RUBBING FASTNESS OF TEXTILE PRINTED WITH SCREEN PRINTING TRANSFER TECHNIQUE

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Abstract
Textiles materials can be printed using various direct or transfer techniques. The screen printing transfer technique is process in which the design is firstly printed onto a flexible, non-textile substrate and later transferred by a separate process onto a textile material. Textile materials printed with this technique are usually subjected to the influence of different environmental elements and treatments during the exploitation, such as rubbing, heat, UV radiation, moisture, washing, etc. This paper presents research of rubbing treatment influence on the color changes of the textile material printed using screen printing transfer technique. Rubbing treatment of the prints was done according to ISO 105-X12 standard. Color changes of the printed textile materials to dry rubbing treatment were characterized by the spectrophotometric measurements.
Key words: *rubbing, transfer printing, textile, color difference*

Introduction

Textile products are most often sold to the final consumer with specific pattern or illustration applied on to their surface. This makes textile products more desirable and more valuable [1]. Textile printing can be defined as a process of applying color to fabrics through localized dyeing, or as the art and science of decorating a fabric with a colorful pattern or design [2]. Textiles materials can be printed using various direct or transfer techniques. The process in which the design is firstly printed onto a flexible, non-textile substrate, and later on transferred by a separate process onto a textile material, is called transfer printing. Transfer printing process could be divided in to: sublimation transfer, melt transfer, film release and wet transfer. The reasons why this technique is still popular are numerous. The production of short runs and repeated orders is much easier to produce, sometimes it is easier to produce complex design on the paper than on the textile, designs could be printed on cheap substrate before the transfer to the more expensive textile materials, and sometimes this is the only way to make certain special effects on garments or garment panels. The designs that are printed on paper, decrease both storage space and costs, as relatively cheap equipment is needed (printing machines, irons, etc.), Later, the design may be applied to the textiles with relatively low skill input and low reject rates [3].

Textile materials printed with this technique are usually subjected to the influence of different environmental elements and treatments during the exploitation, such as: rubbing, heat, UV radiation, moisture, washing, etc. [4]. The fastness property of pigment ink on the fabric depends on the adhesion between binder film and fibers and also on the strength of the binder film. In order to achieve desired quality, changes in color should be as small as possible [5]. One of the most influential factors these materials are exposed to is the rubbing process. Color fastness to rubbing is often a topic of research. Standard ISO 105-Xl2 can be used to examine influence of rubbing treatment on changes in printed material. This standard criteria for evaluation of color fastness uses grey scale (visual judgment). When the top quality is a goal, manufacturers cannot rely on subjective visual judgment, as grey-scale method. Much more reliable is determination of color characteristics and color differences by means of objective instrumental measurements which provide numerical values for describing color [6]. That is a reason why colorimetric measurement were used in this experiment.

The aim of this article is to explore rubbing fastness properties of textile printed with screen printing transfer technique.

Materials and methods

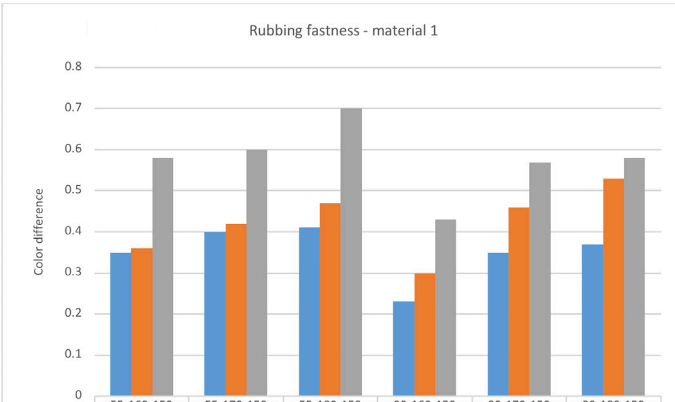
Two different textile materials were used in this experiment. Material characterization was conducted according to the standards ISO 1833 – material composition standard and ISO 3801 (Material 1: cotton 100 %, 150 g/m^2; Material 2: cotton 100 %, 190 g/m^2).

For the analysis of the rubbing fastness a custom test chart was created. The test form consisted three patches sized 12 x 5 cm with blue colors patches. Heat transfer paper (150 g/m^2) were printed using screen printing technique (M & R Sportsman E Series, printing speed was 15 cm/sec, the hardness of the squeegee 80° Shore Type A, the printing pressure 275.8 x 10^3 Pa and the snap-off distance 4 mm, 55 and 90 threads/cm). Printing is done by Sericol Texopaque Classic OP Plastisol inks. After printing process heat transfer paper was transferred to textile substrates (10 s) with three different temperature (160, 170 and 180 ^{0}C). Electronic crockmeter Testex textile instrument LTD. TF411 (rubbing head diameter 16 mm, vertical pressure 9 N, rubbing stroke 104 mm, according to the ISO 105x12/D02 standard), was used for testing colorfastness of textiles to dry rubbing. Colorimetric measurements of the samples were taken and visual control was done after printing and after 500, 1000 and 1500 rubbing repetitions. Colorimetric measurements of the samples before and after rubbing process were taken using HP200 colorimeter (D65 lighting, 2° standard observer, d/8 measuring geometry). Color differences between treated and untreated samples were calculated using ΔE94 formula. Color difference value can be translated to human perception reference as $0 < \Delta E < 1$ – the difference cannot be noticed; $1 < \Delta E < 2$ – small color difference, visible to "trained" eye; $2 < \Delta E < 3{,}5$ – Medium color difference, visible to "untrained" eye; $3{,}5 < \Delta E < 5$ – Obvious color difference; $\Delta E > 5$ – Massive color difference [7].

For the purposes of image analysis untreated and treated samples were scanned using a flatbed scanner Canon CanoScan 5600F. Scanning resolution was set to 600 spi without auto correction function.

Results and discusion

Values of the calculated color differences between prints just after printing and after rubbing treatment repeated 500, 1000 and 1500 times are shown in figures 1 and 2.



	55-160-150	55-170-150	55-180-150	90-160-150	90-170-150	90-180-150
500x	0.35	0.40	0.41	0.23	0.35	0.37
1000x	0.36	0.42	0.47	0.3	0.46	0.53
1500x	0.58	0.60	0.70	0.43	0.57	0.58

Figure 1: Color differences between samples before and after rubbing treatment – material 1 (Remark: numbers 55 and 90 represent threads/centimeter, number 160, 170 and 180 represent temperature in °C; number 150 represent fabric weight for material 1)

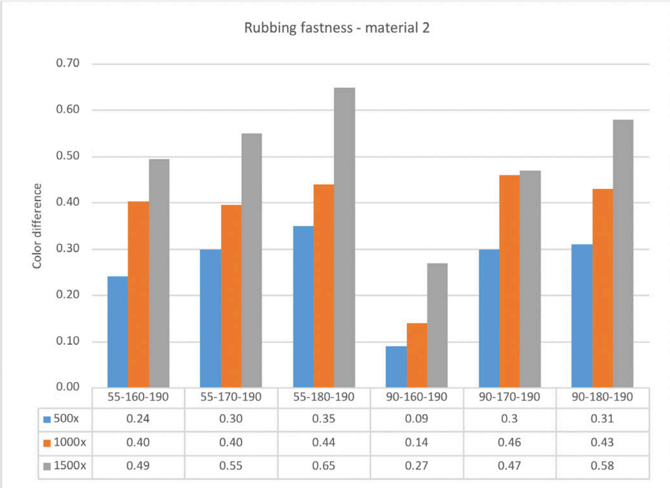


Figure 2: Color differences between samples before and after rubbing treatment – material 2 (Remark: numbers 55 and 90 represent threads/centimeter, number 160, 170 and 180 represent temperature in °C; number 190 represent fabric weight for material 2)

The analysis of the color changes measured between samples before and after rubbing treatment shows that color difference values are higher with increase of rubbing repetitions. For both materials and all samples the highest color differences (ΔE) were caused by a 1500 x rubbing repetitions, although the difference cannot be noticed visually.

Comparison of materials reveals that the material 2 has the best resistance to rubbing, due to its has higher fabric weight. Probably because when printed, ink penetrates deeper in to the structure, thus print layer will be lower and rubbing process cannot destroy a large amount of ink. Considering thread count of screen printing mesh it can be concluded that prints produced with higher thread count screen shows better rubbing fastness due to lower amount of ink deposited. With thinner ink layer there is less pigment to be removed by rubbing process thus lower values of color difference between samples before and after rubbing process. Also, better rubbing fastness was observed in samples where the transfer was done with under temperature.

Scanned images of samples after rubbing process are shown in Figure 3. It can be seen that rubbing process did not significantly damaged the printed samples visually.

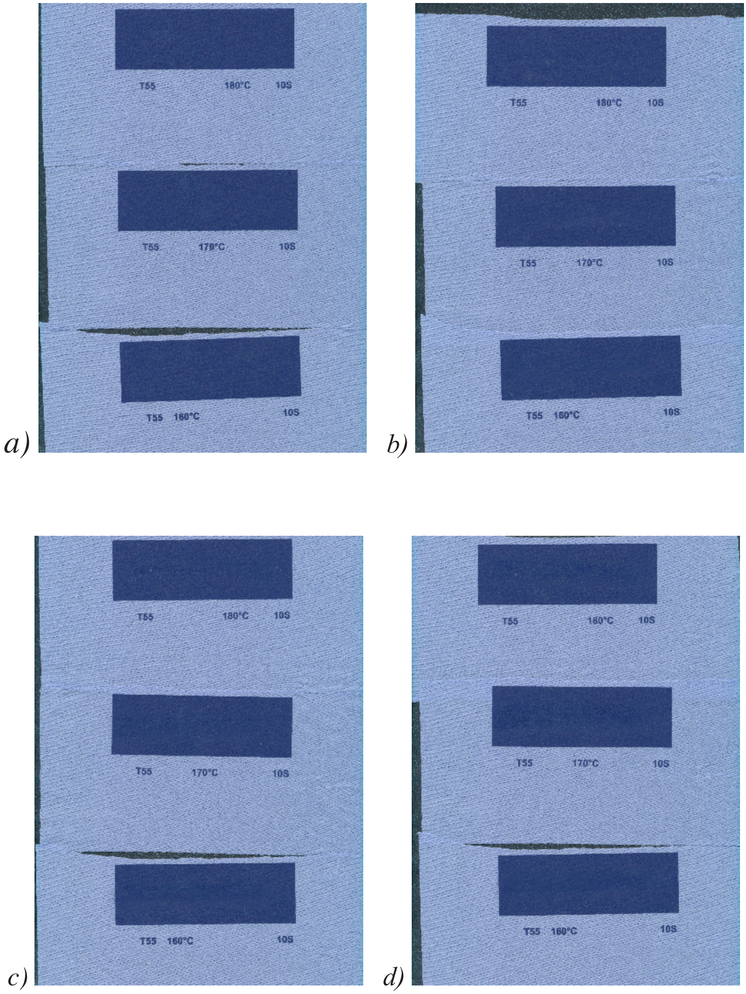


Figure 3: Scanned samples after printing process and rubbing treatment – material 1: a) after printing process, b) after 500 x rubbing repetitions, c) after 1000 x rubbing repetitions, d) after 1500 x rubbing repetitions (Remark: number 55 represent screen thread, number 160, 170 and 180 represent temperature in °C)

Conclusions

The study has been made to evaluate the rubbing fastness properties of samples printed using transfer screen printing. Rubbing is shown to be insignificant factor in exploitation of textile products printed using this technique. In case that rubbing repetitions increase, color difference values will be higher but those values will not be high enough to cause significant visible damage.

Careful consideration of combination of material properties, screen thread count and temperature in transfer process, can resulting in better rubbing fastness.

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