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Physical Modification of Polypropylene

- Preparation of Disperse dyeable Fibers -

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1. Introduction

Polypropylene fibers are difficult to dye by conventional dyeing techniques due either to lack of dye receptor sites in their molecular structure to with the dye molecules may become attached, or to difficult of penetration of certain types of dye molecules into the structure[1]. Although the diffusion coefficient of disperse dyes into polypropylene is quite high, the saturation values are very low. It should be emphasized that the mass pigmentation is still the most widely used coloration method for polypropylene[2, 3]. However, development of various conventional dyeing techniques is in progress. The efforts have been concen trated on three different directions:

1. Dyeing of unmodified polypropylene fibers by conventional techniques involving suitable dyes such as vat, azoic, and hydrocarbon-soluble dyes, carriers, and other treatments.
2. Copolymerization or graft copolymerization of polypropylene with dye-receptive monomers.
3. Introduction of additives to polypropylene has been suggested[4~6].

The present work aim at investigation the effect of the poly(ethylene-co-vinyl acetate) (EVA) copolymer, which has been incorporated in polypropylene at different vinyl acetate contents and melt flow indexes, on disperse dye absorption of modified polypropylene fibers.

2. Experimental

2.1 Materials

The isotactic polypropylene (PP), PP-180 (MFI=26), supplied by DAELIM industrial Co., Ltd. The EVA copolymers containing 28, 33 wt % vinvl acetate (VA) were EVAFLEX-260 (MFI=5), EVAFLEX-150 (MFI=30), a product of Du Pont-Mitsu

Polychemicals Co respectively. The dyes used were C. I Disperse Red 60, C. I Disperse Blue 79 and C. I Disperse Yellow 42. Dyes and auxiliaries used were of commercial grade.

2.2 Preparation of Blends

The PP/EVA blends of compositions 1, 3, 5, 7, 9 wt% EVA content were prepared by melt mixing at screw speed of 250 rpm and temperature range of 200~210℃ from first zone to die in a single-screw compounder (WERNER & PFLEIDERER type ZSK25).

The strands obtained from the compounder were cut into small granules in a granulator and used for melt spinning.

2.3 Preparation of Melt Spinning

Before melt-spinning, the pellets of blend were dried in a vacuum drier for 5 h at 80℃.

The pellets were fed into a spinning machine (Han-Kook Spin-Draw M/C) with spinning nozzle having 30 orifices each of 0.5 ㎜ diameter, melt spun at an extrusion rate of 19 g/min, take up rate of 1450 m/min, draw temperature 95~110℃ and draw ratio of 3.8 at a temperature of spinning head 230℃. The drawn multifilaments were knitted to a tubular fabric.

2.4 Mechanical Determinations

Mechanical testing of modified polypropylene filaments were determined at room temperature using an Instron (4301) tensile tester, equipped with a 2 kgf load cell. The gauge length was 100 ㎜. All the tensile properties to be presented are the average of at least five tests.

2.5 Dyeing of Modified Polypropylene fibers

The dyeing of the modified polypropylene fabrics were carried out in dyeing machine (Mathis Labomat Beaker Dyer Type BFA-8/16).

The dyeing recipe used was

- Fabric, 2g
- Dye, 1 % o. w. f.
- Disperse agent (CIE 111)
- Liquor ratio, 50 : 1

Dyeing was started at 40℃, reached the boil (130℃) in 20 min time and continued at this temperature for 40 min. Washing solution containing 0.5 % (w/v) standard washing soap was used at a liquor ratio of 50 : 1 at 40℃ for 30 min under continuous agitation to remove unfixed surface dye.

2.6 Analyzing Depth of Shade

K/S values as calculated from Kubelka-Munk equation $K/S = (1-R)^2/2R$ were used to determine the depth of shade of dyed polypropylene fabrics. The reflectance spectra for dyed polypropylene fabrics were recorded on a Computer Colour Matching(Spectraflash 500, Datacolor Co., Ltd, USA).

3. Results and Discussion

Figure 1 shows mechanical properties of PP and Modified PP fibers. When EVA copolymer is incorporated into Polypropylene fibers by melt blending, mechanical properties are slightly deteriorate at higher EVA content. But all modified polypropylene fibers have good mechanical properties for textile end uses.

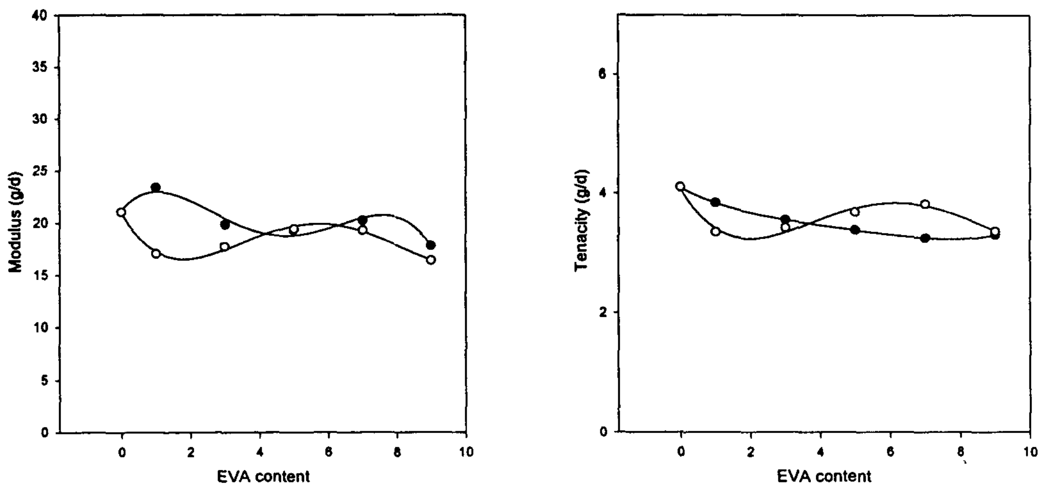

Fig. 1 Mechanical properties of PP and Modified PP fibers (draw ratio 3.8, drawing temperature 95~110℃) (●); EVA 28 (○); EVA 33.

Figure 2 shows K/S value of PP and Modified PP fibers. The K/S value of Modified PP fibers were much higher than unmodified PP fiber.

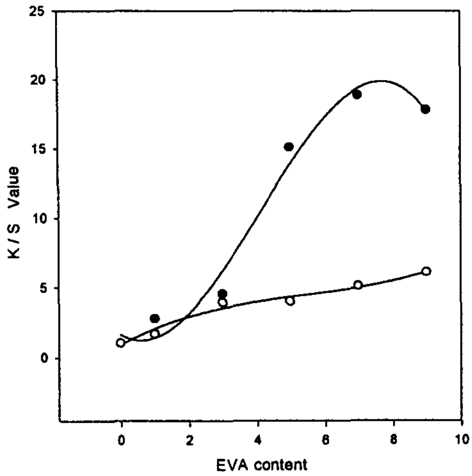

Fig. 2 K/S Value of C. I. Disperse Red 60 on PP and Modified PP fibers (●); EVA28, (○); EVA 33.

4. Conclusion

When poly(ethylene-co-vinyl acetate) copolymers are incorporated into polypropylene fibers by melt blending, the dye uptakes are higher. The dye uptakes are proportional to the amount of additive for a given polymer. Industrial acceptable shade level can easily be attained by selecting the amount, PP/EVA (93/7 wt %), and disperse dye in suitable combination. The light fastness of dyed modified polypropylene fibers excellent. Spinn ability on a small scale is good with EVA copolymers.

5. References

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