Chapter - 1

INTRODUCTION

1. Introduction

As per history, the word 'electricity' comes from 'electron' and it was Thales of Miletus who first observed this specific property related to field of electrical and electronic products. It was titled as 'electrical' in 1600 by William Gilbert who is said to have begun the scientific study of electric and magnetic field and its effects[1].

1.1 Industry defined problem (IDP)

With the progress of science & technology and invention of new materials, electrical and electronic devices have grown rapidly[2]. Miniaturization of electrical and electronic components gave rise to new possibilities to increase the performances and reduce the sizes of electrical devices, but at the same time increased their vulnerability to generate new problems[3-4].

Today, the growth of the electronic industry and the widespread use of electronic equipment in communications, computations, automations, biomedicine, space, and other purposes have led to many electrostatic discharge, electromagnetic field/radiation and contamination related problems as systems operate in close proximity. Here, all three problems are discussed in brief:

1.1.1. Electrostatic Discharge (ESD)

Electrical based technology is at the core of modern existence. While there are many useful attributes of electrical phenomena, there exists some negative properties and one in particular concerns the issues surrounding static electricity and its generation[5]. The transfer of charge between "bodies" at different electrical potentials, which is generally called as electrostatic discharge, can damage or destroy sensitive electronic components, erase or alter magnetic media, or set off explosions or fires in flammable environments. Investigations performed in different regions of the world show that about 30-50 % of all failures in electronic products detected during manufacturing can be attributed to some kind of electrical overstress, of which electrostatic discharge (ESD) is one type[6-11].

Electrostatic discharge is a critical issue especially with handling of sensitive electronic items (e.g. IC chips, data storage devices, space, defence or medical instruments) due to their susceptibility towards ESD[12-16].

1.1.2. Electromagnetic field/Radiation

Electrical and electronic devices transmit electromagnetic waves of different frequencies. It is known that electromagnetic wave is usually attenuated by three mechanisms: reflection, absorption and multiple reflections[17-18]. Electromagnetic interference (EMI) is becoming an alarming issue which disturbs the usual performance of electronic appliances and may even adversely affect the human health[19-22]. If an electromagnetic wave gets into an organism, it vibrates molecules to give out heat. In the same way, when an electromagnetic wave enters the human body, it will obstruct a cell's regeneration of DNA and RNA. Furthermore, it brings on abnormal chemical activities to produce cancer cells, and increases the possibility of leukemia and other cancers. Electromagnetic interference and potentially destructive effects can corrupt data in large-scale computer systems, cause inaccurate readings and output in aircraft guidance systems, and interrupt the functioning of medical devices, such as pacemakers.

1.1.3. Contamination

Cleanroom contaminants are generated by people, process, facilities and equipment. Contamination can lead to expensive downtime and increase production costs. McFadden R. (Coastwide Laboratories) and Ramstorp M. have notified that contaminants can produce a "killer defect' in a miniature circuit mainly at microelectronic industry, semiconductor manufacture, industries (sensitive micromechanical work), optical industries, etc[23].

1.2 Solution of IDP - Development of high functional textile fabrics

In principle, electrical conduction is the most important requirement for safe and rapid dissipation of static charges and for efficient EMI shielding action[24-25]. With incorporation of conductive material, textile fabrics have possibility to give effective solution for electronic industry and more specific to cleanrooms[26]. Numbers of research works are made for conductive textiles but they have certain limitations for cleanroom applications. These limitations are highlighted in the research gap.

1.2.1 Research gap

Limitations of previous research work:

- Specific to any one or two problems (electrostatic discharge, radiation or contamination)
- Use of limited variety of conductive materials
- Not fit to cleanroom requirements

Hence, significant efforts are desirable for cleanroom to develop high functional textile fabrics that can provide effective solution for electrostatic discharge, electromagnetic field and contamination control. They must fulfil following requirements for cleanroom:

- prevent the generation of Static
- dissipate electrostatic charges
- provide shielding from electromagnetic fields
- attract, generate or transfer less particulate contamination.

Producing these types of functional conductive fabrics for cleanroom is one major aspect for researchers and manufacturers.

1.2.2 Objectives

The main objective of present study is to develop different variety of heterogeneous high functional textile fabrics with primary aim of electrostatic discharge control & secondary aim of electromagnetic field & contamination control for cleanroom environment.

To put an attempt to explore the development of high functional protective fabrics that can handle parallel situations of electrostatic discharge, electromagnetic field and contamination simultaneously in optimized manner.

Secondary objectives of study are as under:

- To develop special, low cost field (signal) strength measurement test set up.
- To develop fabric particle density transfer rate (F-PDTR) tester for textile materials with minimum particle detection capacity of 0.8 microns.
- To conduct different tests like surface resistivity, field strength, air permeability and fabric particle density transfer rate etc.
- To study effect of material, EPI/PPI, fineness, weft space, water repellent treatment, conductive pattern on test results.
- To carry out analysis with use of statistical methods.
- To recommend optimise solutions for cleanrooms.

1.2.3 Work plan

In this work, efforts are put up to develop high functional conductive textile fabrics from woven process to avoid hazardous malfunctions in working area. Conductive fabrics are made where a grids or stripes of conductive yarns are present inside a matrix of cotton or polyester yarns. Particular attention is paid, in the selection, design and preparation of these conductive fabrics to ensure that they can provide an optimal service.

Surface resistivity, field strength, air permeability and fabric particle density transfer rate tests are carried out for these fabrics. For test results, effect of material, EPI/PPI, yarn fineness, water repellent treatment and conductive pattern are studied to judge and to optimize electrostatic discharge properties of fabrics with balance of radiation and contamination control. With fabric analysis, optimize solutions are also recommended for ISO 3 & ISO 4 cleanroom applications.