Investigating the Impact of Graphene on Dyeing Properties of Graphene/PET Fiber Materials for Carbon Neutrality in Fiber Material Development

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탄소 중립 섬유 신소재 개발을 위한 Graphene 입자 기반 섬유 소재의 염색 특성 분석

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Abstract

In this study, we investigated the impact of micronized graphene particles incorporated into PET on the dyeing properties of PET filament. Knitted fabrics were produced using PET filament containing micronized graphene particles and 100% PET filament, and exhaustion dyeing curves were measured. Due to the unique color and particle size of graphene, graphene/PET filament is generally challenging to dye; thus, micronized graphene was utilized. Colorimetric values were measured using Computer Color Matching (CCM) to analyze the difference in color of the dyed material. Results showed no significant difference in dyeing speed and absorption rate between graphene-containing and pure PET yarns. Additionally, no notable difference was observed in the L*, a*, b* values of the two dyed materials. Consequently, this study confirms that micronized graphene has minimal effect on the dyeability of PET material and that the colors of graphene and pure PET knitted fabrics remain similar even after dyeing. Through this study, the feasibility of developing Graphene/PET fibers in various colors and Graphene/Recycled PET fibers has been demonstrated, contributing to the realization of a carbon-neutral society.

1. Introduction

Graphene, owing to its exceptional properties such as high electrical conductivity, antimicrobial attributes, and thermal conductivity, holds vast potential for diverse applications. Particularly in textiles, its superior far-infrared radiation and antimicrobial properties render it suitable for premium outdoor apparel materials. However, in the case of Graphene/PET filament, an issue arises where Graphene dispersed within the PET filament unevenly, leading to difficulties in dyeing. Consequently, this study investigates the impact of Graphene on the dyeing properties of fibers. By utilizing Graphene particles sized at 150nm to enhance dispersion, we compare the dye absorption behavior and color deviation post-dyeing between Graphene-enhanced filament and 100% PET filament. This research aims to assess how Graphene influences the dyeability of fibers, thus contributing to a deeper understanding of its role in textile dyeing processes.

2. Methods

2.1 Materials

To assess the dye absorption characteristics of Graphene and PET filaments, fabrics were knitted using Graphene filaments and PET filaments, respectively. Dispersed dyes, including Synolon Orange SMD, Synolon Rubine SMD, and Blue SMD produced by Kyung-In Yanghang, were employed for dyeing. Furthermore, the dispersed dyeing process involved the use of acetic acid (CH_3COOH) and a dispersing agent (DP-50A).

2.2 Experiment

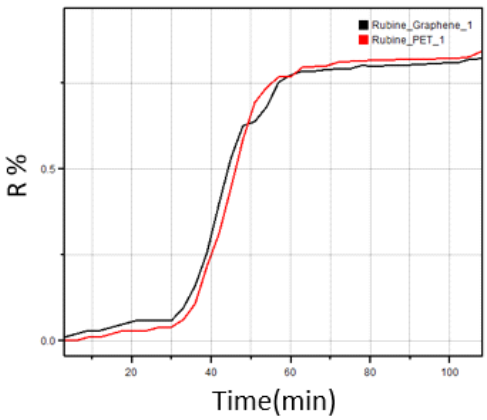
To analyze the dyeing behavior of Graphene and PET fabrics, dye solutions were prepared by stirring 1g/L of dye, 0.3g/L of acetic acid, and 1g/L of dispersing agent in distilled water. Each fabric sample, weighing 20g, was dyed with a liquor ratio of 1:20. Dyeing was carried out for 40 minutes at 130°C, using a dyeing machine equipped with an exhaustion dyeing curve

measuring device. Additionally, during the dyeing process, absorbance of the dye solution was measured at 3-minute intervals. The absorption rate was calculated by retroactively determining the dye concentration at each time point.

3. Results and Discussion

The analysis of dye absorption behavior between Graphene and PET fabrics revealed no significant differences in the absorption characteristics of the two samples. Based on this, it was observed that the enhanced dispersion of micronized Graphene resulted in minimal influence of Graphene particles on the dyeability of Graphene/PET fibers. Color difference measurements (using CCM) were conducted after dye absorption analysis for both dyed and undyed fabric samples. While notable color differences were observed in the undyed fabric samples, significant differences in the L*, a*, b* values were not observed in the dyed fabric samples.

This study confirms that the enhanced dispersion of micronized Graphene within PET fibers facilitates easier dyeing of Graphene/PET fibers under standard PET fiber dyeing conditions. Additionally, the research indicates the feasibility of developing Graphene/Recycled PET fibers in various colors.



[Fig. 1] Exhaustion Dyeing Curves of Graphene and PET(Rubine)

Name	L*	a*	b*
PET 100 %	94.53	-0.2	-0.35
Graphene	86.49	-0.52	0.95
PET 100 % : Rubine	40.18	56.38	26.69
Graphene : Rubine	39	53.01	24.47

[Table 1] Table title

4. Acknowledgment

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