

Polyester Fibres Finished with Polyaniline

Introduction

Polyester (PET) fibres have excellent practical properties, and their production has grown most rapidly of all chemical fibres. At the same time, they are expected to meet more and more requirements. For this reason, they are modified in a variety of ways. Some of these modifications are attempted specifically to provide them with antielectrostatic properties. Many methods are employed to obtain this effect, such as treatment with finishing agents, mainly based on ion compounds. The paper presents the results of coating polyester with doped polyaniline.

So far, most papers in this field have been devoted to coating PET fibres with PANI through chemical [1-4] or electrochemical [5] polymerisation.

In this study, PET fibres were padded with PANI dissolved in an organic solvent. The treated textiles were subsequently thermoset. The results obtained are discussed below.

Experimental

Materials

- Polyester raw woven fabric of basis weight 120 g/m²,
- polyaniline – synthesised as in [6],
- dodecylbenzenesulphonic acid (DBSA), supplied by the Rokita company from Brzeg Dolny, Poland

Equipment

For recording UV Vis spectra, a Hitachi U.2001 spectrophotometer was used. It had an RSA.HI.20 attachment with an

Abstract

The study attempted to obtain antielectrostatic polyester fibres. Polyaniline (PANI) doped with dodecylbenzenesulphonic acid (DBSA) was used to make the fibres conductive. PET textiles were padded with PANI solution. The paper presents the test results of early attempts to modify PET fibres. The textiles were examined using optical and electron microscopy (SEM), UV-Vis; electrical resistance was also measured.

Key words: Polyaniline, poly(ethylene terephthalate) fibres, composite coating.

integrating sphere for recording reflected and diffused light.

The images were obtained in a POLAM P.113 polarising microscope equipped with a digital camera.

The morphology of fibre surfaces was examined using a JSM.5500 LV JEOL scanning microscope with a tungsten electron source.

The electrical resistance measurement was made using a 2410 1100V SourceMeter® from Keithley and a Keithley 617 Programmable Electrometer apparatus

Preparing samples for examination

The polyaniline was doped with DBSA in a molar ratio of 1:0.5 and then dissolved in an organic solvent [7, 8].

The textile samples were placed in frames and padded with polyaniline solution. They were then subjected to increased temperature for a short time. Thus the prepared samples were further examined.

Results and discussion

The textiles obtained were tested organoleptically regarding their colour, appearance and handle. The samples had good handle, a pleasant appearance and colours ranging from light green to dark green. All these properties were determined by the modification method applied. When viewed under an optical microscope, the samples were green over their entire length. In passing light, they displayed a translucent greenish colour.

Under an electron microscope, the uneven surface of the fibres was revealed (Fig1). This may have been due to the amount of padded polyaniline as well as to the entire process of thermo-setting, its dura-

tion and – particularly – the number of padding cycles.

Figures 2 and 3 are photographs of cross-sections of fibres from the modified textiles. Both photographs reveal the laminar structure of the fibres. Figure 2 shows a ring around the proper fibre, with a clear phase boundary. Figure 3. shows a partly disconnected coating. The thickness of this layer, measured under both optical and electron microscope, ranges from 1 mm to 2 mm, or 5÷10% of fibre diameter.

Applied in this way, polyaniline from organic solvent solution creates a coating, which is not strongly bound with the fibre, making a separate phase with a distinct phase boundary.

UV-Vis examination was also carried out and electric resistance was measured. The

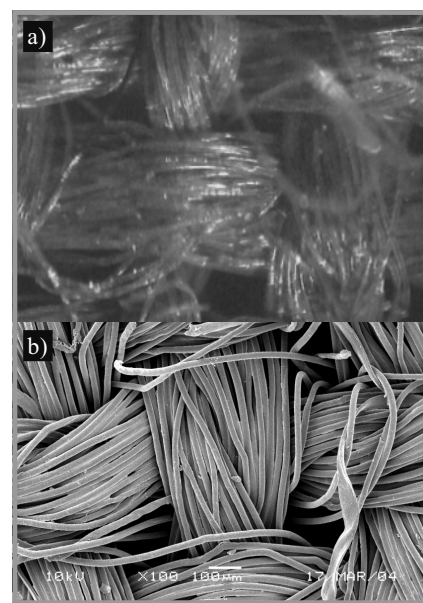


Figure 1. Microphotographs of textile taken under a) optical microscope; b) electron microscope.

results obtained seem to be strongly affected by the duration of thermo-setting and the number of padding/thermo-setting cycles.

As Figure 4 shows, resistance varies depending on the duration of thermo-setting. For single padding, it decreases initially as the thermo-setting duration grows, but then rises sharply. For double and triple padding/thermo-setting cycles, resistance does not rise quickly, although it generally increases as the thermo-setting duration grows. It seems reasonable to say that when PANI is padded only once, a thin layer is produced, which degrades quickly during longer thermo-setting. When the PANI layer is thicker, this destruction has a far weaker effect on the total resistance value.

With a higher number of padding/thermo-setting cycles, the total absorption of visible light increases (Figure 5), which is accompanied by a shift of the polaron band

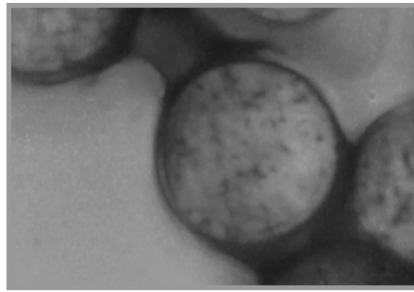


Figure 2. Microphotograph of fibre cross-section taken under an optical microscope (magnitude $\sim 2000\times$).

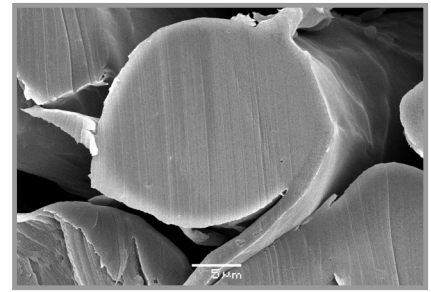


Figure 3. Microphotograph of fibre cross-section taken under an electron microscope (magnitude $3000\times$).

towards higher energies. As a result of repeated polyaniline padding, its light-absorbing layer becomes thicker, but on the other hand this polyaniline is destroyed by high temperatures.

The UV-Vis results correlate with the results of resistance measurements obtained for the same textiles. As the number of padding/thermo-setting cycles grows, the textile resistance decreases. As a result

of repeated polyaniline padding, an increasingly thick conductive layer is created on the textile surface. It becomes continuous, with more and more conductive paths, and consequently the textile conductivity increases. The shift of the polaron band towards lower energies seems to weaken this effect. However, the polyaniline degradation is easily compensated for by the thickness and continuity of polyaniline layer.

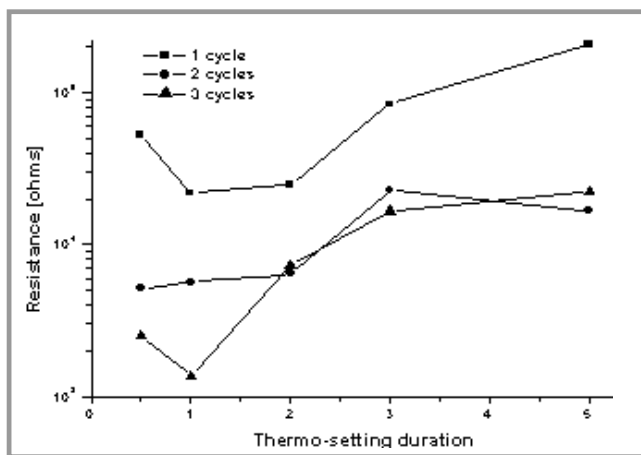


Figure 4. Relationship between resistance and thermo-setting duration for varying numbers of padding/thermo-setting cycles.

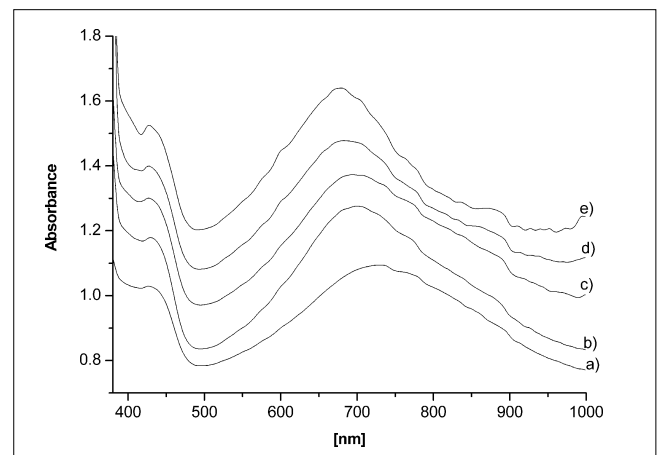


Figure 5. UV-Vis spectra of textiles coated with polyaniline, padded and thermo-set 1 to 5 times (a-e).

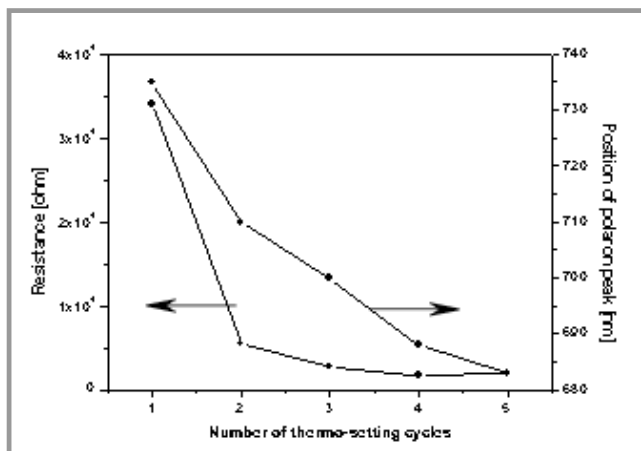


Figure 6. Relationship between resistance and polaron band maximum for varying numbers of padding/thermo-setting cycles.

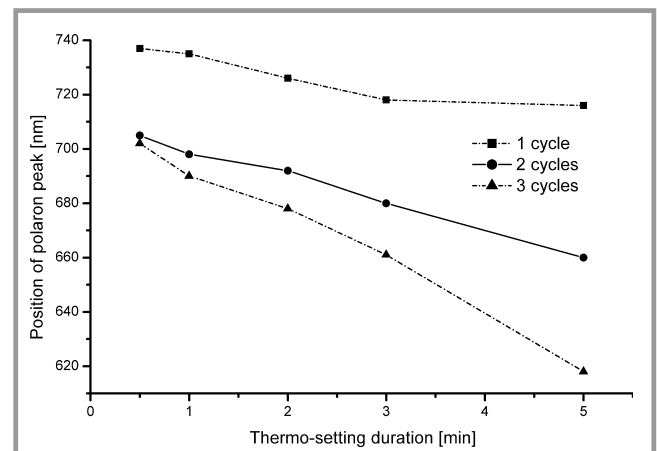


Figure 7. Relationship between the position of polaron band maximum and the duration of thermo-setting for various numbers of padding cycles.

An important effect that confirms the influence of temperature on the quality of coating is the relationship shown in Figure 7. The duration of thermo-setting affects the position of the polaron band maximum. As the duration increases, this band shifts towards higher energies. The shift has its maximum value for the longest duration, i.e. 5 minutes. If thermo-setting is repeated a number of times for the same sample, the polaron band shift towards higher energies increases.

For a sample treated three times over 5 minutes, the polaron peak maximum has the lowest value of 618 [nm]. The position of this band may suggest that polyaniline is poorly protonated, and its substantial destruction is already possible.

■ Conclusions

The method of polyaniline application presented in this paper is a new and interesting way of modifying PET fibres. When subjected to higher temperature for a short time, polyester becomes permanently coated with polyaniline. The coatings obtained are characterised by good practical properties and a pleasant green colour. Low resistance suggests that the coatings have good antielectrostatic properties and can be widely used for modifying PET. However, it should be stressed that extending the duration of thermal treatment significantly weakens polyaniline and makes its layer degrade. Consequently, the resistance of the textiles obtained grows. □

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