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Study of Conductive Textile Laminates by direct examination SEM method

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Abstract – *A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that can be detected and that contain information about the sample's surface topography and composition. The electron beam is generally scanned in a raster scan pattern, and the beam's position is combined with the detected signal to produce an image. SEM can achieve resolution better than 1 nanometer. Specimens can be observed in high vacuum, in low vacuum, in wet conditions (in environmental SEM), and at a wide range of cryogenic or elevated temperatures. The most common SEM mode is detection of secondary electrons emitted by atoms excited by the electron beam. In present study, direct examination of conductive textile yarn and laminates through SEM is carried out to justify arrangement of basic materials in final Laminates.*

Key words *– SEM, Conductive textile, Yarn, Fabric, Laminates*

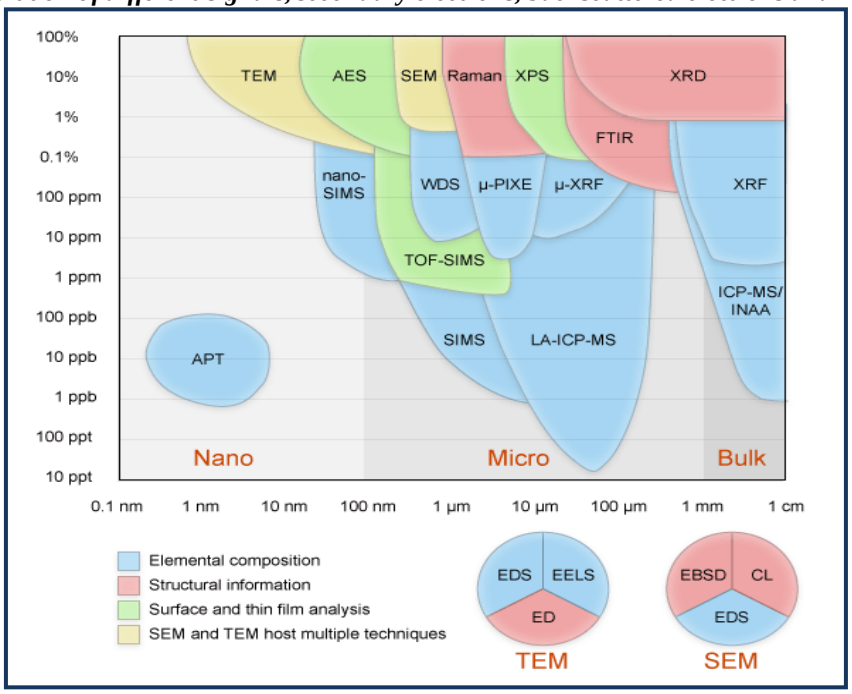
I. INTRODUCTION

The interest in conductive textiles was renewed when the concept smart textiles emerged some fifteen years ago [1]. In the electronic industry, today ESD control/protective products need to meet various requirements [2]. Electronic components that are electrostatic discharge/Electromagnetic radiation sensitive (ESDS) must be protected throughout the entire manufacturing cycle [3]. For this, side by side, well arranged, homogeneous mixture of conductive strand within composites/laminates is of prime requirement in today's era. Hence, SEM is very common to study distribution pattern and to understand position of material either in core or in sheath.

1.1 Basics of SEM :

A different approach to the direct examination of surfaces is provided by the Scanning Electron Microscope in textiles [4]. The schematic diagram of mostly used micro analytical techniques and Scanning Electron Microscope with spatial resolution is shown in Figure 1.

"Figure 1 – A) Most commonly used microanalytical techniques B) The Scanning Electron Microscope [5] C) The typical spatial resolution of different signals, secondary electrons, backscattered electrons and X-rays in SEM[6]"



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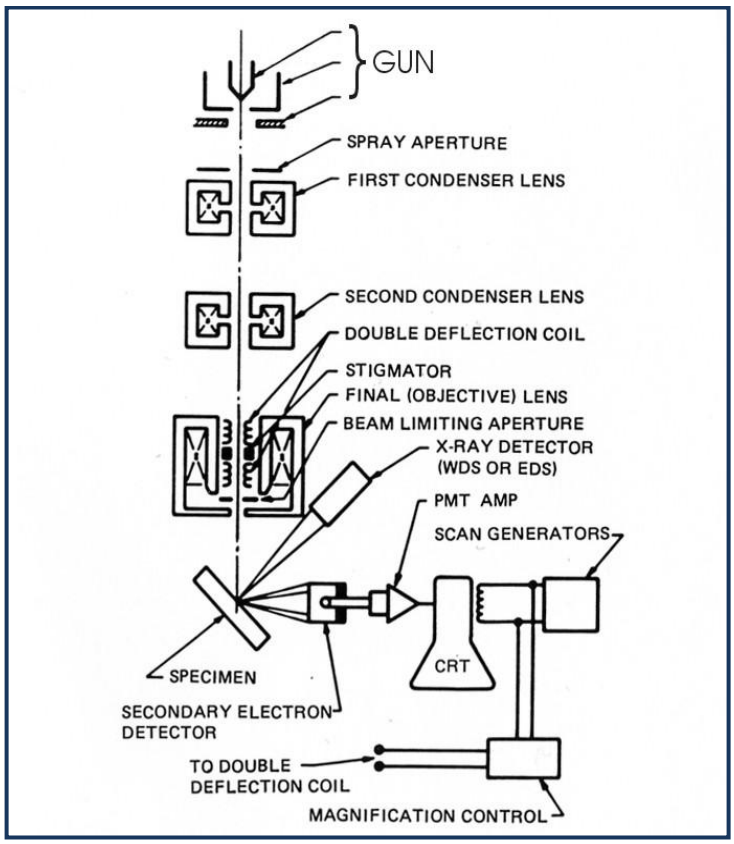

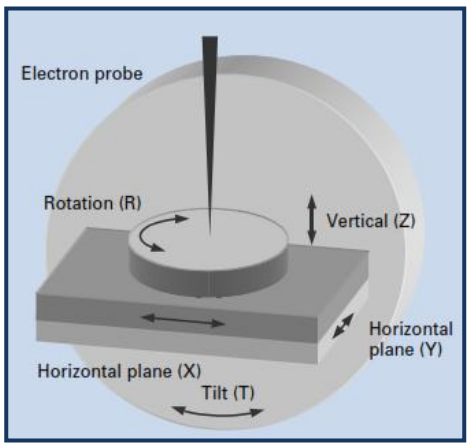

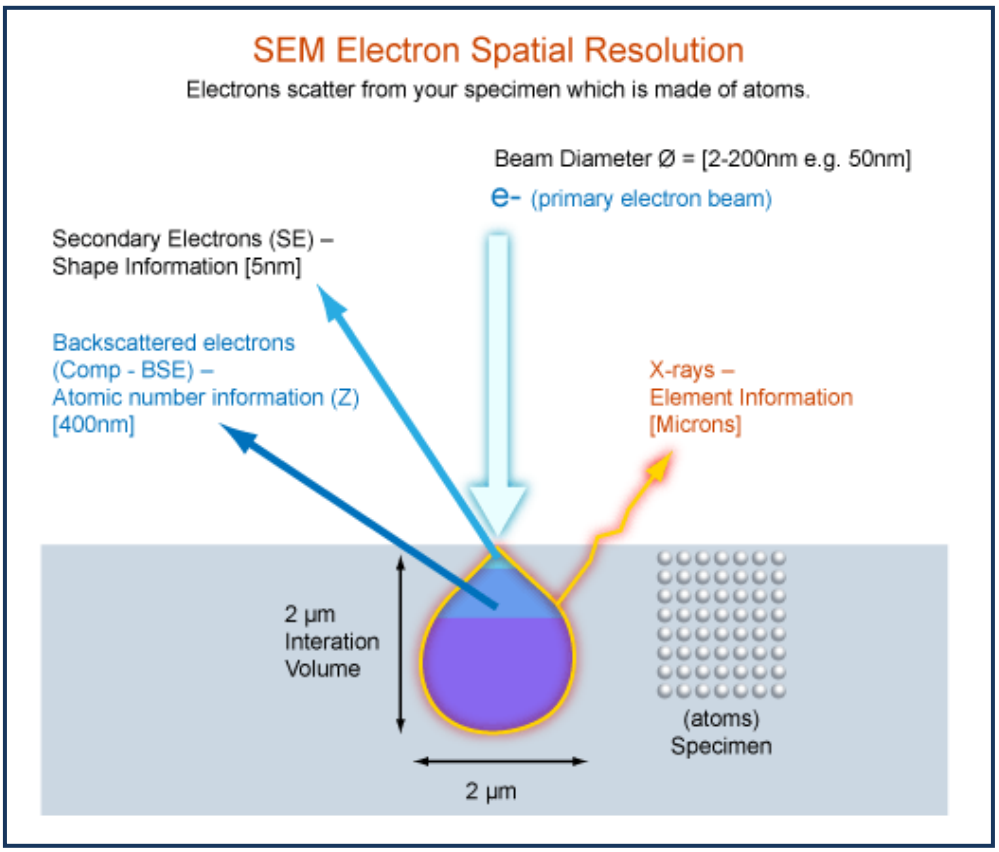

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1.2 SEM Application :

(A) Fractography

Fractography has been extensively used for study of failure mechanisms such as :

- ❖ Initiation of crack/cracks
- ❖ Cleavage steps in brittle fracture
- ❖ Dimples in ductile mode
- ❖ Striations in fatigue
- ❖ Mode of crack propagation during fatigue, SCC or HIC
- ❖ Hydrogen embrittlement in steels

(B) Metallography

- ❖ Single or multi layered plating for evaluation of plating composition, continuity and dimensions.
- ❖ SEM imaging of extremely fine – grained microstructures, which are too small, to be resolved by the light microscope e.g. very fine ferrites and pearlite in high strength low alloy steels.
- ❖ Elemental identification of the base matrix, segregated phases and inclusion in metal and ceramics.

(C) Powder Metallurgy

SEM observation of metal power has been found to be more effective. One can study :

- ❖ Size, shape and distribution of metal power in a confined areas.
- ❖ During sintering change in grain size and porosity at various stages

(D) Corrosion

SEM can study surface damage to various types of corrosion :

- ❖ Pitting corrosion
- ❖ Corrosion by cooling water
- ❖ SCC and HIC or hydrogen embrittlement
- ❖ Damage by erosion corrosion
- ❖ Identification of corrosion products in the corroded samples
- ❖ Damage due to carburisation in ASS

(E) Applications in other areas

1) Geological Study

In geology the applications are very wide. These includes :

- ❖ Identification of minerals and its surface characteristics
- ❖ Study of morphology of minerals
- ❖ Study of clay fabric and texture to know the origin and type of a clay

2) Fibers & Fabric studies

Detail information can be obtained with the help of SEM about :

- ❖ The nature of fiber fracture
- ❖ Fabric wear
- ❖ Chemical degradation
- ❖ Abrasion and fatigue

This can help to improve fiber and fabric life.

Fabric examination under SEM can be useful for :

- ❖ Different type of wear
- ❖ Chemical check
- ❖ Defect in processing
- ❖ Results of washing, dying and chemical finishing etc.

3) SEM studies are also used in Biological applications and in Papermaking.

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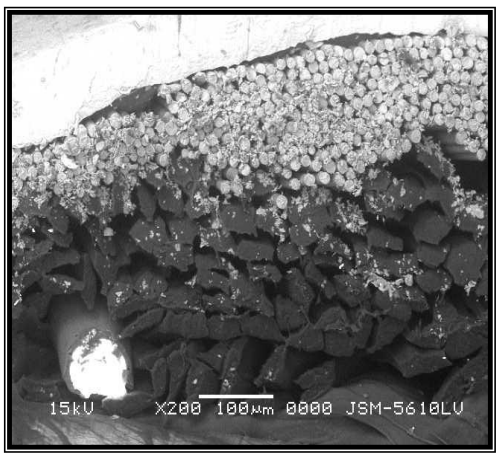
II. TESTING

Machine : Scanning Electron Microscope model JSM – 5610LV with energy dispersive analytical X – ray (EDAX).
Range of magnification is X18 to X3,00,000.
Image resolution up to 3.0nm in high vacuum and 4.5nm in low vacuum.
Suitable for micro - structural examination, failure analysis, quantitative and qualitative elemental analysis.

III ANALYSIS

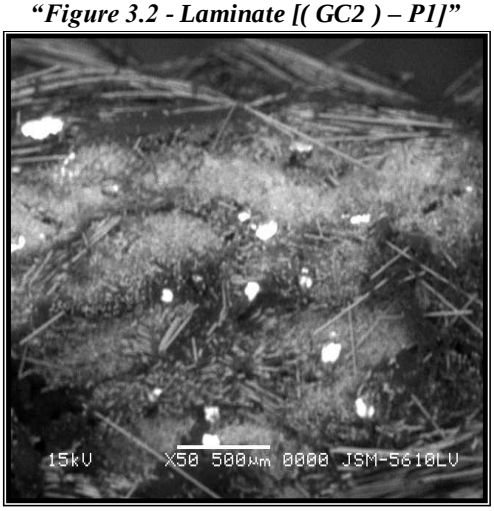
The Scanning Electron Microscope analysis of the yarn (developed on Hollow spindle m/c) cross section and laminates in the X and Y - direction are shown in the figures below [7][8] :

"Figure 3.1 - Composite yarn [(GC2P2) – P1]"



In yarn, cross section at 200x shows the perfect distinguished parent yarns. The glass is of cylindrical shape, polypropylene is of nearly oval shape and copper is in the shiny circular shape. Due to the method of mounting the yarn on a flat plate and fixing it by a alluminium foil and subsequent cutting of the yarn, the cross section becomes flat. However, the side-by-side arrangement of the glass and polypropylene yarns and the copper wire clearly seen.

"Figure 3.2 - Laminate [(GC2) – P1]"



In laminate (GC2) - P1, X - direction at 50x shows the even distribution of copper wire inside the body of laminate.

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"Figure 3.3 - Laminate [(GC2P2) – P1]"

In laminate (GC2P2) – P1, Y – direction at 200x shows the homogeneous mixture of polypropylene matrix and glass filaments, with copper wire has embedded.

IV. CONCLUSION

Scanning Electron Microscopy of conductive yarns shows side by side arranged position of components and the same is distributed evenly at Laminate state with homogeneous mixture of material contributes significantly in ESD/Radiation protection applications.

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