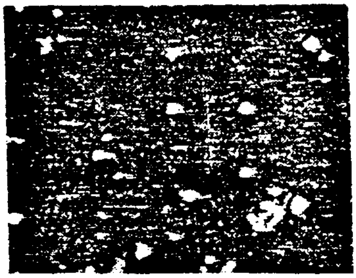

Fig. 3 The cross section of antistatic polyester fibre by blending spinning with PR-86(SEM)

Fig. 4 The vertical section of antistatic polyester fibre by blending spinning with PR-86(SEM)

From figure 3 and figure 4. The sea-island structure of fibre can be seen clearly. The antistatic agent PR-86 with long and narrow fibril form (island phase) is dispersed in polyester (sea phase) fibre. Because PR-86 contain a little agent of adjusting rheological behaviour, the PR-86 is distributed in the centre of fibre. Therefore the antistatic agent

PR-86 in fibre can not be washed away. The fibre of sea-island structure of which island phase is distributed in centre of fibre, that is made by using agent of adiusting rheological behaviour on common single screw spinning machine. It is not using double screw composite spineret spinning machine. This is a new technique of fibre formation. This technique is very important for industrial development of new fibre material by blend spinning. This formation technique of fiber had been reported at ISF-85 International Symposium on Fibres Science and Technology, 229 Hakone, Japan, 1985. Here not detail report again.

Up to now, there are two kind of main antistatic mechanism for all antistatic fibre of industrial development.

(1) Adding large amount of carbon black or metal powder into synthetic fibre, the conductive fiber is made by double screw composite spinneret spinning. This conductive fibre can be spun into blend yarn with common synthetic fibre again. This melt spinning process is difficult and complex. It can make mechanical properties of fibre bad and these fibres often have colour.

(2) Introduced moisture absorption group into polymer macromolecule or added moisture absorption type antistatic agent into fibres by graft copolymerization and blend or complex spinning method. The antistatic mechanism of this type fibre is dependent on enhancement of moisture absorption and decrease of electric resistance.

The charateristic of antistatic polyester fiber developed by the authors is that relative humidity has not influence on its antistatic property. This type fibre has a durably fine antistatic property and a good spinnability.

According to the measurement data of friction static voltage, twine, fly in the textile process and the productivity operating flexibility, the improving textile processability has been proved. This antistatic fibre is different from previous common antistatic fibres. Put this antistatic fibre into drying oven (101308Pa vacuum, 100℃, 24hours), than drawn the fibre from drying oven, dust absorptivity is measured immediatly (namely, the measurement in the extreme drying condition). The measurement conclusion shows clear antistatic property of fibre still. So we studied on the antistatic machanism of this fibre and advanced a new antistatic mechanism.

For the new antistatic mechanism, we studies on many industrial testing, for example as follows.

The common polyester fabric and antistatic polyester fabric with same fabric construction, fabric design, made from 100% polyester DTY (Draw Textured Yarn). Their dielectric properties are shown as figure 5 and figure 6.

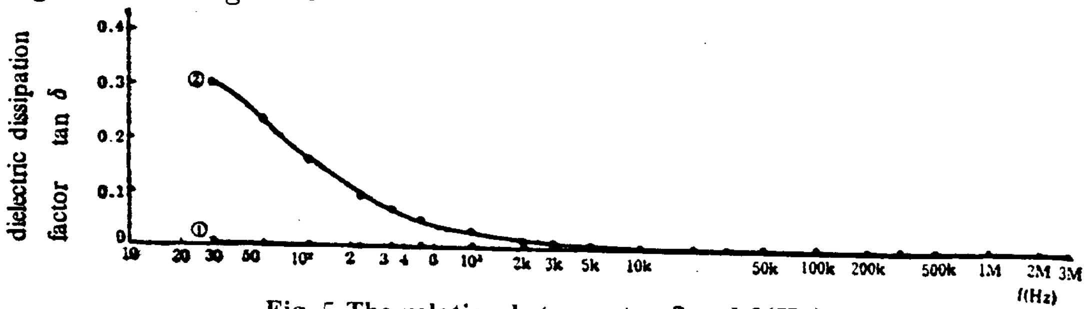

Fig. 5 The relation between tan δ and f(Hz)

① common polyester fabric; ② antistatic polyester fabric

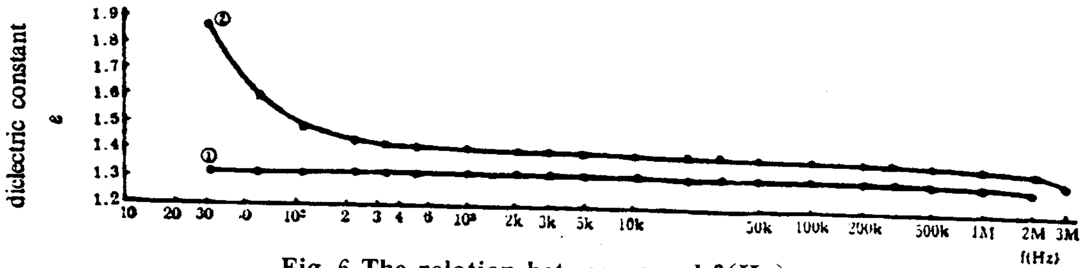

Fig. 6 The relation between ε and f(Hz)

① common polyester fabric; ② antistatic polyester fabric

For the fabric of antistatic polyester DTY, the dielectric dissipation factor curve [tan δ-f(Hz)] has a peak at 30 Hz. The dielectric constant has a large of enhancement at frequency less than 2KHz. For antistatic polyester DTY, because of the high speed spinning , so that the " island" structure tends to longer and narrower. The conclusion is that it is not electron polarization and is not dipole polarization too, the strong polarization of larger size particules occurred at lower frequency. Namely the interfacial polarization occurred.

A new antistatic mechanism consisting of the polarization of the "island" in the fibre under the action of electricfield and discharging electric charge within the fibre have been advanced and proved.

4. THE DEVELOPMENT OF DYEABILITY PET FIBRE BY HIGH SPEED SPINNING

On the basic of manufacture of multiphase structure fibers by blend spinning above, further, the PET fully drawn yarn(FDY) with 0.7 d.p.f was industrial manufactured by high speed spinning, that spinning speed is 6200m/min, with controlling special spinning condition.

Because using quench air and hot bobbin spinning, moreover, the microfibres have large specific surface area, the special ununion structure of fibre cross section can be formed. The interference fringe pattern in oblique cross section of these PET fibres under a polarized microscope is shown as figure 7.

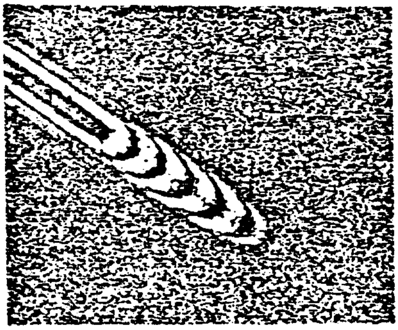

Fig. 7 Interference fringe pattern in oblique cross section of PET fibres under a polarized microscope.

In the fibre formation process, the sheath(outer) layer of this fibre bears large stress. So that, in this sheath(outer) layer of the fibre , the orientation degree is higher, the crystallinety is higher also , and the crystalline size is little. But in the core of this fibre, the orientation degree is low, it even has not crystalline.

Use colourant DISPERSOL RED E-38, colourant concentration is 1%(o.w.f.), the colourant can diffuse uniformly inside through sheath layer of this fibre, in atmospheric pressure dyeing process. After dyeing and setting process, the crystallinity of the sheath layer for this fibre changes to high. So it has good colour fastness. The dyeuptake is high 96.4% (The common PET fibre is less than 30%) The dyeing uniformity reach 5 grade. This fibre has a good colour shade and high dye level. In addition, this fibre has fine mechanical property and good thermostability. This new PET fibre will be capable of replacing cashionic dyeable polyester (CDP) or easy cashionic dyeable polyester (ECDP) fibres.