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Analysis of Surface resistivity behaviour of Conductive Woven fabrics made from Pure Metal Wires & Cu Jari for ESD control

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Abstract —*Electrostatic discharge (ESD) is the sudden flow of electricity between two electrically charged objects caused by contact, an electrical short, or dielectric breakdown. A buildup of static electricity can be caused by tribocharging or by electrostatic induction. Electrostatic Discharge (ESD) can damage or destroy sensitive electronic components, erase or alter magnetic media, or set off explosions or fires in flammable environments. In present scenario, requirements for the ESD control/protective products in electronics industry are very diverse. Control of ESD can be achieved through High functional conductive textile fabrics. Furthermore, metal wires are more and more frequently used for their high conductivity ranges. These are antistatic, low tribocharging and assure excellent shielding properties. In this work, conductive woven fabrics are developed from Silver, Copper, Aluminium, Stainless steel wires etc. as well as Cu Jari and Surface resistivity of these fabrics are studied to justify its nature for ESD control.*

Keywords*-Surface resistivity, ESD, Conductive material, Woven fabrics, Textiles, Jari*

I. INTRODUCTION

The field of conductive textile can be viewed as an integration of technologies of materials, electronics and textiles in order to create a new generation of flexible/comfortable small or large multifunctional textile structures with conductive capabilities. The age of electronics brought with it new problems associated with static electricity and electrostatic discharge. As electronic devices became smaller and faster, their sensitivity to ESD increased (Figure 1). Electrostatic discharge (ESD) is known as "the invisible threat"[1,2].

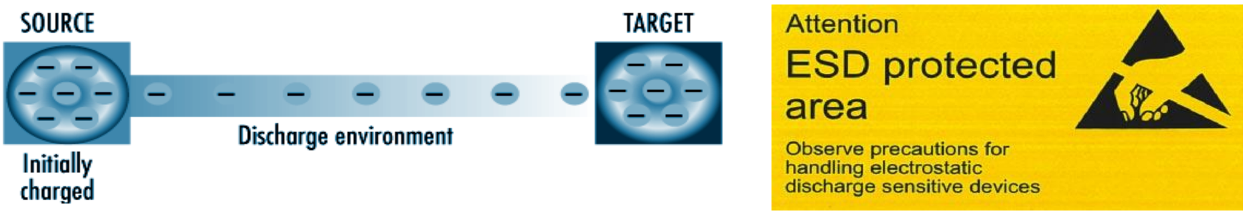


Figure 1 : Schematic of electrostatic discharge problem & indication through Attention of ESD Protected Area

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].

The discharge can be caused by a variety of sources, most commonly a direct discharge from a person or equipment into a sensitive object. The modes in which ESD damage occurs are [5] :

- Discharge to the device
- Discharge from the device
- Field-induced discharge

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 [6,7].

Electronic components that are electrostatic discharge sensitive (ESDS) must be protected throughout the entire manufacturing cycle [8]. Development of products through woven or knitted process (Figure 1) for Electrostatic discharge control is greatest need of present market to avoid hazardous malfunctions in working area.

The main purpose of ESD control fabrics is to minimise risks of ESD failures to sensitive electronics due to charged clothing [9]. 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 (Figure 2)[10,11] **:**

- Conductive material : Excellent
- Static Dissipative/Antistatic : Good
- Insulator : None

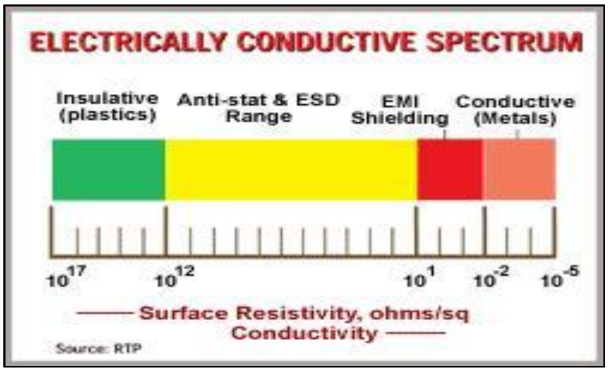


Figure 2 : Electrically Conductive Spectrum

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 [12,13].

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 (Metal wires and Cu Jari) woven into fabric as weft with cotton or polyester base warp yarns and surface resistivity is studied to justify its nature for ESD control [14,15,16].

II. MATERIAL

Different Conductive materials used as Weft during weaving process : Silver (S1), Copper(C1-42 & C2-45 SWG), Aluminium(A1), Stainless Steel (S2) metal wires & Cu Jari (J1)(Figure 3).

Figure 3 : Metal Wires

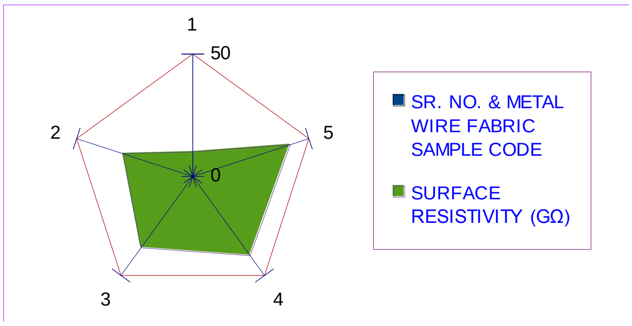
Development of High functional Conductive woven fabrics : Rapier & Water jet looms used to develop conductive fabrics of basically two varieties Warp : Cotton yarn (C1), Warp : Polyester yarn (P1).
Weft wise conductive yarn pick distance in cotton fabrics: 0 (No. 6), 14mm (No. 1 to 5, 7), 27mm (No. 8), 38mm (No. 9)
Weft wise conductive yarn pick distance in polyester fabrics : 0 (No. 10), 9mm (No. 11)
Weave Detail: Cotton fabrics : 1/1 plain weave (Stripe pattern) & Polyester base fabrics : 2/1 twill weave (Stripe pattern)

III. TESTING & ANALYSIS

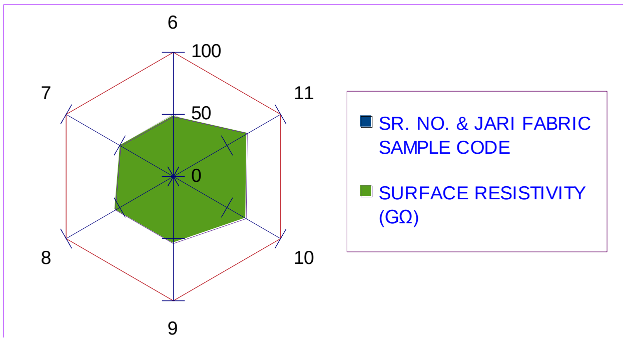
Textile fabric samples were prepared; five measurements of the thickness of each specimen were measured, and their average values were recorded. Surface resistivity was measured as per ASTM D257 standard with the help of Megger MIT510/2 (5 kV Insulation Resistance Tester) & 16008A Resistivity Cell [17].

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

SR. NO. & METAL WIRE FABRIC SAMPLE CODE		SURFACE RESISTIVITY (GΩ)
1	C1S1-01	10
2	C1C1-02	30
3	C1C2-03	36
4	C1A1-04	40
5	C1S2-05	42



SR. NO. & JARI FABRIC SAMPLE CODE		SURFACE RESISTIVITY (GΩ)
6	C1J1-06	48
7	C1J1-07	49
8	C1J1-08	54
9	C1J1-09	54
10	P1J1-01	68
11	P1J1-02	69



SR. NO. & FABRIC SAMPLE CODE		SURFACE RESISTIVITY (GΩ)
1	C1S1-01	10
2	C1C1-02	30
3	C1C2-03	36
4	C1A1-04	40
5	C1S2-05	42
6	C1J1-06	48
7	C1J1-07	49
8	C1J1-08	54
9	C1J1-09	54
10	P1J1-01	68
11	P1J1-02	69

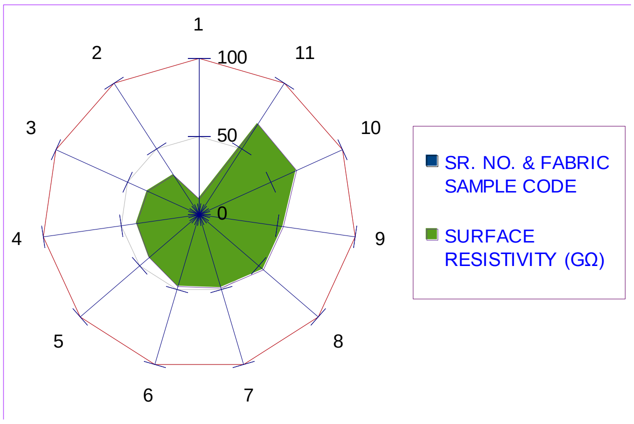


Table & Chart 1,2,3 : Surface resistivity of materials & presentation with NET Charts

Analysis of Surface resistivity of materials indicate that C1 fabrics with S1, C1, C2, A1, S2 as weft is in range of 10-42 GΩ at 250V and C1 fabrics with J1 as weft is in range of 48-54 GΩ at 250V. P1 fabrics with J1 as weft value lies in range of 68-69 (Table & Chart 1,2,3). Surface resistivity value is lowest for C1S1-01 & highest for P1J1-02. Values are increased from C1S1-01 to C1C1-02, C1C2-03, C1A1-04, C1S2-05, C1J1-06, C1J1-07, C1J1-08, C1J1-09, P1J1-01 & P1J1-02 respectively. Also resistivity values increases from C1J1-06 fabrics to C1J1-09 & P1J1-01 fabrics to P1J1-02 gradually.

IV. CONCLUSION

As a result of the present study, we can conclude that 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. Polyester fabrics show insulating nature with higher resistivity compared to Cotton fabrics. Cu Jari has higher resistivity compared to Metal wires. Silver has lowest resistivity and Cu Jari with polyester warp at 9mm pick distance has highest resistivity values. Also as distance of conductive materials in stripe pattern increases resistivity values increases respectively this has direct influence on ESD characteristics of Conductive fabrics.

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