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Short Communication

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Electromagnetic Shielding Effectiveness of Conductive Knitted Fabrics

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Abstract

Electromagnetic waves are known to have harmful effects on human health. The aim of this project is to investigate the application of knitted textile materials for the purpose of protection against electromagnetic waves and the effect of raw material, yarn and fabric parameters on electromagnetic shielding properties extensively. To obtain conductive textile surfaces, copper and silver filaments were used with cotton by using an apparatus on ring spinning machine.By using conductive yarns single jersey, rib, and futter (2 threads) knitted fabrics were produced. Cotton fabrics were also produced for comparison.

Keywords

Electromagnetic waves; Electromagnetic shielding; Conductive knitted fabrics; Technical textiles

Introduction

The use of electronic devices casuses electromagnetic radiation which results in an unwanted electromagnetic interference (EMI) [1].

Many devices such as AC motors, digital computers,calculators, point-of-sle terminals, printers, modems,electronic home appliances and cellular phones are capable of emiting electromagnetic waves that will result in elecromagnetic interference (EMI) problems [2].

Electromagnetic shielding is an important subject for protect the people from hazardous effect of electromagnetic waves.

Several methods are used for shielding the electromagnetic radiations such as ionic plating, electroless plating, cathode sputtering, conductive paints, vacuum metallization, and conductive fillers such as copper, stainless steel, and aluminum. The above methods can be categorized under two headings, such as surface treatments and fillers. Surface treatments are often time consuming, labor intensive, and costly. Using fillers for shielding is more effective and cheaper than surfaces treatments [3].

Textile materials can be used for electromagnetic shielding applications when they are turned into electrical conductors. The most important factors effecting on the electromagnetic shielding effectiveness of the textile surfaces are the amount of the conductive inclusion, conductivity property of the materials used, structure of the material surface and the conductive net [4].

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Experimental

Copper and silver filaments were used to produce core yarns. For the feeding the metal filaments to the ring machine, a special apparatus were used. Three types of yarns were produced by using ring machine.

- The core yarns containing silver coated filaments with cotton sheath
- The core yarns containing fine copper filaments with cotton sheath.
- % 100 cotton yarns (for comparision)

By using core yarns three type knitted fabrics were produced; yarns single jersey, rib, and Futter (2 yarns). The copper filaments fineness are of 0,05 mm diameter.

2 yarn futter fabrics produced with 135 and 75 denier core filaments (Tables 1 and 2).

Table 1: Names of the knitted fabrics containing copper filament.

Yarn Components	Fabric Structure	Fabric Name
100% Ne 13 copper core yarn	Jersey	B1
66,7% Ne 13 copper core yarn, 33,3% Ne 22 cotton yarn	Jersey	B2
50% Ne 13 copper core yarn, 50% Ne 22 cotton yarn	Jersey	B3
33,3% Ne 13 copper core yarn 66,7% Ne 22 cotton yarn	Jersey	B4
100% Ne 13 cotton yarn	Jersey	P

Table 2: Name of the knitted fabrics containing silver filament.

Yarn Structure	Core thickness	Yarn thickness	Fabric Structure	Fabric Name
Silver core yarn	135 denier	Ne 27	Jersey	GS1
Silver core yarn	135 denier	Ne 30	Rib	GR1
Silver core yarn	135 denier	Ne 30	Futter (2 yarns)	GF1
Silver core yarn	75 denier	Ne 30	Jersey	GS2
Silver core yarn	75 denier	Ne 30	Rib	GR2
Silver core yarn	75 denier	Ne 30	Futter (2 yarns)	GF2
Silver core yarn	38 denier	Ne 30	Jersey	GS3
Silver core yarn	38 denier	Ne 30	Rib	GR3
Silver core yarn	38 denier	Ne 30	Futter (2 yarns)	GF3
Cotton yarn		Ne 30	Jersey	PS
Cotton yarn		Ne 30	Rib	PR
Cotton Yarn		Ne 30	Futter (2 yarns)	PF

The shielding properties of the fabrics were tested by using EMC (Electromagnetic Competence) test system.

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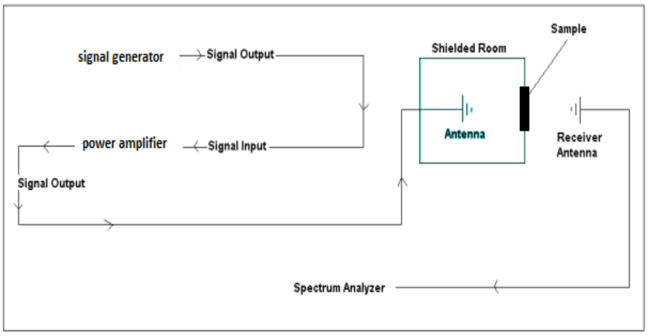

Figure 1: Working principle of the EMC test system [5].

EMC test system is composed of a signal generator which produces the signals to be sent onto the sample, an RF power amplifier which amplifies the signals before being sent to the sample, two antennas; one is connected to the signal generator to send the signals to the sample and the other to the spectrum analyzer as receiver and a spectrum analyzer where the data is collected for evaluation. EMSE measurements were performed between 100 MHz-1 GHz frequencies according to EN50147-1 standard. The results were analyzed with SPSS statistics programme.

Results

The results show that conductive fabrics have high EMSE (Electromagnetic Shielding Effectiveness) values when compared to cotton fabrics (Figures 1 and 2).

Highest results were obtained with B1 which has the highest copper percentage in its structure. EMSE decreased with decreasing copper percentage in the structure.

Figures 3-5 show that high EMSE (Electromagnetic Shielding Effectiveness) results can be obtained from the knitted fabrics produced with silver core yarns. It was observed that conductive fabrics have high EMSE values when compared to cotton fabrics. 2 yarn futter knitted fabrics showed higher values compared to jersey and rib fabrics, due to higher amount of conductive yarn in unit area of the fabric. It was also seen that higher shielding effectiveness results were obtained with conductive filaments in the structure. Therefore the highest results were obtained with GF1 and GF2 fabrics; which are compared to jersey and rib. Also the fabrics that contain copper have high EMSE values.

Electromagnetic shielding effectiveness of the textile surfaces vary depending on type of material that is used. Also it is depending on the structure of textile surface.

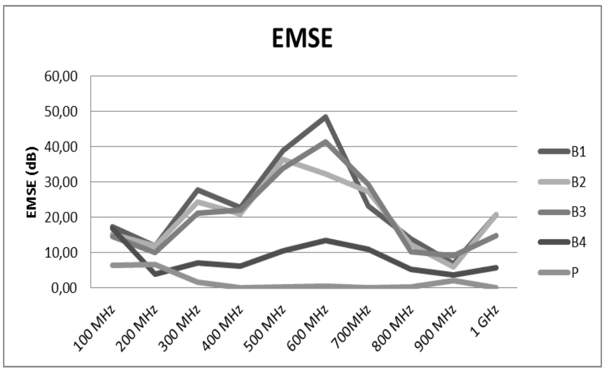

Figure 2: Comparison of the EMSE measurement results of jersey fabrics produced with copper core yarns and 100% cotton yarn.

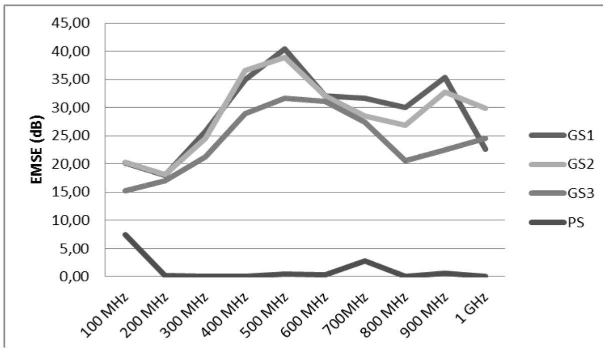

Figure 3: Comparison of the EMSE measurement results of jersey fabrics produced with silver core yarns and 100% cotton yarn.

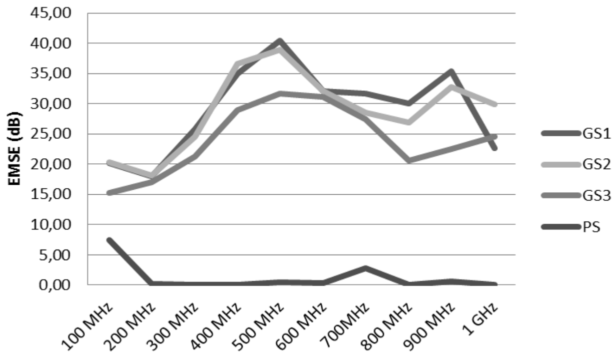

Figure 4: Comparison of the EMSE measurement results of rib fabrics produced with silver core yarns and % 100 cotton yarn.

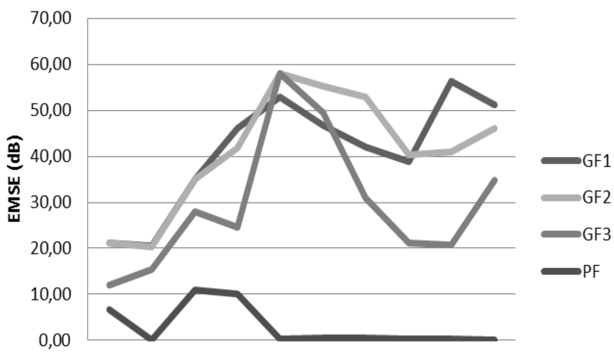

Figure 5: Comparison of the EMSE values of futter fabrics produced with silver core yarns and 100% cotton yarn.

Futter knitted fabrics show better values when compared to jersey and rib. Also the fabrics that contain copper have high EMSE values.

Discussion

Protecting human with textiles from electromagnetic interference is possible. Type of the raw material, amount of the conductive filament in fabric structure and type of the knitted fabric structure have significant effects on electromagnetic shielding effectiveness. Copper and silver filaments have good conductivity. By using them as core, electromagnetic shielding can be provided.

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Conclusions

In this study knitted fabrics were produced for the purpose of protection against electromagnetic waves.

The results show that conductive fabrics have high EMSE (Electromagnetic Shielding Effectiveness) values when compared to cotton fabrics. Futter knitted fabrics show better values when compared to jersey and rib. Also the fabrics that contain copper have high EMSE values.

Electromagnetic shielding effectiveness of the textile surfaces vary depending on type of material that is used. Also it is depending on the structure of textile surface.

Increasing metal content in the fabric provides good EMSE (Electromagnetic Shielding Effectiveness) values according to SPSS results.

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