International Journal of Advance Research in Science and Engineering
Vol. No.4, Issue 08, August 2015
www.ijarse.com
IJARSE
ISSN 2319 - 8354

STUDYING THE FUNCTIONAL PERFORMANCE PROPERTIES OF THE FABRICS INCLUDING METALLIC YARN

Mohamed Abd El-Gawad

Assistant Professor in Spinning, Weaving and Knitting Dept. Faculty of Applied Arts, Helwan University

ABSTRACT

In the recent years, the using of the metallic yarns has been increased mainly in upholstery and clothing fabrics because it is gives an aesthetic and decorative value in the textiles. But using the metallic yarns by large ratio may cause some undesirable effects and also can influence on the physical and mechanical properties of the produced fabrics. The aim of these researches is to investigate the effect of the presence of the metallic yarns inside the fabrics on the functional performance properties and to put the most suitable standards for using the metallic to produce balanced product has aesthetic form and functional performance properties. In this research each fabric of the produced contains different ratios of metallic yarns, the polyester yarns were chosen to use as a conventional yarns beside the metallic yarns because it is the most commonly used material in the upholstery field. The produced fabrics were finished by heat setting. Then grey and finished fabrics were tested with some mechanical tests determine their functional performance they are produced for. The test results obtained showed that the finished fabrics have scored high rates for tensile strength, elongation, abrasion resistance than grey fabrics. The grey fabrics have scored high rates for tear strength, fabric stiffness.

Keywords: Metallic Yarns, Heat Setting, Tensile Strength, Tear Strength, Abrasion Resistance.

I. INTRODUCTION

In addition to technical considerations, aesthetics is also important in the production of fashionable fabrics. For most fabrics, aesthetic factors provide the initial impulse of attraction and may be the only factor that influences the decision to buy [1]. Fancy yarns create interesting decorative effects in the fabrics rather than functional purposes. Fancy yarns are one that differs from the normal constructions of single and folded yarns by deliberately produced irregularities in its constructions [2].

1.1 What is Metallic Fiber?

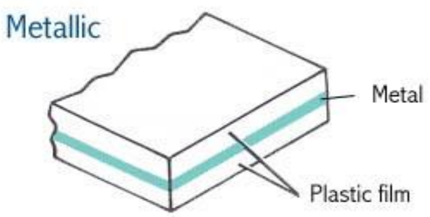
Metallic fibers are manufactured fibers composed of metal, plastic-coated metal, metal-coated plastic, or a core completely covered by metal as shown in fig. (1). Gold and silver have been used since ancient times as yarns for fabric decoration. More recently, aluminum yarns, aluminized plastic yarns, and aluminized nylon yarns have replaced gold and silver. Metallic filaments can be coated with transparent films to minimize tarnishing.[3].

1.2 History of Metallic Fibers

Gold and silver have been used since ancient times as decoration in the clothing and textiles of kings, leaders, nobility and people of status. Many of these elegant textiles can be found in museums around the world. Historically, the metallic thread was constructed by wrapping a metal strip around a fiber core (cotton or silk), often in such a way as to reveal the color of the fiber core to enhance visual quality of the decoration [4].Ancient textiles and clothing woven from wholly or partly gold threads is sometimes referred to as Cloth of Gold These were the first man-made fiber which came thousands of years before nylon or rayon [5].

1.3 Production Methods

There are two basic processes that are used in manufacturing metallic fibers. The most common is the laminating process, this are mainly American made yarns described as ham sandwich which seals a roll of aluminum foil of 0.00045 inch thickness and 20 inch wide. To both sides of the sheet is applied a thermoplastic adhesive to which has already been added the required colouring matters. The adhesive-coated foil is heated to about 90-95oc, and a sheet of cellulose acetate-butyrate transparent film is laminated to each side of the foil by passing through squeeze roller at a pressure of 2000 lb/inch. These fibers are then cut into lengthwise strips for yarns and wound onto bobbins. The metal can be colored and sealed in a clear film, the adhesive can be colored, or the film can be colored before laminating. There are many different variations of color and effect that can be made in metallic fibers, producing a wide range of looks [6].



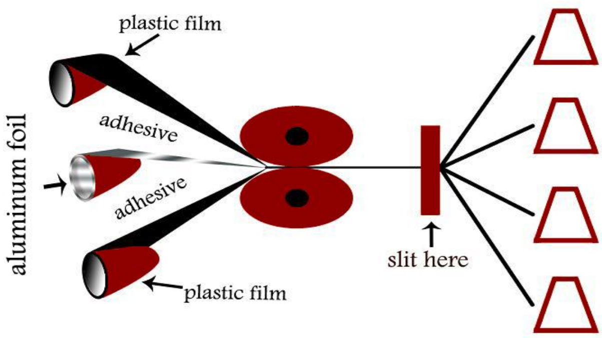


Fig.(1) Structure of Metallic Fiber **Fig. (2) Laminating Process**

Metallic fibers can also be made by using the metalizing process. This process involves heating the metal until it vaporizes then depositing it at a high pressure onto the polyester film. This process produces thinner, more flexible, more durable, and more comfortable fibers [7].

1.4 Fiber Properties

1.4.1 Physical Properties

Fine structure and appearance: Metallic fibers are flat, ribbon like filaments, commonly 3.2-0.2 mm (1/8-1/128 in) width. They are smooth-surfaced and may be colored or uncolored.

Tenacity: It varies with types of metallic fiber and the range is from 2.6 cN/tex to 11.0 cN/tex i.e (0.3 g/den to 1.25 g/den).

Elongation: It varies from 30% to 140% with the types of metallic fibers.

Abrasion resistance: It has good abrasion resistance.

1.4.2 Chemical Properties

Acids: Generally good resistance.

Alkalis: Good resistance to weak alkalis but degraded by strong alkalis.[5]

1.5 Heat Setting

Heat setting is a term used in the textile industry to describe a thermal process taking place mostly in either a steam atmosphere or a dry heat environment. The effect of the process gives fibers, yarns or fabric dimensional stability and, very often, other desirable attributes like higher volume, wrinkle resistance or temperature resistance. Very often, heat setting is also used to improve attributes for subsequent processes [8].

During the heat-setting process crystalline of synthetic yarns is modified bringing the desired changes in properties. The general physical properties of the cord or fabric can be adjusted by selecting the conditions of heat setting. Heat setting stabilizes the yarn and reduces the changes in properties on exposure of the yarn to heat [9].

II. EXPERIMENTAL WORK

This research is concerned with investigate the Effect of ratio of metallic yarns inside the fabrics on mechanical properties (tensile strength, tear strength , stiffness ,abrasion resistance) To enrich it and also improving its properties, meeting the functional purpose it is produced for .

2.1 The Parameters Used for Producing the Samples Under Study

In this research 5 fabrics were produced according to table (1)each fabric contains different ratio of metallic yarns ,the polyester yarns were chosen to use as a conventional yarns beside the metallic yarns because it is the most commonly used material in the upholstery field . At the research the metallic yarns used as a wefts with different ratios inside the fabrics through changing the weft arrangement of the wefts between polyester yarns and metallic yarns. The produced fabrics were finished by heat setting at temperature 160 °C . Then grey and finished fabrics were tested with mechanical tests to determine their suitability to the functional performance they are produced for.

Table (1): Parameters used for Producing the Samples Under Study

Samples	Ratio of wefts	
	polyester	Metallic yarn
Sample No. 1	100 %	0 %
Sample No. 2	25 %	75 %
Sample No. 3	50 %	50 %
Sample No. 4	75 %	25 %
Sample No. 5	0 %	100 %

2.2Specifications (Machine and Fabrics)

2.2.1. The Specification of the Machine Used in Producing the Samples

1-Loom type: rapier machine. 2- Loom model: super excel..

3-Machine speed: 290 pick/min. 4-reed: 11 dent/cm

5- Jacquard type: staubli cx-880 6-Jacquard format: 2688

2.2.2The Specifications of the Produced Fabrics

1-Material of warp: polyester. 2- Count of the warp ends: 150/1denier.

3-No. of warp ends: 66 end/cm. 4- Material of weft: polyester - metallic.

6-No. of picks: 20 pick/cm. 6- Weave structure: satin 10

7-Count of weft: polyester 150/1 - metallic yarn 120/1.

2.3 Laboratory Tests Applied to Samples Under Study

2.3.1 Tensile Strength Test

The test was carried out according to American standard specifications of (ASTM-D-5034-90) [10].

2.3.2 Tear Strength Test

The test was carried out according to American standard specifications of (ASTM-D-2661-71) [11].

2.3.3 Abrasion Resistance Test

The test was done according to American standard specifications of (ASTM-D-3885-99) [12].

2.3.4 Fabric Stiffness Test

The test was done according to American standard specifications of (ASTM-D-4158-2001) [13].

III. RESULT AND DISCUSSION

The produced fabrics in this research were tested for some essential functional properties which reflected to their end uses.

Table (2): Presents the Results of the Tests to the Grey Fabrics.

Samples	Ratio of wefts %		Properties								
	polyester	Metallic yarn	Warp tensile strength	Weft tensile strength (kg)	Elongation in warp direction	Elongation in weft direction %	Warp tear strength	Weft tear strength (kg)	Stiffness (warp)	Stiffness (weft)	Abrasion resistance (no. turns)
1	100 %	0 %	1001	340	24.9	19	138	84	94.1	87	229
2	25 %	75 %	989	324	23.7	20.6	123	120	92.5	82.2	202
3	50 %	50 %	922	276	22.1	22.7	107	147	87	79.3	181
4	75 %	25 %	887	250	20	23.9	90	155	83.6	75	159
5	0 %	100 %	839	230	18.3	25	40	164	77.5	67	119

Table (3): Presents the Results of the Tests to the Finished Fabrics (Heat Setting).

Samples	Ratio of **wefts %**		Properties								
	polyester	Metallic yarn	Warp tensile strength	Weft tensile strength	Elongation in warp direction	Elongation in weft direction	Warp tear strength	Weft tear strength	Stiffness (warp)	Stiffness (weft)	Abrasion resistance (no. turns)
1	100 %	0 %	1104	383	25.5	18.1	123	74	80.7	70.1	303
2	25 %	75 %	1059	347	23.3	20.6	111	93	74.5	62.4	261
3	50 %	50 %	983	299	22.1	22.7	99	110	63.7	54.6	234
4	75 %	25 %	922	274	20	23.9	69	125	59.1	49.3	198
5	0 %	100 %	890	253	18.3	26.7	42	141	53.3	42	163

3.1 Tensile Strength in Warp Direction

From figure (3) it can be observed that there is an inverse relationship between the presence of the metallic yarn inside the fabrics and the tensile strength in warp direction, as the ratio of the metallic yarn which used as a weft increased inside the fabric the tensile strength decreased and vice verse . this is behavior can be interpreted on fact that the polyester yarn has compressibility higher than the metallic yarn , it can absorb the tension of warp ends leading to increase in the tensile strength of the fabrics in the warp direction.

It is obvious that the finished fabrics (heat setting) has scored high rates for tensile strength in warp direction than the grey fabrics , because the heat setting change the fiber structure by increasing the crystalline region as a result the warp tensile strength increased.

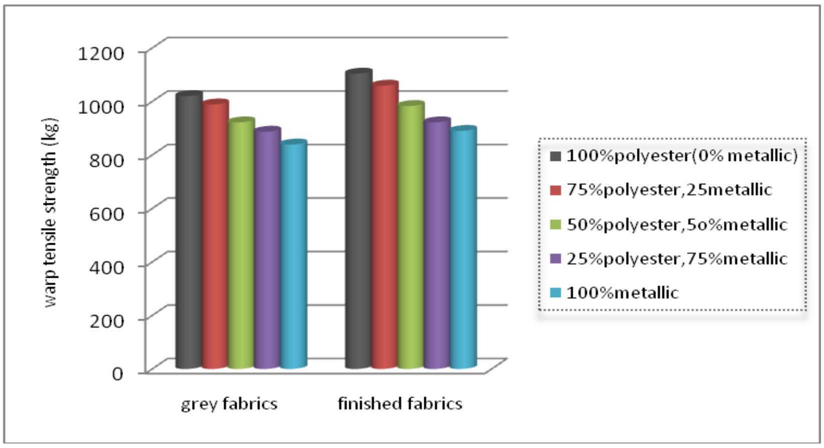


Fig. (4) Effect of the Ratio of Metallic Yarn Inside the Fabrics on Tensile Strength in Weft Direction.

3.2 Tensile Strength in Weft Direction

From figure (4) it can be notice that there is an inverse correlation between the ratio of the metallic yarn in the fabrics and the tensile strength in weft direction, as the ratio of the metallic yarn increased inside the fabric the weft tensile strength decreased and vice verse. This is due to the metallic yarn has less tenacity compared to polyester fibers which are very strong because of their extremely crystalline polymer system. These was agreed with what mentioned by gohl and vilensky[14]..

It is clear that the finished fabrics (heat setting) has scored high rates for tensile strength in warp direction than the grey fabrics ,due to during heat setting the fibers become more oriented or aligned in longitudinal axis inside the yarns (more parallel to each other)so the weft tensile strength increased.

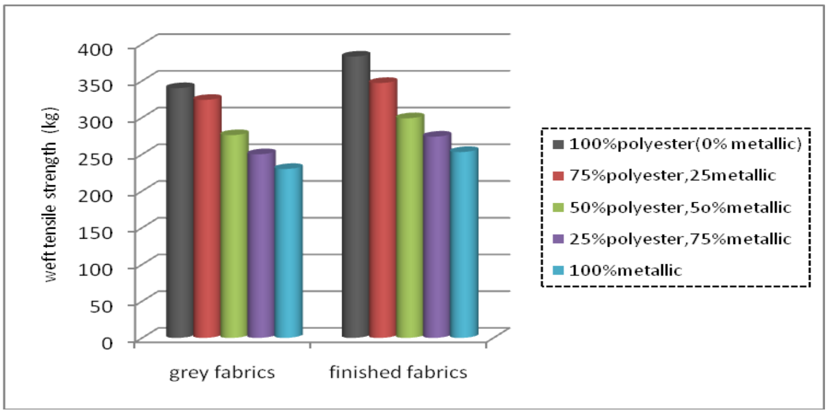


Fig. (4) Effect of the Ratio of Metallic Yarn Inside the Fabrics on Tensile Strength in Weft Direction.

3.3 Elongation in Warp Direction

From figure (5) it can be observed that there is an inverse relationship between the presence of the metallic yarn inside the fabrics and the elongation in warp direction, as the ratio of the metallic yarn which used as a weft increased inside the fabric the elongation decreased and vice verse .this could be explained that as the specific density of the materials decreased (more bulkiness) the thickness of the yarns increased, so the polyester yarn which is more bulky than the metallic yarn increases the warp crimp leads to increase the fabric elongation in warp direction. The finished fabrics (heat setting) have scored high rates for elongation in warp direction than the grey fabrics.

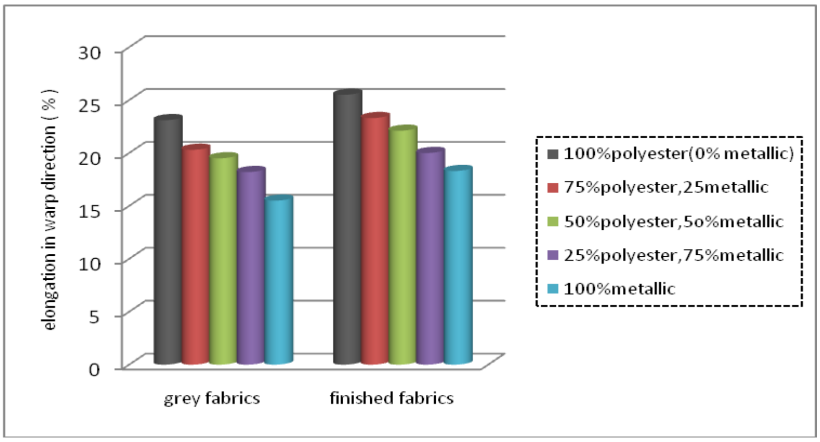


Fig. (5) Effect of the Ratio of Metallic Yarn Inside the Fabrics on Elongation in Warp Direction.

3.4 Elongation in Weft Direction

Figure (6) show that there is a direct relationship between the presence of the metallic yarn inside the fabrics and the elongation in weft direction, as the ratio of the metallic yarn which used as a weft increased inside the fabric the elongation in weft direction increased and vice verce.This is owing to the metallic fibers polymer system may be regarded as very crystalline and held together by vanderwaals force (weak force).so the polymers of the metallic fibers are able to slide over each other when it is bend or crushed ,due to this metallic yarns have high elongation than polyester material. It is clear that the finished fabrics (heat setting) have scored high rates for elongation in weft direction than the grey fabrics.

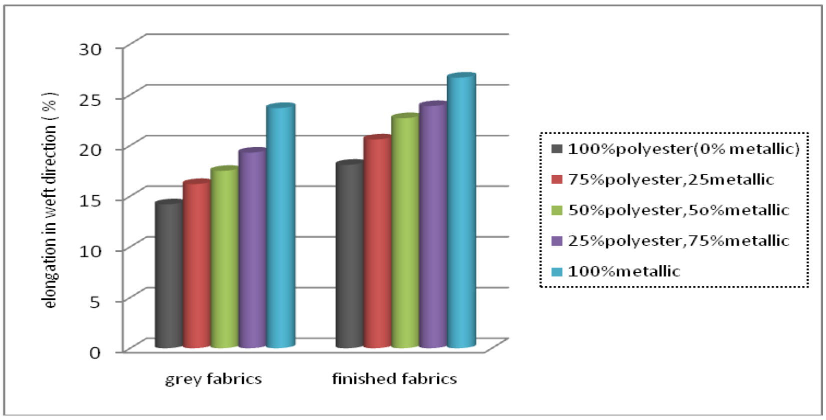


Fig. (6) Effect of the Ratio of Metallic Yarn Inside the Fabrics on Elongation in Weft Direction

3.5 Tear Strength in Warp Direction

From figure (7) it can be seen that, there is an inverse relationship between the ratio of the metallic yarns inside the fabrics and the warp tear strength, as the ratio of the metallic yarn which used as a weft increased inside the fabric the tear strength in warp direction decreased and vice verse. This is because the polyester fibers could be compressed more the metallic fiber so it can absorb the warp tension and the warp ends inside the fabrics become more free to move as a result the tear strength in warp direction increased .The grey fabrics have scored high rates for tear strength in warp direction than finished fabrics ,this is due to after heat setting happened shrinkage to the fabrics as a result the become compact so the movement of the warp thread inside the fabrics restricted leading to decrease in tear strength in warp direction.

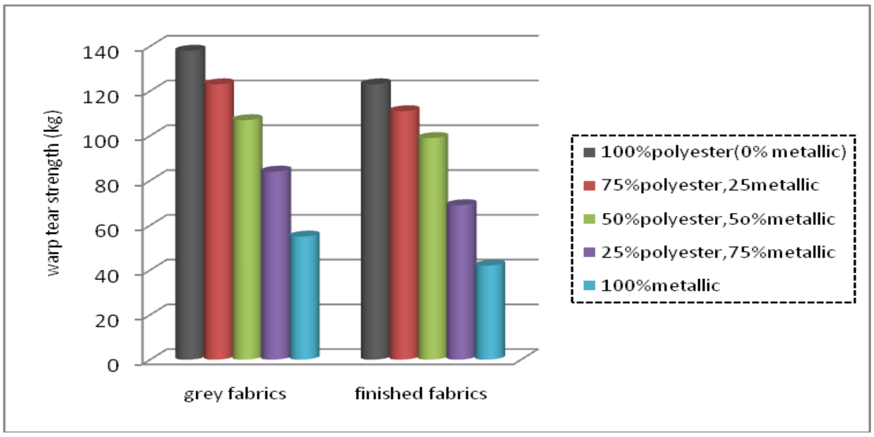


Fig. (7) Effect of the Ratio of Metallic Yarn Inside the Fabrics on Tear Strength in Warp Direction.

3.6 Tear Strength in Weft Direction

From figure (8) it is clear that ,there is a direct correlation between the ratio of the metallic yarn inside the fabrics and the weft tear strength, as the ratio of the metallic yarn (which used as a weft)increased inside the fabric the tear strength in weft direction increased and vice verse. This is behavior can be interpreted on fact that the metallic yarn has high elongation and at the same time is less in hairiness (the ability of the hairiness yarns to move is arrested)so as a result gives high resistance to tear strength in weft direction.

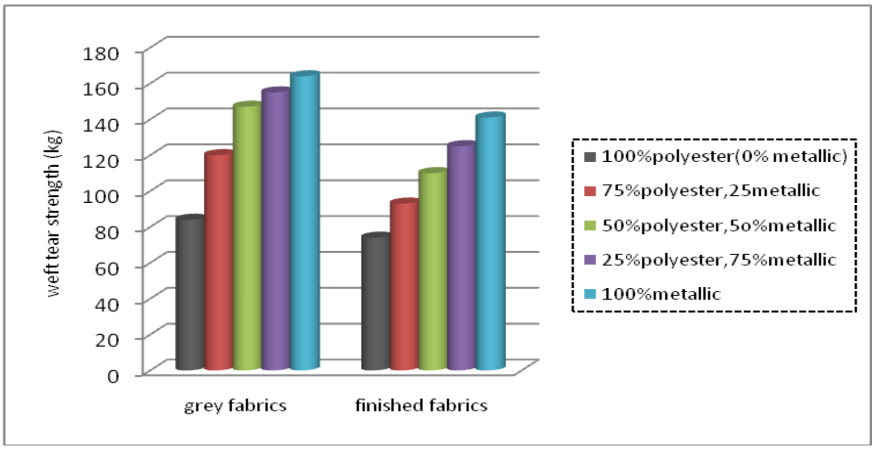


Fig. (8) Effect of the Ratio of Metallic Yarn Inside the Fabrics on Tear Strength in Weft Direction.

It is clear that the grey fabrics have scored high rates for tear strength in weft direction than finished fabrics. This is due to after heat setting happened shrinkage to the fabrics so the threads inside the fabrics become closer to each other leading to restrict the movement of the threads as a result the tear strength in weft direction decreased.

3.7 Stiffness in Warp Direction

From figure (9) it is obvious that there is an inverse relationship between the ratio of the metallic yarn inside the fabrics and the stiffness in warp direction. So as the ratio of the metallic yarn increased the stiffness in warp direction decreased and as the ratio of the polyester yarns inside the fabrics the stiffness increased .due to the polyester fibers contains high crystalline regions than metallic fibers as a result the polyester fibers are more stiff than metallic fibers. The metallic yarn count is 120/1 denier while the polyester yarns count is 150/1 denier so as the ratio metallic yarns increased the weight and the thickness of the fabrics decreased as a result the stiffness decreased. It is clear that grey fabrics have scored high rates for stiffness in warp direction than the finished fabrics because the weight of the finished fabrics is reduced by heat setting so as a result the stiffness of the fabrics is decreased.

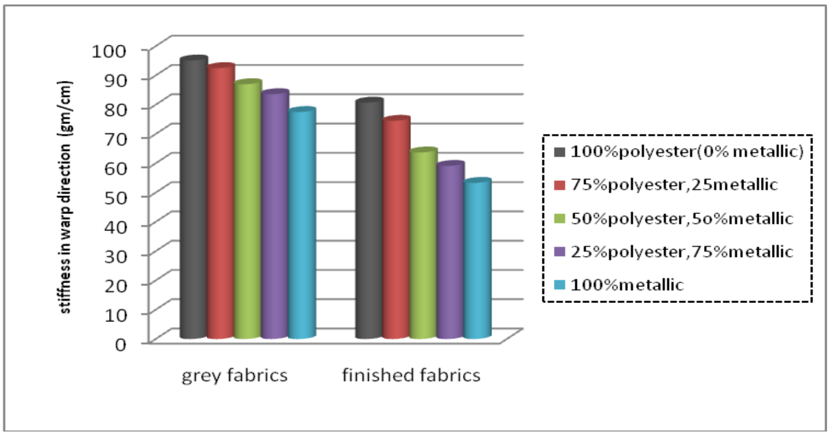


Fig. (9) Effect of the Ratio of Metallic Yarn Inside the Fabrics on Stiffness in Warp Direction.

International Journal of Advance Research in Science and Engineering
Vol. No.4, Issue 08, August 2015
www.ijarse.com
IJARSE
ISSN 2319 - 8354

3.8 Stiffness in weft direction.

From figure (10) it is obvious that there is an inverse relationship between the ratio of the metallic yarn inside the fabrics and the stiffness in weft direction. So as the ratio of the metallic yarn increased the stiffness in weft direction decreased.

It is clear that grey fabrics have scored rates for stiffness in weft direction than the finished fabrics because the weight of the finished fabrics is reduced by heat setting so as a result the stiffness of the fabrics is decreased.

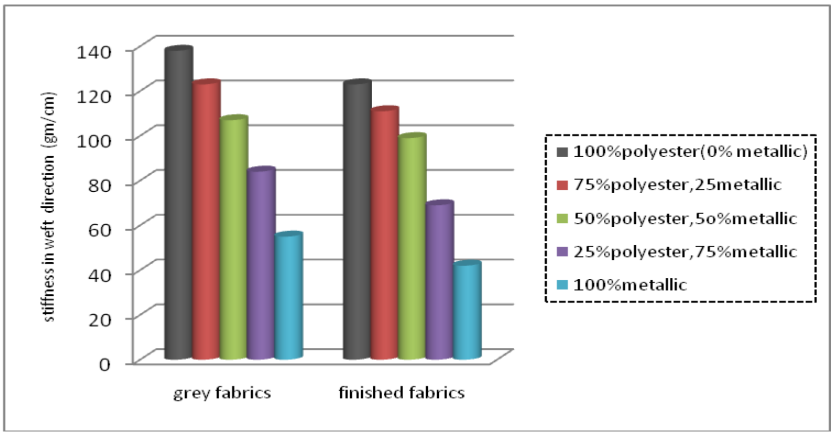


Fig. (10) Effect of the Ratio of Metallic Yarn Inside the Fabrics on Stiffness in Weft Direction.

3.9 Abrasion Resistance

Figure (11) indicate that there is an inverse relationship between the fabric abrasion resistance and the ratio of the metallic yarn inside the fabrics ,so as the ratio of the metallic increased the wear of the fabrics increased .this owing to the metallic yarn have smooth surface than the polyester yarn so it is can abraded easily than polyester. And the fibers inside the polyester yarns are held more tightly as a result the yarn is stiffer so it is unable to flatten or distort under pressure when being abraded, this enables the yarn to resist abrasion. These was agreed with what mentioned by Nilgün ozdil1, Gonca ozçelikKayseri[15].

It is clear that the finished fabrics have scored high rates for abrasion resistance than the grey fabrics. This is mainly due to during heat setting the fibers on the fabrics surface will cling to it , hence the fabric will achieve a closer state ,and the movement of fibers within the yarn will be limited ,as a result the abrasion resistance increased.

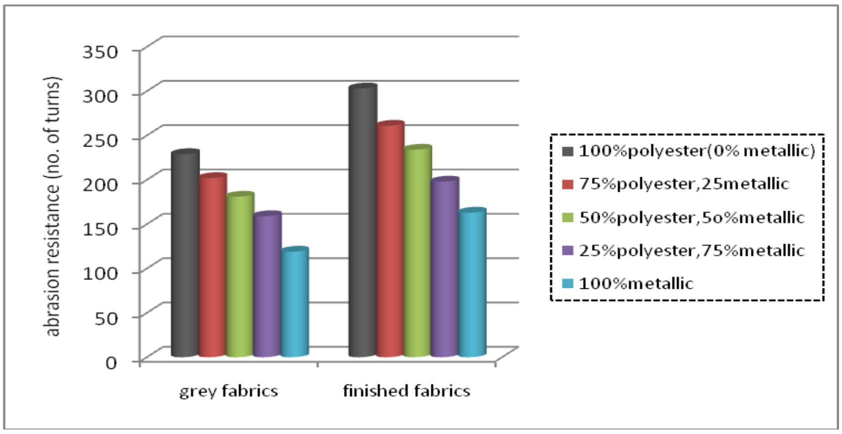


Fig. (11) The Effect of the Ratio of Metallic Yarn Inside the Fabrics on Abrasion Resistance

IV. CONCLUSIONS

From the previous results and discussion concerning some conclusions were achieved benefiting from it in the production of these type fabrics and these could increase the efficiency of the functional performance of those fabrics. These conclusions are:

1-There is direct relationship between the ratio of the metallic yarns inside the fabrics and elongation in weft direction and tear strength in weft direction

2-There is inverse relationship between the ratio of the metallic yarns inside the fabrics and tensile strength in both directions, elongation in warp direction, tear strength in weft direction, fabric stiffness in both directions, and abrasion resistance.

3-The finished fabrics by heat setting have scored high rates for tensile strength in both directions, elongation in both directions, and abrasion resistance than grey fabrics.

4-The grey fabrics have scored high rates for tear strength in both directions, fabric stiffness in both directions.

REFERENCES

[1]. Banu UyGun Negis, Factors Influencing the properties of ladder-knit fancy yarns. Istanbul Technical University Turkey Textile Research Journal, August, 2002, P. 686-688.

[2]. Textiles magazine 2004 No. 1. P. 19.

[3]. hafez said “effect of using metallic yarns on the properties of some upholstery fabrics” thesis (M.sc) 2011.

[4] www.wikipedia.org/wiki/metallic_fiber .

[5]. www.scribd.com/doc/38492355/metallic-fibers-final-assign

[6]. G.MOHAN KUMAR & V.S.SIDHARTH “METALLIC YARNS AND FIBRES IN TEXTILES” www.fibre2fashion.com 2012 .

[7]. Kadolph, Sara J. and Langford, Anna L. "Textiles Ninth Edition" pg. 129-130.

[8] https://en.wikipedia.org/wiki/Heatsetting

[9] Howard l. needs, “textile fibers,dyes,finishes and processes” noyes publications.1968.

[10]. ASTM-D 5034-90 "Standard test method for measuring tensile strength for fabric".

[11]. ASTM-D 2661-71 "Standard test method for measuring tears strength for fabric".

[12]. ASTM-D 5034-90 "Standard test method for measuring tensile strength for fabric".

[13]. ASTM-D-4158-2001" Standard test method for measuring fabric stiffness".

[14] Gohl- Vilensky "Textile science" an explanation of fibre properties second edition 1983 P. 45, 58, 95, 115.

[15]. Nilgün Özdil1, Gonca Özçelik Kayseri and Gamze Süpüren Mengüç “ Analysis of Abrasion Characteristics in Textiles” 2011.