Analysis of Surface resistivity behavior of Conductive Woven fabrics made from Copper Jari & S.S./Polyester yarns for ESD control

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Abstract - ***Occurrence of Electrostatic discharge (ESD) has been around since the beginning of time. However, this natural phenomenon has become a significant issue with the widespread use of electronics in the world. All materials (insulators and conductors alike) are sources of ESD. ESD can damage or destroy sensitive electronic components, erase or alter magnetic media, or set off explosions or fires in flammable environments. There are basically two categories of damage from ESD: Catastrophic damage or Latent damage. Control of ESD can be achieved through High functional Conductive textile fabrics. These are antistatic, low tribocharging and assure excellent shielding properties. In this work, conductive woven fabrics are developed from Copper Jari & S.S./Polyester yarns and Surface resistivity of fabrics are studied to justify its nature for ESD control.***

Key Words: *Surface resistivity, ESD, Conductive material, Woven fabrics, Textiles, Jari*

1. INTRODUCTION

The age of electronics brought with it new problems associated with static electricity and electrostatic discharge. And, as electronic devices became smaller and faster, their sensitivity to ESD increased. Electrostatic discharge (ESD) is known as "the invisible threat"[1,2].

Today, ESD impacts productivity and product reliability in virtually every aspect of today's electronics environment. ESD affects production yields, manufacturing costs, product quality, product reliability, and profitability. Industry experts have estimated average product losses due to static range from 8-33%. Others estimate the actual cost of ESD damage to the electronics industry as running into the billions of dollars annually [3,4].

ESD protection through fabrics can be divided into two different—but often complementary—goals.

- One goal is to eliminate static charges as they occur, a task that can be accomplished simply by providing a rapidly conducting path to ground or often more effectively, by controlled dissipation, sometimes with conversion of much of the electrical energy into heat.
- The second goal of ESD protection is to prevent the triboelectric generation of static charge build up in the first place (Fig. 1)[5,6].

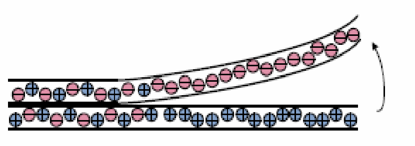


Fig. - 1: Triboelectric effect

The main purpose of ESD control fabrics is to minimise risks of ESD failures to sensitive electronics due to charged clothing [7]. Controlling ESD can be achieved with fabrics that do not generate high levels of charge but instead dissipate charges before they can accumulate to dangerous levels. Moreover, an ESD control fabrics attract less particulate contamination to its surface than an insulative material since fewer charges are generated and accumulated on its surface (particles are attracted to charged surfaces).

ESD Protection (Fig. 2)[8,9] **:**
Conductive material : Excellent
Static Dissipative/Antistatic : Good
Insulator : None

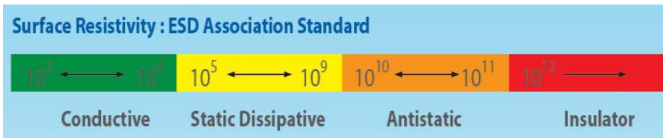


Fig. 2 : Surface Resistivity Range and classification of materials

Surface resistivity is defined as the electrical resistance of the surface of an insulator material. It is measured from electrode to electrode along the surface of the insulator sample. Since the surface length is fixed, the measurement is independent of the physical dimensions (i.e., thickness and diameter) of the insulator sample [10,11].

Under ASTM D257, surface resistivity is determined from measurement of surface resistance between two electrodes forming opposite sides of a square. Values are stated in ohms per area. Here, conductive yarns woven into fabric as weft with cotton or polyester base warp yarns and surface resistivity is studied to justify its nature for ESD control [12,13,14].

2. MATERIALS

Different Conductive materials used as Weft during weaving process : Copper Jari (J1) & 80% polyester fiber blended with 20% Stainless steel (S.S.) staple fiber yarn (S4)

Development of High functional Conductive woven fabrics : Rapier & Water jet looms used to develop conductive fabrics of basically two varieties of Warp : Cotton yarn (C1) & Polyester yarn (P1)

Weft wise conductive yarn pick distance in cotton fabrics: 0 (No. 1 & 7), 14mm (No. 2 & 8), 27mm (No. 3 & 9), 38mm (No. 4 & 10)
Weft wise conductive yarn pick distance in polyester fabrics : 0 (No. 5 & 11), 9mm (No. 6 & 12)

Weave Detail:

- Cotton base fabrics : 1/1 plain weave (Stripe pattern)
- Polyester base fabrics : 2/1 twill weave (Stripe pattern)

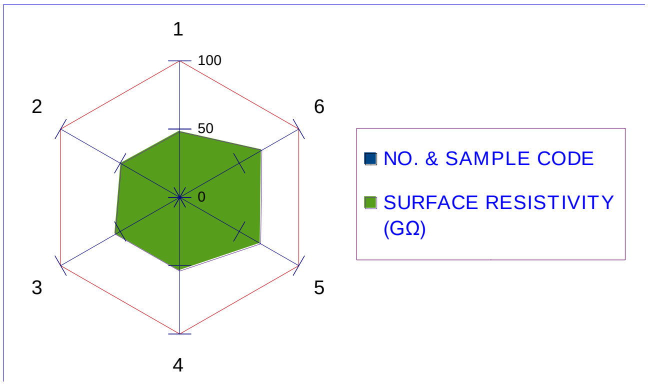
3. TESTING & ANALYSIS

Textile fabric samples were prepared; five measurements of the thickness of each specimen were measured, and their average values were recorded. Surface resistivity was measured as per ASTM D257 standard with the help of Megger MIT510/2 (5 kV Insulation Resistance Tester) & 16008A Resistivity Cell (Fig. 3)[15].

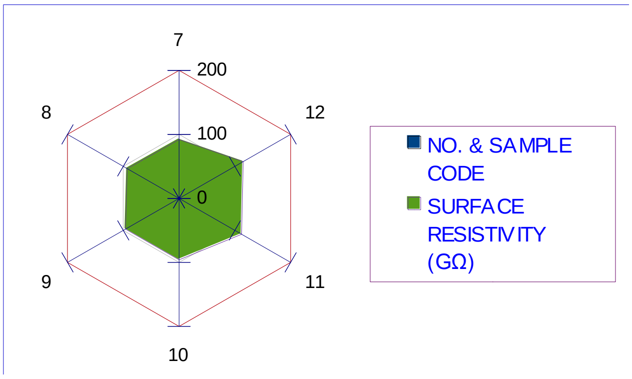
Fabric sample was inserted into sample holder and charged for 1 minute at 250V. Surface resistivity measurements were carried out at 27± 2° C.

Fig. 3 : Megger MIT510/2 & 16008A Resistivity Cell

SR. NO. & JARI FABRIC SAMPLE CODE		SURFACE RESISTIVITY (GΩ)
1	C1J1-06	48
2	C1J1-07	49
3	C1J1-08	54
4	C1J1-09	54
5	P1J1-01	68
6	P1J1-02	69



SR. NO. & S.S./POLYESTER FABRIC SAMPLE CODE		SURFACE RESISTIVITY (GΩ)
7	C1S4-14	92
8	C1S4-15	93
9	C1S4-16	96
10	C1S4-17	96
11	P1S4-05	112
12	P1S4-06	115



SR. NO. & FABRIC SAMPLE CODE		SURFACE RESISTIVITY (GΩ)
1	C1J1-06	48
2	C1J1-07	49
3	C1J1-08	54
4	C1J1-09	54
5	P1J1-01	68
6	P1J1-02	69
7	C1S4-14	92
8	C1S4-15	93
9	C1S4-16	96
10	C1S4-17	96
11	P1S4-05	112
12	P1S4-06	115

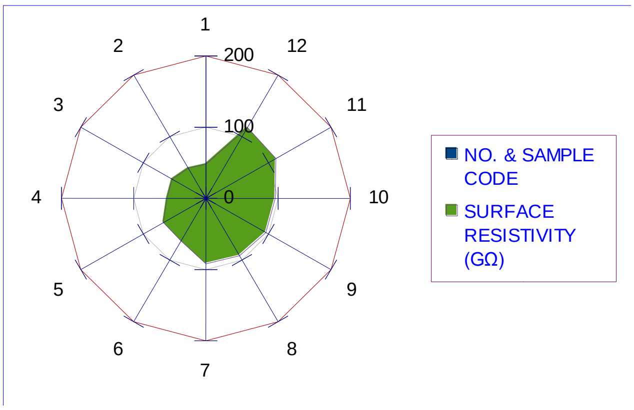


Table & Chart 1,2,3 : Surface resistivity of materials & presentation with NET Charts

Analysis of Surface resistivity of materials indicate that C1 fabrics with J1 as weft is in range of 48-54 GΩ at 250V and C1 fabrics with S4 as weft is in range of 92-96 GΩ at 250V. P1 fabrics with J1 as weft value lies in range of 68-69 & P1 fabrics with S4 as weft value lies in range of 112-115 (Table & Chart 1,2,3). C1J1 values are on lower side compared to C1S4 values with same construction detail. Compare to C1J1-06,07 & C1S4-14,15 fabrics, P1J1-01,02 & P1S4-05,06 fabrics give higher resistivity values respectively. Also resistivity values increases from C1J1-06 fabrics to C1J1-09 & C1S4-14 fabrics to C1S4-17 gradually. Same effect is observed in polyester base fabrics P1J1 & P1S4.

4. CONCLUSIONS

As a result of the present study, we can conclude that most of the conductive fabrics are of Static dissipative in nature at 250V. Type of warp and weft, distance of conductive yarns in fabric and weave pattern has significant influence on resistivity of fabrics. S.S./Polyester has higher resistivity compared to Copper Jari material. Also as distance of conductive materials in stripe pattern increases resistivity values increases respectively which has direct influence on conductive fabric ESD characteristics.

ACKNOWLEDGEMENT

Authors are thankful for the kind technical support given by Mr. S. M. Falnikar, Manager MSDE, Electrical Research & Development Association, Vadodara, Gujarat, INDIA.

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BIOGRAPHIES

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