Платформа 2

Сучасні аспекти матеріалознавства та технологій в текстильній та фешн-індустріях

UDC 677

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A NOVEL APPROACH FOR THE EVALUATION OF MICROFIBER RELEASE IN A DRY STATE

Purpose. *Evaluation of the microfiber release from textiles in a dry state suggesting a novel approach to the testing method.*
Keywords*: microfibers, microplastic, textile, sustainability.*

Objectives. Airborne microfibers have been addressed in scientific studies numerous times [1, 2]. Microfibers can be released into the air due to fiber slippage from a yarn structure or its breakage, when clothing experience all types of friction [3], e.g., with the human body, other garments, and surrounding surfaces. However, standard methods for investigating microfibers primarily focuses on microfibers released into wastewater during washing [4, 5, 6]. These findings highlight the importance of microfiber investigation before textile materials are washed.

Consumers use various pill removers to maintain garments, which can also collect microfibers. Lint rollers with self-adhesive tape sheets gather microfibers on their surface and allow for easy visual analysis. To perform this analysis effectively, it is important to determine the optimal peeling force required to remove the self-adhesive sheet from any type of textile sample and ensure that this force effectively collects microfibers.

Methodology. Self-adhesive tape with a thickness of 85 µm, consisting of flat paper as a backing material and acrylic adhesive, was used for testing. The dimensions of the working zone of the self-adhesive tape were as follows: width b_0 was equal to 50 mm and length l_0 = 50 mm.

Five specimens were tested from each of three investigated textiles. These textiles were selected based on representative textiles classified into three types according to the amount of microplastic they release during washing, as reported in researches published by other scientists [7]: *high* (releases the highest amount of microplastics [8]) – fabric M1, light blue polyester fleece with the area density of 413,9 g/m^2 and 2,26 mm thickness; *mid* (releases the average amount of microplastics compared to the other two groups [9]) – fabric M2, black knitted merino wool with the area density of 213,6 g/m^2 and 0,82 mm thickness; *low* (releases the lowest amount of microplastics [10]) – fabric M3, dark blue woven polyester with coating having the following characteristics: 320,6 g/m^2 area density and 0,37 mm thickness.

The peeling test was performed with CRE (constant rate of extension) tensile machine *H10KT (Tinius Olsen)* at 300±0.2 mm/s rate, adjusting 100 mm distance between jaws.

After the peeling test, the working zone of the self-adhesive tape was imaged using an *iPhone SE2* single-lens camera (Fig. 1).

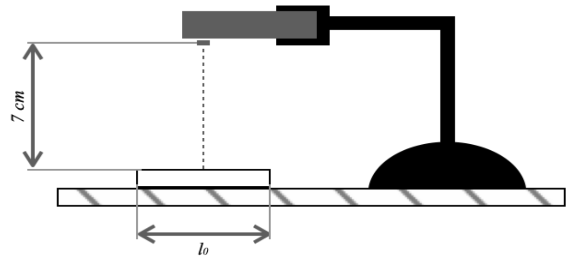

Fig. 1. **The scheme of specimen imaging (distance between the camera and the self-adhesive tape sample – 70 mm)**

ImageJ software was used to improve the contrast of the images and mark one 10 × 10 mm^2 size area in the middle of the self-adhesive tape work zone (Fig. 2).

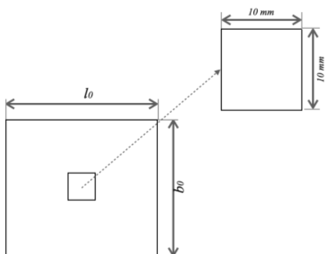

Fig. 2. **The scheme of 10 × 10 mm^2 size area on the working zone of the self-adhesive tape**

The number, length and shape of the microplastics in the marked area were analyzed.

Research results. The test results and statistical analysis confirmed that the peeling force of 0.0024 – 0.0027 N/mm at 300±0.2 mm/s rate effectively peeled the self-adhesive tape from the three types of examined textiles (Fig. 3 – Fig. 5).

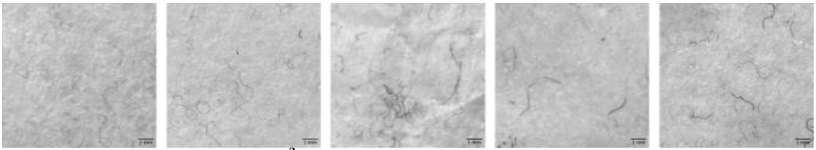

Fig. 3. **Images of 10 x 10 mm^2 working areas of M1-1 – M1-5 specimens (from left to right)**

The total number of microplastics on the specimens of M1 fabric ranged from 11 to 50. The longest microplastic particle was 4.931 mm and the shortest was 0.114 mm. The average length of the microplastics of the 5 specimens was 1.677 mm. The imaged microplastics were fiber shaped, some of them appearing in clusters (Fig. 3).

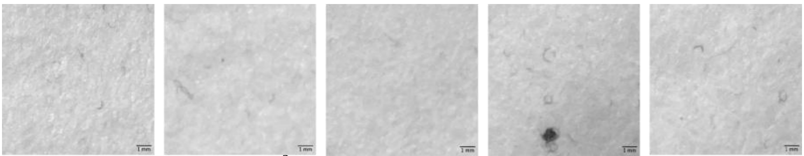

Fig. 4. **Images of 10 x 10 mm^2 working areas of M2-1 – M2-5 specimens (from left to right)**

The number of microfibers from the M2-1 - M2-5 specimens (Fig. 4) varied from 4 to 14. The longest microfiber particle was 3.983 mm long, while the shortest microfiber particle was 0.120 mm. The average length of the microfibers of the 5 specimens was 0.893 mm. The microfibers were fiber-shaped and curved; only one cluster appeared on one of the samples (M2-4).

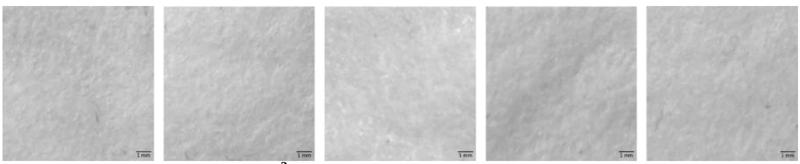

Fig. 5. **Images of 10 x 10 mm^2 working areas of M3-1 – M3-5 specimens (from left to right)**

Microplastic counts from specimens M3-1 to M3-5 ranged from 2 to 7. The longest microplastic measured 1.517 mm and the shortest was 0.113 mm. Across the five specimens, the average microplastic length was 0.528 mm. The microplastics were typically fiber-shaped and sparsely situated (Fig. 5).

Conclusion. The results showed that the peeling force between 0.0024 – 0.0027 N/mm at 300±0.2 mm/s rate was efficient in peeling the self-adhesive tape from all three types of tested fabrics and collecting microplastics. Visual imaging analysis also confirmed that the amount of microplastics collected in the dry state depended on the type of fabric and the results correlated to those obtained from other studies where microplastics were collected from wastewater after washing.

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