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Statistical Analysis of Electromagnetic Shielding Effectiveness of Metal Fiber Blended Fabrics

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Electromagnetic shielding,
Conductive fabric,
Microwave frequency,
Descriptive statistics,
ANOVA method

Abstract: In this paper the electromagnetic shielding effectiveness (EMSE) of knitted fabrics made of copper, silver and stainless steel blended conductive yarns were analyzed statistically. Data obtained by the experiments carried out in 1.7 - 2.6GHz frequency band with the help of waveguide system was evaluated by statistical methods. A total of 29 different knitted fabric samples were used in the experiments, including rib, weft, milano, lacoste and cardigan types. In order to test the stability of shielding effectiveness (SE) descriptive statistics were presented for all fabric samples. Subsequently, data was distributed into clusters by means of ANOVA method. In this way, the fabrics with the worst and best shielding performance were found at 95% confidence level. The statistical findings overlapped with experimental results.

Metal Özlü Kumaşların Elektromanyetik Ekranlama Etkinliklerinin İstatistiksel Analizi

Anahtar Kelimeler
Elektromanyetik ekranlama,
İletken kumaş,
Mikrodalga frekansı,
Tanımlayıcı istatistik,
ANOVA metodu

Özet: Bu çalışmada bakır, gümüş ve paslanmaz çelik tel içeren örme kumaşların elektromanyetik ekranlama etkinliklerinin istatistiki analizi yapılmıştır. İstatistik metodları ile değerlendirilecek veriler dalga kılavuzu yöntemi ile 1.7 - 2.6GHz frekans bölgesinde gerçekleştirilen deneylerden elde edilmiştir. Deneylerde ribana, süprem, milano, pike ve selanik türleri olmak üzere 29 farklı örme kumaş numunesi kullanılmıştır. Ekranlama etkinliği değerlerinin kararlığını test etmek için tüm kumaş örneklerinin tanımlayıcı istatistikleri çıkarılmıştır. Ardından, değerler ANOVA metodu yardımı ile kümelere dağıtılmıştır. Böylece, en iyi ve en kötü ekranlama performansına sahip kumaşlar 95% güven düzeyinde tespit edilmiştir. İstatistiki bulguların deney sonuçları ile örtüştüğü gözlenmiştir.

1. Introduction

Currently conductive fabrics are commonly used in shielding electromagnetic fields. These fabrics include conductive or ferromagnetic metal fibers blended to yarns. Conductive fabrics have a promising future in the field of industry, military and civil electromagnetic shielding issues [1, 2] as well as medicine, telecommunication and wearable technology [3].

Due to its easy implementation and integration with composite materials, textile fabrics gain popularity among scientists evermore. In last decade, the subject was backed up by theoretical basis establishments and experimental studies continuously [4–9]. The results should be analyzed in terms of error rate and reliability as in many engineering fields. For this reason, statistical analysis is required as well as the evaluation of the results.

Many studies about statistical analysis on shielding fabrics, were documented in the literature so far. Perumalraj and Dasaradan [10–12] proposed various solutions in order to get optimum shielding material with the help of Taguchi design and ANOVA methods. In their studies, they mainly focused on physical characteristics of metal blended fabrics and environmental conditions. Apart from factors that influence the shielding performances of fabrics, they found exposure time of radiation and temperature of media have neutral/negligible on electromagnetic

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shielding. Rajendrakumar and Thilagavathi [13] in their work concluded that weave and thread spacing of fabric samples had effect on shielding effectiveness (SE) based on statistically significant findings. A similar work was also conducted deeply by Cheng et al. [14] for different frequency ranges. In their work it was emphasized that the factors such as radiant frequency, metal content, metal mesh size and geometry effected SE performance. Hsieh [15] in his work tried to reach optimal manufacturing conditions with the help of statistical methods such as Taguchi approach and Grey relational analysis. His paper presents statistical data which contribute to reduced cost in production of shielding fabrics. Das et al.[16] presented a paper in which stainless steel (SS) filament and polyester/SS hybrid yarn were used separately or together to weave distinct plain type woven fabrics. As a result, depending on statistical analysis, researchers simply pointed out that SS filament and SS/PET hybrid yarn combined fabric showed higher SE than SS filament based fabric. Previously, Krishnasamy et al. [17] in their work found significant difference between the SE of different fabric samples with the help of ANOVA. By this way, they could derive factors that improved shielding performance. In the literature, the researchers used statistics only in characterization of shielding fabrics, trying to obtain an optimal solution. This endeavor contributed to production process of shielding fabric. However, they did not give detailed information about the reliability and preference criterion of end products.

There are many experiments carried out for wider range of frequencies with different kind of composite fabrics. One can find SE results swinging along the operating frequency range. After which, scientists tend to determine the best shielding material by examining output graphics. They do this both for whole frequency range and specific sub ranges. Even in some cases the outlier and extreme values are taken into consideration which are statistically should be neglected. By applying the steps presented in the paper, scientists will have an idea about the material and its behavior by analyzing descriptive statistics. Besides they can group the materials and get the best group with 95% confidence level.

A waveguide transmission setup was conducted to carry out experiments in the frequency range of 1.7 - 2.6GHz. For the experiments, 29 metal composite knitted fabrics in five types were manufactured. Knitted fabric types are rib, weft knitted, lacoste, milano and cardigan. Fabrics contain three different conductive fibers such as copper, silver and stainless steel. Statistical evaluations are based on the data gathered from the experimental results.

In this work, descriptive statistics were done based on SE values and grouping tests were performed on shielding materials in order to check the statistical significance of results.

For this, firstly it was tested if variants were distributed normal or not. Welch test was performed in accordance with significance values. Based on 95% confidence level test results confirmed that there were differences between group values. In order to determine the differences between the graphs ANOVA test was performed. Comparison of a sample with another was done and results were observed if there were any distinctions between the means of them. For grouping SE values, Hierarchical and Two Step clustering algorithms were used. Both two algorithms divided the input (29 knitted fabrics) into two groups. In order to divide data into more specific sections, algorithms' settings were altered so that the next output would be four groups. Consequently, it was seen that three knitted fabrics with best shielding performances were put in same group while the others were distributed to other three groups.

2. Material and Method

2.1. Experimental setup

The experimental setup consists of WR430 waveguide system and Anritsu MS4624B network analyzer is connected to this system to read scattering parameters. Operating frequency for this standard is 1.7 - 2.6GHz. The scheme of the system is shown in Figure 1.

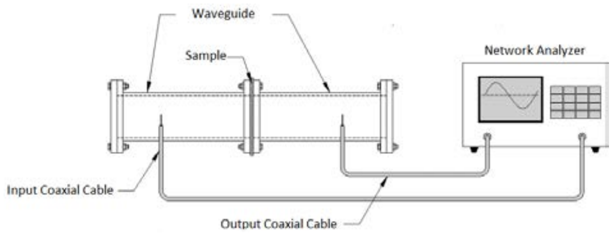


Figure 1. Schematic layout of the experimental waveguide setup

The waveguide tube consists of two parts which are connected with flanges in the middle. Flanges have aperture with size 54.61x109.22mm which is enclosed by each fabric sample to prevent radiation passing through. The fabric sample placed between flangs reflected and absorbed the radiation partly. The scattering parameters were read by the software installed in the computer connected to network analyzer. Finally, the data evaluated for statistical purposes was obtained by converting scattering parameters to shielding values [18]. The photograph of the system is shown in Figure 2.

Figure 2. Photograph of the waveguide measurement system

In the proposed study, 29 knitted fabrics had been produced for the experiments. They differ from each other by their texture and metal content. The physical characteristics of all samples used in experiments are shown in Table 1.

Table 1. Physical characteristics of knitted fabrics

Fabric code	Knit type	Stitch length(mm)	Metal type
RC2	Rib	2	Copper
RC4		4	
RC6		6	
MC4	Milano	4	
MC6		6	
LC2	Lacoste	2	
LC4		4	
LC6		6	
CC4	Cardigan	4	
CC6		6	
WC2	Weft	2	
WC4		4	
WC6		6	
RS2	Rib	2	Silver
RS4		4	
RS6		6	
WS2	Weft	2	
WS4		4	
WS6		6	
MSS6	Milano	6	Stainless steel
MSS8		8	
RSS2	Rib	2	
RSS4		4	
RSS6		6	
CSS6	Cardigan	6	
CSS8		8	
WSS2	Weft	2	
WSS4		4	
WSS6		6	

In order to get reliable results from statistical analysis methods, large number of inputs are required. For this reason, SE values of significant numbers of composite fabrics were obtained from the experiments with the help of waveguide system which operated in 1.7 - 2.6GHz frequency range. The setup system was configured out so that it divided frequency range into 400 equal ranges. This means, for every test sample 400 SE values could be obtained which was enough for proper statistical analysis.

2.2. Descriptive statistics

Descriptive statistics had been deduced for all test samples. Descriptive statistics were used to describe the basic features of the data. For this work, means, medians, standard deviations, minimum and maximum values relating to all SE values obtained from the experiments for all test samples had been introduced. In this way, it was possible to observe the results and use them for further statistical analysis purposes.

2.3. Grouping

In order to group the SE values of samples statistically, checking whether variances of the values are homogeneous or not is the prior step. As a result of established hypothesis, if the variances are not homogeneous, then it means there are groups. In order to identify them Welch test is needed to be applied. By this way it is aimed to determine whether there are differences between means of groups. In accordance to established hypothesis and significance level if there are such differences then ANOVA should be applied.

ANOVA is a collection of statistical models which analyses relations between the values of two or more groups. It is developed on the difference of correlation values among groups and of means of member within group.

TamHane's T2 test determines the difference of each sample from the others. Correct reading of significant level is necessary. If the significance level is smaller than 0.05, then there are significant differences among means of groups at 95% confidence level which means there are two or more groups. For grouping the values clustering algorithm is needed. Generally to assure the reliability of grouping results, more than one algorithm is preferred. In this work Hierarchical clustering and Two Step clustering had been conducted.

3. Results

The shielding experiments carried out within the 1.7 to 2.6GHz frequency range. All of the shielding effectiveness values of fabrics are illustrated in Figure 3 which represents fabrics containing metal filament types as copper, silver and stainless steel, respectively.

As it is seen from Figure 3, the results were distributed into sub-figures to monitor them easily. But still, large number of samples make it difficult to classify the results.

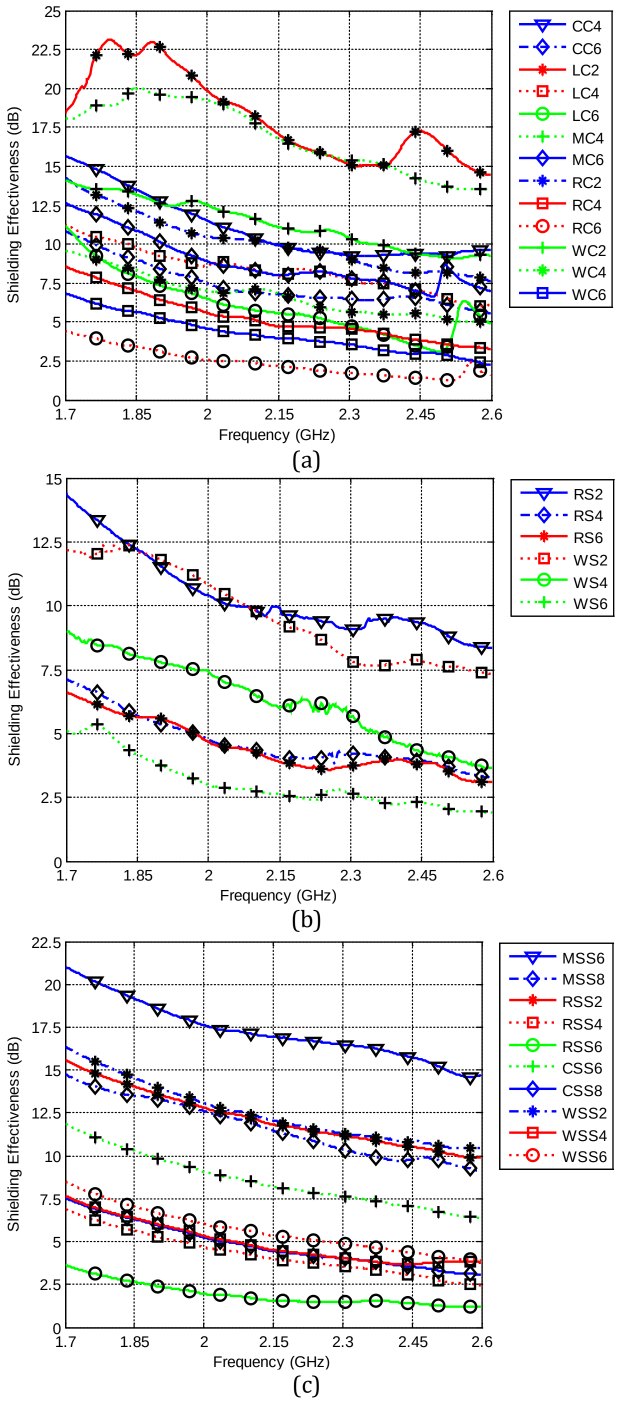


Figure 3. SE values for (a) copper, (b) silver, (c) stainless steel composite knitted fabrics

Statistical analysis is required to make the data more compact. In the first stage, the descriptive statistics were performed for the SE values of all test samples. The results are shown in Table 2.

In Table 2 the median Med. is the middle number in a sorted list of numbers which gives a clue whether the SE results are stable or not along the frequency range. If the mean and the med are close then the values are well distributed, otherwise there may be some outlier or extreme values among data gathered from the experiments, which are generally neglected. Apart from these, accepted values are determined by means of the relation defined as

$$Mean - 3 \times S.Dev < Accepted < Mean + 3 \times S.Dev \qquad (1)$$

From (1) it is obvious that the shielding values of each sample converge if the Std.Dev. values decrease. So, lower Std.Dev. values imply that SE performance of relating sample is stable along the frequency range. This information gives a foresight for classifying samples by means of their SE performances. However, clustering is a more effective way.

Table 2. Descriptive statistics of SE values

Sample	Mean	Med.	Std.Dev.	Min.	Max.
RC2	10.11	9.97	1.74	7.61	14.29
RC4	5.27	4.71	1.43	3.27	8.60
RC6	2.39	2.18	0.86	1.26	4.45
MC4	16.87	16.80	2.19	13.46	19.98
MC6	8.48	8.21	1.59	6.36	12.68
LC2	18.19	17.25	2.77	14.43	23.1
LC4	8.33	8.31	1.31	5.99	11.30
LC6	6.05	5.71	1.87	3.07	11.22
CC4	11.02	9.93	2.00	9.21	15.70
CC6	7.37	6.76	1.35	5.56	10.87
WC2	11.33	11.10	1.56	9.08	14.12
WC4	6.72	6.84	1.32	4.98	9.56
WC6	4.21	3.98	1.18	2.23	6.87
RS2	10.33	9.66	1.56	8.35	14.42
RS4	4.64	4.20	0.98	3.23	7.15
RS6	4.46	4.00	0.98	3.09	6.62
WS2	9.64	9.29	1.80	7.30	12.44
WS4	6.30	6.23	1.57	3.65	9.00
WS6	3.05	2.72	0.98	1.91	5.35
MSS6	17.27	16.95	1.64	14.60	21.03
MSS8	11.62	11.47	1.64	9.13	14.78
RSS2	12.17	11.83	1.58	9.88	14.62
RSS4	4.25	3.98	1.18	2.47	6.89
RSS6	1.91	1.56	0.64	1.18	3.65
CSS6	8.55	8.20	1.49	6.35	11.86
CSS8	4.80	4.45	1.24	3.08	7.53
WSS2	12.51	12.07	1.70	10.43	16.38
WSS4	4.94	4.52	1.17	3.66	7.68
WSS6	5.36	5.36	1.23	3.92	8.53

In order to start clustering firstly homogeneity of variances was tested. Test results are shown in Table 3.

Table 3. Homogeneity tests of variances

Levene Statistic	df1	df2	Sig.
96,431	28	11571	,000

The abbreviation df stands for degree of freedom. df1 is the number of distinct test groups to which each group is compared and df2 is the total number of observations obtained by the calculation of formulas related with aforementioned statistical method.

- 0 hypothesis: variances are homogeneous.
- 1 hypothesis: variances are not homogeneous.

By looking Table 3 since the significance level (Sig.) < 0.05, null hypothesis is rejected in 95% confidence level. Thus, Welch test had been conducted. The results are shown in Table 4.

Table 4. Equality test of the means

Test	Statistic	df1	df2	Sig.
Welch	3652,298	28	4129,690	,000

- 0 hypothesis: the means of all groups are equal to each other.

- 1 hypothesis: at least one of the groups' mean is distinct.

From Table 4 since the significance level < 0.05, null hypothesis was rejected in 95% confidence level. In this case at least one of the groups' mean is distinct. Since the variances are found to be not homogenous, to determine which groups are different from others, TamHane's T2 was conducted (App. B).

- 0 hypothesis: there is no difference between the mean of group i and group j, where i≠j.

- 1 hypothesis: there is a difference between the mean of group i and group j.

If the significance level < 0.05, then there is statistical difference between the means of group i and j with 95% confidence level. Otherwise, there is no statistical difference between the means of group i and j. With the help of TamHane's T2 test it was found that there are samples having similar SE values. Since clustering determines the number of groups, Hierarchical and Two Step clustering algorithms were applied. Using both algorithms, all samples were distributed into 2 clusters. The samples RC4, RC6, LC6, CC6, WC4, WC6, RS4, RS6, WS4, WS6, RSS4, RSS6, CSS8, WSS4 and WSS6 were put in cluster 1 while the others like RC2, MC4, MC6, LC2, LC4, CC4, WC2, RS2, WS2, MS6, MS8, RSS2, CSS6 and WSS2 were put in cluster 2 by the algorithms. A small number of clusters indicated that SE values of samples were not far different from others. However, a considerable number of samples make it difficult to deduct the best and the worst shielding material. For this reason, in the next stage algorithms were forced to group the samples into 4 clusters. The model summary and the test quality are shown in Figure 4.

In Figure 4 the quality of algorithm confirms the reliability of clustering results which is revealed in Table 5.

As it is seen from Table 5 there are 4 clusters and each contains some of samples. The samples in first cluster are the worst while the samples in the fourth one are the best shielding fabrics among samples tested in this experiment. From Table 1, RC6,WS6 and RSS6 in cluster 1, stand for copper core Rib 6mm, silver core Weft 8mm and stainless steel core Rib 6mm respectively, while MC4, LC2 and MSS6 stand for copper core Milano 4mm, copper core Lacoste 2mm and stainless steel core Milano 6mm respectively. An explicit difference between cluster 1 and cluster 4 is illustrated as in Figure 5.

Figure 4. Two Step clustering algorithm, summary and quality

Table 5. Samples inside clusters

Cluster No	1	2	3	4
	RC6	RC4	RC2	MC4
	WS6	CL6	MC6	LC2
	RSS6	CC6	CL4	MSS6
		WC4	CC4	
		WC6	WC2	
Samples		RS4	RS2	
		RS6	WS2	
		WS4	MSS8	
		RSS4	RSS2	
		CSS8	CSS6	
		WSS4	WSS2	
		WSS6		

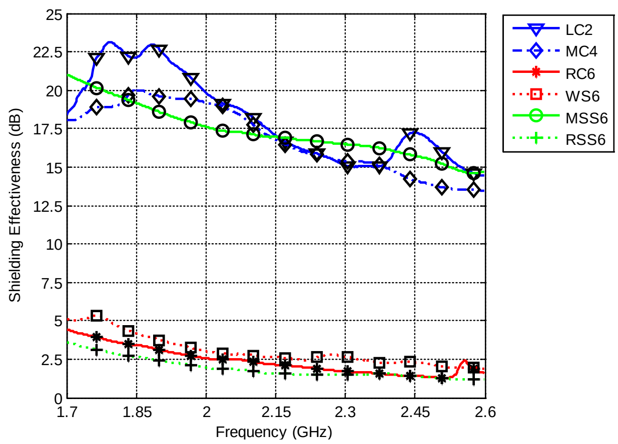


Figure 5. SE of the samples in the cluster 1 and 4

It is obvious from Figure 5 that there is 10 to 20dB difference between values of cluster 1 and 4. It can be inferred that the remaining clusters are located in the region between the cluster 1 and 4.

4. Discussion and Conclusion

The SE values obtained from the experiments were successfully processed by statistical methods and algorithms. In this scope, firstly descriptive statistics of test samples were introduced. Low value of standard deviation factor gave a clue about the stability of results. By this means, evaluating the results, it was found that SE values of samples are stable along the frequency range. Secondly, ANOVA tests and clustering algorithms were conducted. As a result, 4 clusters were generated. The fabric samples with worst SE performance were put into cluster 1 while the best ones were put into cluster 4 by the algorithms. Consequently, copper core milano 4mm, copper core lacoste 2mm and stainless steel core milano 6mm were chosen as the best shielding fabrics by statistical analysis methods in the 95% confidence level. Findings were also verified by naked eye observations during the experiments.

The proposed research can be expanded to similar studies. The statistical analysing methods and the underlying statistical assumptions presented in paper can be adapted easily in researches which cover the experiments carried out for wide frequency ranges with large number of test samples.

References

[1] Liu, Z. and Wang, X.C. 2012. Influence of Fabric Weave Type on the Effectiveness of Electromagnetic Shielding Woven Fabric. Journal of Electromagnetic Waves and Applications, 26(2012), 1848-1856.

[2] Oxley, C.H., Williams, J., Hopper, R., Flora, H., Eibeck, D., Alabaster, C. 2007. Measurement of the Reflection and Transmission Properties of Conducting Fabrics at Mill-metric Wave Frequencies. IET Science Measurement and Technology, 1(2007), 166-169.

[3] Banaszczyk,J., Mey, G.D., Schwarz A., Langenhove, L.V. 2009. Current Distribution Modelling in Electroconductive Fabrics. Fibres and Textiles in Eastern Europe 17(2009),28-33.

[4] Das, A., Kothari, V.K., Kothari, A., Kumar, A. 2009. Indian Journal of Fibre and Textile Research, 34(2009), 144-148.

[5] Wang, X., Liu,Z. 2012. Influence of Fabric Density on Shielding Effectiveness of Electromagnetic Shielding Fabric. Przeglad Elektrotechniczny, 11a (2012), 236-238.

[6] Perumalraj,R. and Dasaradan,B.S. 2010. Electromagnetic Shielding Effectiveness of Doubled Copper-Corn Yarn Woven Materials. Fibres and Textiles in Eastern Europe, 18(2010), 74-80.

[7] Soyaslan,D., Goktepe, O., Comlekci, S. 2014. The Effects of Fabric Lamination Angle and Ply Number on Electromagnetic Shielding Effectiveness of Weft Knitted Fabric-Reinforced Polypropylene Composites. Science and Engineering of Composite Materials, 21(2014), 129-135.

[8] Liu, Z. and Zhou, Z. 2013. Computation of Shielding Effectiveness for Electromagnetic Shielding Blended Fabric, Przeglad Elektrotechniczny 3a(2013), 228-230.

[9] Ortlek, H. G., Saracoglu, O. G., Saritas O., Bilgin, S. 2012. Electromagnetic Shielding Characteristics of Woven Fabrics Made of Hybrid Yarns Containing Metal Wire. Fibers and Polymers, 13(2012), 63-67.

[10] Perumalraj, R., Dasaradan, B. S. 2009. Electromagnetic shielding effectiveness of copper core yarn knitted fabrics. Indian Journal Fibre Text. Res., 34(2009), 149–154.

[11] Perumalraj, R., Dasaradan, B.S. 2011. Electroless nickel plated composite textile materials for electromagnet compatibility. Indian Journal Fibre Text. Res., 36(2011), 35–41.

[12] Perumalraj, R., Dasaradan, B.S. 2011. Optimization of electromagnetic shielding tester process parameters for conductive textile composite materials through Taguchi design and ANOVA. Elixir International Journal, 40(2011), 5477–5482.

[13] Rajendrakumar, K., Thilagavathi, G. 2012. Electromagnetic shielding effectiveness of copper / PET composite yarn fabrics.Indian Journal. Fibre Text. Res.,37(2012), 133–137.

[14] Cheng, L., Zhang, T., Guo, M., Li, J., Wang, S., Tang, H.2014. Electromagnetic shielding effectiveness and mathematical model of stainless steel composite fabric. The Journal of Textile Institute, 5000(2014), 1–10.

[15] Hsieh C. 2015. Optimization of Conductive Fabric Using the Taguchi Method and Grey Relational Analysis: An Application in Manufacturing Process Design. Journal of the Hwa Gang Textile, 141(2015), 141–146.

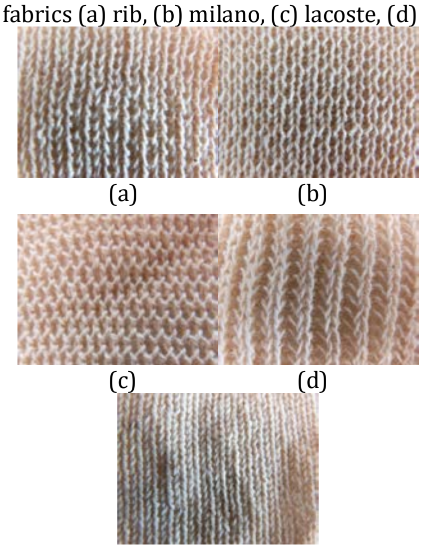
[16] Das,A., Krishnasamy,J., Alagirusamy,R., Basu,A. 2014. Analysis of the Electromagnetic Shielding Behavior of Stainless Stell Filament and PET/SS Hybrid Yarn Incorporated Conductive Woven Fabrics. Fibers and Polymers,15(2014),2423-2427.

[17] Krishnasamy,J., Ramasamy, A., Das,A. Basu, A. 2016. Effect of Fabric Cover and Pore Area Distribution of Carbon/Stainless Steel/Polypropylene Hybrid Yarn-Woven Fabric on Electromagnetic Shielding Effectiveness. Journal of Electronic Materials, 45(2016), 3087-3100.

[18] Abdulla, R., Delihasanlar, E., Abdulla, F. G. K., Yuzer, A. H. 2017. Electromagnetic Shielding Characterization of Conductive Knitted Fabrics. Progress In Electromagnetics Research M, 56(2017), 33–41.

Appendices

Appendix A. Photographs of copper core fabrics (a) rib, (b) milano, (c) lacoste, (d) cardigan, (e) weft with 4mm stitch length



(a) (b) (c) (d) (e)

Appendix B. TamHane's T2 test results

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Fabric samples	RC2	RC4	RC6	MC4	MC6	LC2	LC4	LC6	CC4	CC6	WC2	WC4	WC6	RS2	RS4	RS6	WS2	WS4	WS6	MSS6	MSS8	RSS2	RSS4	RSS6	CSS6	CSS8	WSS2	WSS4	WSS6
i RC2	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.103	0.06
RC4	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RC6	0	0	X	0	0	0	0	0	0	0	0	0	0	1	0	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0
MC4	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0	0	0	0	0	0	0	0	0
MC6	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.91	0	0	0	0
LC2	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LC4	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.0	0	0	0	0
LC6	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0.085
CC4	0	0	0	0	0	0	0	0	X	0	0.997	0	0	0	0	0	0	0	0	0	0.002	0	0	0	0	0	0	0	0
CC6	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WC2	0	0	0	0	0	0	0	0	0.997	0	X	0	0	0	0	0	0	0	0	0	0.995	0	0	0	0	0	0	0	0
WC4	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0.020	0	0	0	0	0	0	0	0	0	0	0
WC6	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0.426	0	0	0	0	0	0	1.0	0	0	0	0	0	0
RS2	0	0	1.0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RS4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0.947	0	0	0	0	0	0	0	0	0	1.0	0	0.055	0
RS6	0	0	0	0	0	0	0	0	0	0	0	0	0.426	0	0.947	X	0	0	0	0	0	0	0.970	0	0	0.006	0	0	0
WS2	0	0	0.059	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0
WS4	0	0	0	0	0	0	0	0	0	0	0	0.020	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0
WS6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0
MSS6	0	0	0	0.696	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0
MSS8	0	0	0	0	0	0	0	0	0.002	0	0.995	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0
RSS2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0.786	0	0
RSS4	0	0	0	0	0	0	0	0	0	0	0	0	1.0	0	0	0.970	0	0	0	0	0	0	X	0	0	0	0	0	0
RSS6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0
CSS6	0	0	0	0	0.909	0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0
CSS8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.0	0.006	0	0	0	0	0	0	0	0	0	X	0	1.0	0
WSS2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.786	0	0	0	0	X	0	0
WSS4	0.103	0	0	0	0	0	0	0	0	0	0	0	0	0	0.055	0	0	0	0	0	0	0	0	0	0	1.0	0	X	0
WSS6	0.060	0	0	0	0	0	0	0.085	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X