

Analysis the physical properties of laser fading on denim fabric

Abstract

The laser fading process is acknowledged as a very strong alternative compared to the conventional physical and chemical processes used for aged-worn look on denim fabrics. In this study, the beams from a CO₂ (10.6μm) laser was used for the fading of denim fabrics. In terms of both color and mechanical properties, it is found that 100 and 150μs pulse times are suitable for laser fading process of denim fabrics. This study aims that the effects of laser beam on denim fabrics were investigated and optimum process conditions were determined by tensile strength, tear strength, rubbing fastness of fabric. According to the observation from this project both tensile and tearing strength decreased (respectively on both warp and weft direction) and color fastness to rubbing was decreased in significant level comparison with both before and after fading effect of denim fabrics.

Keywords: laser beam, CO₂ laser, denim fabric, fading, mechanical properties

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Introduction

Denim is made from rugged securely woven twill in which the weft passes under two or more warp threads. Lengthwise, the yard is dyed with indigo or blue dye; horizontal yarns remain white. The yarns have a very durable twist to make them more durable, but this also affects the denim's color. The yarns are twisted so tightly that indigo dye usually colors only the surface, sendoff the center of the yarn white. The blue strands turn into the threads that show on the outside of your denim and the white are the ones that make the inside of your denim look white.¹ Dyeing process of indigo on core of the warp yarns remains white, generates denim's fading physical appearance, Herein modern period, denim pants have a shabby look and tend to the fade and worn out look trousers of denim upraised. Therefore several washing stages applied on fading process after desizing.² Another possibilities to fabricate faded denim applying different physical processes such as sand spraying, sanding, brushing, embroidering; and chemical processes such as pre-washing, rinsing, stone washing, sand washing, snow washing, stone washing with enzymes, bleaching.^{3,4} The technology of laser is an energy source which can be focused on desired objects and intensity of power can be easily controlled.⁵ According to Ondogan et al.,⁶ by using a laser it is probable to create a faded look on denim, this is the alternative technique to conventional procedures. From the result confirmed an infrared laser is one which is suitable means for the discoloration of indigo-dye on denim fabric. In contrast with conventional techniques of processing denim fabric, a laser beam showed some recompense: it is eco-friendly with respect to the use of chemical agents, has little consumption of water, and gives flexibility.⁷

Materials and methods

Materials

Fabric: For this experiment denim Twill fabric was used. The fabric was faded by laser fading process. The final target of this work is to find the effect of fading by different intensity level which is applied in the raw denim. Denim fabric was collected from Pacific Jeans Ltd,

Chittagong, Bangladesh. The sample (2/1 Right Hand Twill) weight was 357gm/m with a warp density 78ends/inch (10Ne slub yarn) and weft density is 46 picks/inch (9Ne OE). The fabric was produced in the air jet loom. The yarns of the fabrics were dyed by indigo-dyes. For laser fading CO₂ (10.6 micrometers) laser was used. Crocking meter, Tensile and Tearing strength tester and Spectrometer were used to do the physical, mechanical and visual properties of denim fabrics (Figure 1) (Figure 2).

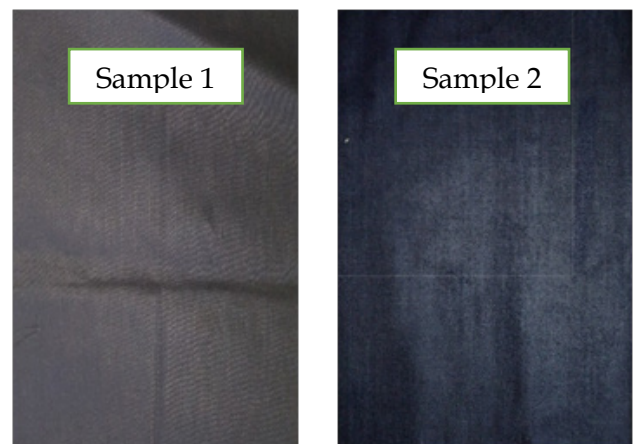


Figure 1 Raw fabric (Before Fading).

Machine

- Lens of laser Engraving Machine for garments
- Laser Engraving Machine for garments

Methods

The sample was developed and tested in Pacific Jeans Ltd, Chittagong, Bangladesh and analyzed the samples by the following testing standards:

- i. **Color fastness to rubbing:** Color fastness to rubbing is determined by ISO 105x12; 1993.
- ii. **Tensile strength test:** Tensile Strength is determined by ISO 13934-2.
- iii. **Tearing strength test:** Tearing Strength is determined by ISO 139372.
- iv. **Laser safety:** Laser systems are controlled by international safety regulations (IEC 60825-1).

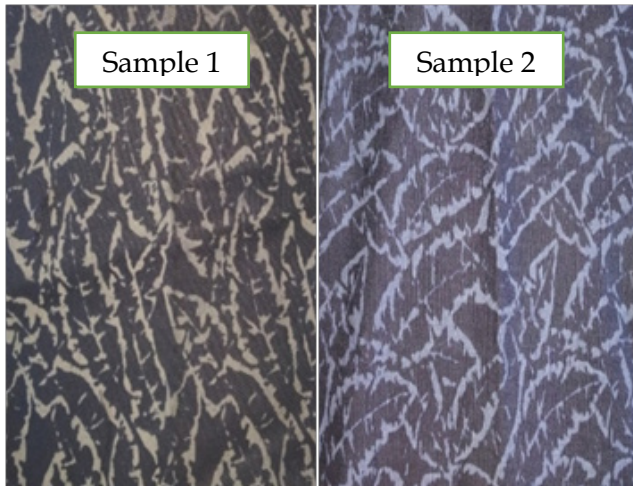


Figure 2 Fabric after fading.

Results

Determination of color fastness to rubbing

This test is designed to determine the degree of color. It is seen that (Table 1) in non-wash condition and the wash condition of the denim fabric wet rubbing is too different for both specimen. The fastness of rubbing in laser fading is significant staining to deep staining.

Table 1 Determination of color fastness to rubbing

Test condition	Specimen 1		Specimen 2	
	Before fading	After fading	Before fading	After fading
Dry	4	5-Apr	5	4
Wet	2	4	3	4

Determination of tensile strength

The tensile strength values of the denim fabrics subjected to different laser fading intensity in tensile strength values of the treated samples calculated based on the untreated sample tensile strength are represented in Table 2. Due to the fact that, tensile strength values indicate damage in fabric structure, different fading intensity causes a decrease in tensile strength values. However, all the fading intensity is almost same which don't cause most effect in fabric tensile strength. The loss in tensile strength values is higher for warp direction about decreasing rate (about 7% to 8%) compared than weft direction (about 1% to 3%).

Determination of tearing strength

In simpler terms Tear resistance (or tear strength) is a measure of how well a material can withstand the effects of tearing. it is

usually measured in kN/m or pound (lb) As it can be seen from Table 3, fading process causes a decrease in tear strength values in warp direction (about 7% to 13%) and in weft direction about (3%-9%).

Table 2 Determination of tensile strength

Direction	Specimen 1		Specimen 2	
	Before fading	After fading	Before fading	After fading
Warp	427 N	395 N	419 N	388 N
Weft	310 N	299 N	310 N	307 N

Table 3 Determination of tearing strength

Direction	Specimen 1		Specimen 2	
	Before fading	After fading	Before fading	After fading
Warp	249N	215N	255 N	235N
Weft	210 N	203 N	219 N	199 N

Discussion

Above all these testing parameters show that the simple difference between before fading and after fading condition. In these experiment help to know about the power intensity how caused in fabric. The end condition of the fabric almost depends the laser intensity which the buyer requirement. Laser intensity mainly depend the buyer requirements. Above the testing of color fastness, tensile strength, tearing strength can help to know about the laser power use in denim fabric.

Conclusion

Now a day's researchers are being done on Ultra Violet laser and in future it will be in great opportunity in use. Many factories in Bangladesh are using this tools replacing of sand blasting, manual hand sanding, destroying, grinding etc. where we know that sands are hazardous for body skin and has bad impact on health of the employers. We can ensure greater use of this technology to increase the production rate and eco-friendly. Here only the fabric strength rate and rubbing fastness properties decreased. Besides the use of the toxic and chemical substance in several stages reduced the productivity, especially during the treatments it is achieved particular effects of denims keeping the productivity up. Besides the rejection rate is 0% which previously was due natural or synthetic variation.

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Conflicts of interest

Authors have declared no conflicts of interest.

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