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# Giant Leap of Textiles in "The Science of Small"

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## ABSTRACT

**Background:** All fields of textile are constantly varying. Variations occur as life styles change or at times these are caused by ever evolving processing mannerism or as government standards for safety, environmental protection, and quality and energy conservation change. The turn of century has witnessed the stern focus of textile industry on scientific and technological advancement, initially this industry was not recognized and it survived as art and craft in early centuries until eighteenth and nineteenth centuries when world was witnessing industrial revolution it had focus upon mechanization and mass production. All over the world the products of textile industry are massively utilized.

**Aim of the Study:** There is a pressing need for an initiative to improve, to facilitate and to accelerate the development and adaptation of the textiles and clothing industries. For the satisfaction of various new customer demands this industry is struggling to employ technology for the enhancement of textiles to fulfill, adapt and adjust to the cravings of change. "The science of small" has emerged as an interdisciplinary science; here knowledge is shared for the extension of nano scale limits by many electronic and material mechanical engineers, physicist, scientist, chemists and biologists.

**Methodology:** This review article attempts to descriptively connect the various potentials of the nano scale in the textile sector especially with a textile designer perspective. This is an effort to compose a meta review to understand the new dimensions of textile sector that highlights the activities and contributions in this emerging new domain of nano scale.

**Findings & Conclusion:** Today by the term nanotechnology a vast arena of knowledge is meant that encompass exploration of technologies for miniaturized processes and structures. Research in this area is not only focused on cost efficiency in use of chemicals but focus is also towards reformulation of some new technology and ultimately developing a work rout that saves manufacture resources like human resource, time and water. All this has resulted in the development of nano fibers, nano compositions, nano polymers and nano finishes in field of textiles. This paper intends to summarize the current expansion of nanotechnology for production of textile products.

**Keywords:** Textiles, Nanomaterials, Miniaturization, Characterization.

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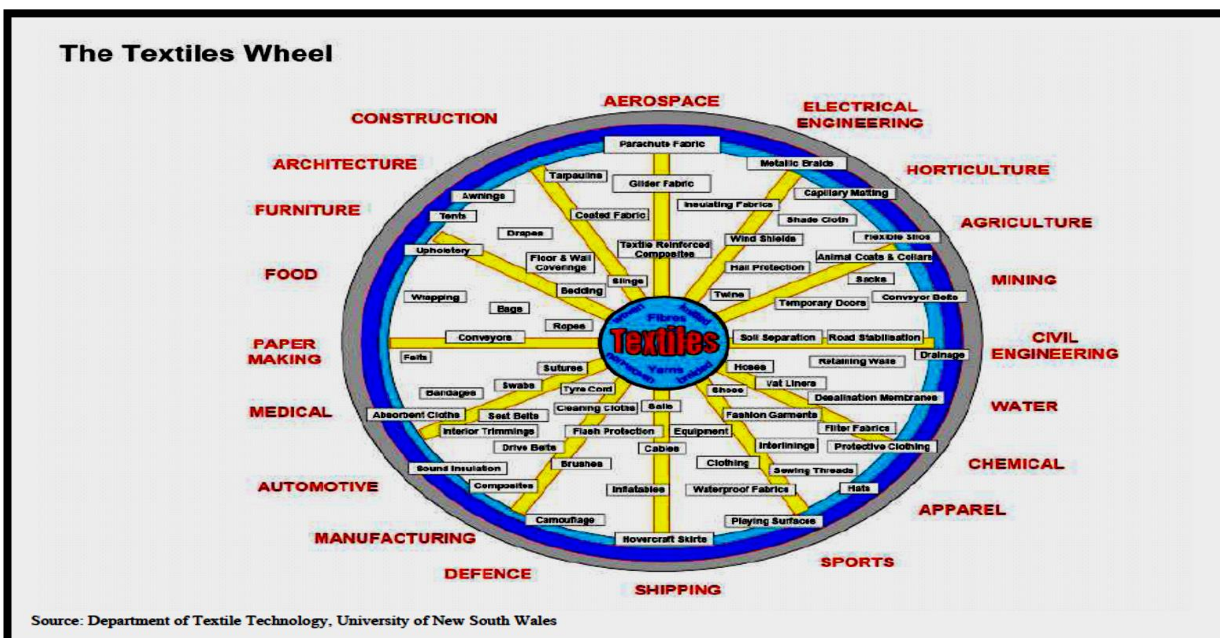
## An Introduction to Contemporary Textiles and Clothing

The contemporary Textiles and Clothing concerns have emerged as an initiative to improve, to facilitate and to accelerate the development and adaptation of this sector to the major changes and challenges arising from the rapidly changing technologies, to the new forms of organizations, as well as to increasing global competition (Horne, 2012). Textile industry is a wonderful complex, including all segments of manufacturing starting right from natural as well as man-made fiber producers moving on to yarn stage including all spinners incorporating fabric construction by weavers or knitters, converters, nonwoven manufacturers as well as finishers, the machinery makers, and all the allied fields. This ever growing and demanding sector is focused to make textile products that will fit the wide and unique range of services expected from these to meet global requirements in timely manner which is also cost efficient. Research is being done to achieve cost efficiency by reformulation of production processes and technology; such shift will ultimately lead to the saving of all type of resources such as manpower, water and time (David, 1995).

With the traditional aura of textiles in mind, it is very less possible for one to think of space travel or racing cars. But all this is now a part of ever enlarging boundary of technical textiles as textile components are integral part of such ventures. Traditional practice focusing jus}t mass production is no longer the objective of industry. In recent years industry has moved into a technologically advanced, state of the art scientific market place. textile components for aircraft wings can now be easily prepared by traditional weavers. All such high performing textiles are major challenges to be met by experts (Charlotte, 2002). The turn of century has witnessed the stern focus of textile industry on scientific and technological advancement, initially this industry was not recognized and it survived as art and craft in early centuries until eighteenth and nineteenth centuries when world was witnessing industrial revolution it had focus upon mechanization and mass production. Textile companies are accelerating their innovation curve, the R&D process and commercialization. Today is a rich environment for collaboration between industry and academia. The new focus is on utilization of technology for the enhancement of textiles by giving textile products all those properties which follow the required transformation proving helpful to adapt or to adjust a variety of new demands in our society. Today textile science carries a fortune full of success for those who possess keen interest. (Charles & Owens, 2003).

Figure 1. *The Textiles Wheel (source: department of textile technology, university of new south wales)*



This changing proportion of consumer textiles demand might propose some risks but is deemed to bestow more opportunities. A significant expansion of global textile market is foreseen in near future. Two factors to be kept in mind for sustaining in theses scenarios are Skills & Competences and Key Trends (Academy, 2003).

**Skills & Competence**. Future will bring dominance of certain abilities resulting in a talent concentrated market. Better organizational practices and the competence to synchronize the detached supply chains is in demand through concentrated brainpower, better perception and excellence of expertise. In this part innovation will be the key word. Innovation curve is needed to be enhanced of novel products, of innovative systems, and of latest applications. Such focused innovation will bring about value addition of current products enabling these to be customized by "fast" varying needs of contemporary fashion and textiles (David, 1995).

**Key Trends**. Season's specific textile and apparels will decrease. Multi seasonal apparels will gain prominence. Future textile production must take into account the ever growing threat of global warming as well as threat of environmental pollution. Textile companies are accelerating their innovation curve, the R&D process and commercialization. Today is a rich environment for collaboration between industry and academia (Charles & Owens, 2003).

## Methodology

An attempt is made to combine the existing knowledge regarding the emerging nano scale aspect of the contemporary textiles. This review article attempts to descriptively connect the various potentials of the nano scale in the textile sector especially with a textile designer perspective. This is an effort to compose a meta review to understand the new dimensions of textile sector that highlights the activities and contributions in this emerging new domain of nano scale.

## Analysis and Findings

A pool of knowledge has to be developed in which original ideas are cultivated, these ideas should be reflected as innovation in its true sense right from core of individual practices and such endeavors must be able to confront current limitations of textile design. Self-motivated designers are the real breath of air for the world of textiles. All contributing designers must be visionary enough to incorporate excellent leadership state of the art strategic approach with responsible inclusion of innovation and higher levels of realization of true purposes behind activity of design.

### *Textiles for the Future*

Textiles of tomorrow need to redefine and reshape the living manner of people, contemporary trends badly need to support textile designers to alter stereotype design margins. A new textile revolution will be marked by the twenty first century, this new wave of trends has to be poetic, ethical, sustainable, and invisible and smart (Horne, 2012).

**Poetic:** Current fast and high tech consumer culture still values the emotional and aesthetic aspect of fashion and clothing design. Study of real human needs is still an inspiring platform and a required motivating force behind current creativity (Horne, 2012).

**Ethical:** New trends of this era include massive globalization, a new division of demographics and novel consumption patterns**.** All of these greatly impact our design practice and must be guarded by ethics. (Horne, 2012).

**Sustainable:** A new responsible trend of textile designing has emerged that caters the increased needs of sustainability. Stereotype design processes and outputs must be revisited in light of new manners of waste management, production cycles and consumption patterns (Horne, 2012).

**Invisible:** Activity of textile design has successfully imparted new builtin functionality in new fibers and current improved textile finishes. All this incorporation is strictly invisible so consumers can enjoy antistress fiber or vitamin-enhanced fabrics or , solar-reactive yarns without any change in mechanical performance and appearance of textile product (Horne, 2012).

**Smart:** A greater collaboration between design and science emerged which greatly aided to transform the processing of textile production. All this resulted in appearance of smart technologies including wonders of nanotechnology, conductive textiles, amazing biomaterials, innovative sensory fabrics and astonishing wearable computing (Horne, 2012).

## “The Science of Small” - Nanotechnology

"The science of small" is beyond doubt an avenue that explores interdisciplinary branches of diverse sciences, which may involve experts of systems engineering, think tanks of bioengineering, masters of electrical engineering, innovators of molecular chemistry, and brains of computer science and genius of physics. Personnel belonging to height of each segment of knowledge pool their knowledge to expand the existing nano-scale expertise; the nano scale refers to one billionth quantity of a meter which might be stated as 80,000 times lesser than a individual hair. Technology of only those objects and instruments can belong to nano scale in which at least one dimension of the parts is smaller than 100 nm. Nano zone is a unique segment of dimensions where classical laws of core sciences fade and quantum theories and mechanical laws. This all signifies that nanotechnology is evolutionary product of machining accuracy, thus this has no marked differences in laws from classical fields of science or engineering. The only important variation is the size (Uldrich, 2002).

To denote 109th part of a quantity or to indicate billionth part of any whole the prefix 'nano' is used. Molecular manufacturing is also given the name of Nanotechnology, this discipline of engineering deals with the miniaturization involving planning and production of tremendously minute, manipulated at molecular level of matter to form electronic circuits as well as tiny mechanical devices. This novel dimension is an inspiration from nature. The study of nano structures found in nature led to the formulation of this amazing level of miniaturized accuracy of manufacturing. Gaining a precise control over matter at its atomic and molecular level became possible for the scientists with this new avenue of discoveries. (Charlotte, 2002).

### *Fields of Nanotechnology*

In today’s world nano science has its application in almost all fields of life. To bring out the best of every field this sphere of technology hybridizes all fields of science. The scope of applications of nano technology are ever increasing and widening in all aspects of life. Nanotechnology has been successfully applied in different segments as in aerospace (launch vehicles, nano tubes), computers (nano chips), biotechnology, colorants and in a variety of additional fields. Nanotechnology is the only promising technology of the future, like all fields it is equally inspiring in the field of textiles too (Charles & Owens, 2003). Till to date there are four major fields of application of nanotechnology:

**Nano textiles-** All efforts are directed towards development of miniaturized nano structures to impart excellent functionality.

**Nano biology-** Explorations are being made for fighting against life threatening Cancer drugs or diagnosis and treatment of many other unknown aspects like aging.

.**Nano material-** Research in this field has resulted in formulation of UV absorbing nano-particles, nanostructure ceramics and scratch resistant nano-coatings.

**Nano electronics-** Emergence of equipment like giant magneto-resistance, new semi-conductor laser and evolution of new computer hard disk drives is made possible only by nano scale innovations.

### Nano-Tex - Giant leap of Textiles in the Science of Small

Textile technology is increasingly influenced by the concepts of nanotechnology like all the other technologies. New innovative curve in the field of textiles comprises of formulation of nano finishes, nano fibers, nano polymers nano composites, ets. This all is result of successful application of nanotechnology in the textile sector. Most recent development of quantum dot dye molecules that are able to cloud fibers are nano sized semiconductor crystals is an example of break through innovative part played by nano technology. In such nano crystals, the variation in color is possible with shift in particle size. This exploration made it possible to get varied color effect by covering the surface with particles of same material which differ in size. Application of this technology makes it possible for ordinary materials to exhibit extraordinary advantageous properties such as super hydrophobicity, bacterial resistance, odor and moisture elimination or enhanced elasticity and strength. This all is made possible with engineering manipulation at nano scale. Scope of application ranges from development of nano scale fibers or application of nano finishes to regular surfaces for enhanced effects. Textile sector will soon revolutionize if manufacturing is devotedly directed towards this small scale advancement. This will also help to devise new drug delivery systems and life saving tissue engineering ventures. Conclusively it can be predicted that nanotechnology has the potential to bring billion dollar business to this sector in next wave of development (Uldrich, 2002).

We are always surrounded by textiles and fiber is the elementary entity of every textile. Nanotechnology is an emerging textile technology and an innovation. This dimension is reshaping existing fiber, yarn or fabric into smart textiles. This new emerging level of science and technologies is responsible for driving new revolution in fibers which are central to all textiles. The ultimate end use and consumer selection of fabrics will be affected by endless innovations in advanced fibers and fabric with application of nanotechnology. Although this small scale technology is still in its emergence phase in scientific world but its impact will be soon witnessed in marketplaces. Molecular scale engineering of fabrics creates wonders in field of textiles. Manipulation at deep microscopic levels in existing unmodified and original materials has brought excellent levels of desirable properties. Production of textile materials that are smart and intelligent is only possible with increased application of nano scale technology on textile and apparel (Charlotte, 2002). Nano finishes has recently surfaced the textile sector as another example of successful introduction of nanotechnology. Using nanotechnology, the textile dreams may come true, it has been made possible to evolve such ‘next-generation’ fabrics which harmonize the required advantages of cotton and man-made fibers. Such accomplishment is possible either by blending at nano fiber level or by the application of novel nano finishes to unmodified material at yarn or fabric level. The ability of dirt-repellency in textile materials is possible with nanotechnology Surface coating on the textile fibers of very tiny particles specially engineered to measure less than 100 nano meters produces a self-cleaning effect. Such nano coatings are currently very expensive so are feasible to be applied just on engineering textiles, but it is estimated that such application will become cost effective for materials used for work clothing and home textiles in near future. Other possibilities include treatment of polyester at nano scale to make it highly water absorbing and evolution of such material at low cost will be ideal for use in the production of undergarments (David, 1995).

### *Nano Fibers*

To classify fibers as nano fibers these should have diameter less than one nano meter. Production of different polymer fibers with diameter small enough to categories these as nano fibers is not possible with the conventional fiber spinning. For manufacture of such nano scale fibers process of electro spinning is evolved, it involves use of electrostatic forces for extraction of very fine filament yarn from polymer solution. A list of some nano fibers is as follows.

- Carbon nano fiber
- Luminescent polyester fiber
- Polyester nano fiber.
- Nylon nano fiber.

There are diverse specialized applications for these nano fibers other than conventional uses, a few of these are listed here.

- Bio nano sensors.
- Netting to absorb fertilizers, pesticides, and other materials
- Biodegradable nano composites.
- Agricultural nanotechnology.
- Protective clothing.
- Air filtration (Uldrich, 2002).

## Characterization and Properties of Nanomaterials

Contemporary researchers face the problem of characterization and defining properties of highly developed available nanomaterials. Atomic level resolution of highly evolved extremely sensitive and accurate equipment is needed for true characterization of individual nanostructures. Current era is witnessing massive advancement in the field of new apparatuses and original novel instruments in the field of nanotechnology. These nanomaterials need to be evaluated for their different dimensions of properties including magnetic properties, mechanical properties, electrical properties, optical properties and thermal properties.

### *Structural Characterization*

Conventional characterization methods and surface analysis techniques applicable for bulk materials became the basic methods for study of nanomaterials. The extremely small size of semiconductor quantum dots is determined by the use of optical Spectroscopy. On the other hand for the determination of lattice constants of nano wires and nano particles as well as measurement of crystallinity of crystal structures X-Ray diffraction has been widely used. For further characterization of nano particles the commonly used methods are electron diffraction, SEM and TEM. In this array of determining methods SPM is a relatively new characterization technique. Atomic force microscopy (AFM) and scanning tunneling microscopy (STM) are recognized as two chief members of SPM family. Both AFM and STM are most accurate techniques for surface imaging. Both of these have the ability to produce true topographic descriptions of any kind of nano surface being studied with atomic resolution in all three dimensions, A deeper study involves combining appropriately designed attachments with these apparatuses for enhanced imagery. Most recently the AFM and STM are also known for a larger and broadened range of many diverse applications. Now it has become possible to accurately view patterned self-assembly, nanolithography and nano indentation by engaging high modification of these methods. (Guozhong, 2004).

### *X-ray diffraction (XRD)*

When it comes to all kinds of issues of addressing crystal structures of solids involving studying any of crystal structure of solids involving preferred orientation of poly crystals, defects, stresses, identification of unknown materials, lattice constants, orientation of single crystals or lattice geometry etc.; the most important experimental technique known is X-ray diffraction. For the surface study of sample a collimated track of X-rays falls on the surface of the sample and the parallelism of the beam is significantly diffracted by the presence of crystalline phases in the sample under study. The pattern produced by such diffraction of X-ray beam is used for the identification of the nature of sample's crystalline phases, this diffraction pattern is also utilized to produce accurate measurements of the structural properties of sample being studied. In the field of material characterization X-ray diffraction method is very widely used. One of the reasons of its popularity is its nondestructive nature; additionally sample for the study does not need any complicated preparation. This method is only workable where the size of particles is very small so it becomes most appropriate for the nano scale characterization of materials. The study of either the film thickness of epitaxial or the study of any highly textured thin films can also be conducted with X-ray diffraction. On comparing electron diffraction methodology and X-ray diffraction methodology the only disadvantage of latter is its low intensity of diffracted X-rays.(Guozhong, 2004).

### *Small angle X-ray scattering (SAXS)*

For the characterization of nano materials one of the dominant tools is SAXS. If ordered arrays of molecules or atoms are found in sample under study the incidence of beam of X- ray causes strong diffraction peaks resulting from practical obstruction of X-rays. The variations found in the resulting diffraction peaks are due to differences in either the density or either due to the differences in composition or these variations might be the outcome of both (Guozhong, 2004).

### *Scanning Electron Microscopy (SEM)*

For characterization of nano materials and nanostructures SEM is one of the mainly used techniques. With SEM an accuracy of the resolution of a few nano meters is possible. Current SEM instruments are able to function at adjustable magnifications that may range from - 10 to over 300,000. The SEM is widely used to obtain very clear topographical information of the sample that helps in the characterization of nano structure being studied. SEM is also admired as it can also provide the true information of chemical composition of sample under study near the surface. For a basic SEM test a massive supply of electrons is focused into a beam which is characterized with an extremely fine spot size, ranging to -5 nm. This incident electron beam has high energy ranging from a few hundred eV to 50KeV, and it falls over the surface of the sample by which is studied by the resulting deflection coils. Results of SEM as images are gathered by collection of emitted electrons on a cathode ray tube. The emission of electrons and photons from surface of sample occur as result of the electrons striking and penetrating as a beam. The extended scope of SEM includes provision of information in minute details about ionic distribution and chemical composition. On the other hand the imagery of the morphology of microstructures is also possible both for the bulk materials or their nano structured derivatives and devices. SEM is capable of generating three basic types of images, these three comprise of elemental X-ray maps, secondary electron images and finally the backscattered electron images.

Tunneling electron microscopy (TEM) on the other hand is characterized by high magnification and its unique ability to provide simultaneous results of accurate and clear information about diffraction from the same sample. For characterization by this method a high speed acceleration of electrons is a priori before the beam is actually projected on the sample layer with the help of condenser lens system. The commencement require specimen to be in very thin layers. As a result theses highly accelerated electrons penetrate the surface of the sample thickness and go on either on a deflected path or an un deflected path. The nature of resulting information is based on the process of scattering as experienced by electrons on their way into the specimen. Diffraction patterns evolve if the scattering is elastic involving zero loss of energy. But on the other hand transmitted electrons experience an intense spatial variation as a result of inelastic interactions occurring among the component sample electrons and participating primary electrons. This pattern is prominently visible in such samples which are heterogeneous in some respect. This heterogeneity might stem from density variation, difference in grain boundaries, presence of some defects, existence of some second phase particles or some kind of internal dislocations. Whichever the reason might be , this phenomenon causes very complex scattering and absorption effects in the execution of this test for determination of characterization. The dual aspects of results can be obtained by bringing variation in the intermediate lens with respect to its strength. In this manner the view can be switched between either the observation of diffraction pattern or the nature of imaging of sample.

For the determination of the unique crystal construction of nano materials of different kinds like nano rods or nano crystals or for same determination of any other crystalline part of the sample selected-area diffraction (SAD) is employed for its exceptional capabilities. For the production of parallel illumination method adopted is the defocusing of condenser lens at the sample. This is made possible with employment of a selected-area aperture to limit the diffracting volume (Guozhong, 2004).

### *Scanning Probe Microscopy (SPM)*

Real-space, three-dimensional images are obtained by the scanning probe microscopy (SPM). It can achieve subatomic spatial resolution if optimum conditions are provided. SPM is an umbrella term consisting of a number of microscopic scanning possibilities which differ from each other on probing force used. Atomic Force Microscopy and Scanning Tunneling Microscopy are two very major members of this family. This array of microscopy allows most accurate study of properties and structures of the sample with respect to correctness of spatially localized respective measurements. Conductive sample surfaces are most accurately characterized by use of atomic force microscopy AFM. On the other hand the only limitation associated with scanning tunneling microscopy STM is the restriction of its appropriateness with only electrically conductive sample surface.

Visualization of the differences in local distribution of the electric charges on the surface of sample is made possible by mapping electrostatic forces between sample surface and tip. Thus the investigation of electrostatic force microscopy is rooted in study of differences of local charges on the tip or surface (Guozhong, 2004).

Another member of SPM worth considering is called Near-Field Scanning Optical Microscopy (NSOM). The results are based upon the study of results due to difference in the resolution of a NSOM. The results are dependent on variation of probe size and the level of separation between sample and probe. NSOM experimentation is greatly lesser than the optical wavelength resulting in the accurate resolution of both dimensions (Guozhong, 2004).

### *Gas Adsorption*

Another powerful technique in determination of characteristic sizes and surface area of porous structures and particles is known as the chemical and physical adsorption isotherm also called as gas adsorption. The uniqueness of this characterization manner also lies in the fact that results are accurate regardless of crystal structures and chemical composition of the samples. The procedure involves reduction in surface energy. This all commences under suitable conditions of pressure and temperature. , for the reduction of attractive imbalance surface atomic forces a gas is brought in close contact with a solid surface. The gas adsorption may either occur at chemical level or physical level. The only difference in the nature of physical and chemical adsorption is the manner in which gas can be removed. Physically adsorbed gases are easily removed from solid surfaces as the partial pressure is reduced. On the other hand chemically adsorbed gases require some difficult levels of manipulation for their removal. Chemically adsorbed gases might involve heating to very high temperatures for reversing the change occurred on the surface of solid being studied for its characterization (Guozhong, 2004).

## Chemical Characterization

By the term chemical characterization is meant the determination of spatial distributions as well as their surface composition of atoms and compounds or their counter parts as interior atoms and compounds. With the passage of time there are number of techniques which proved them to be very appropriate for determination of chemical analysis of surface analysis which are equally suitable for thin films. All of these approved methods are equally applicable to chemical characterization and analysis of nano materials as well as nanostructures (Guozhong, 2004).

**Optical Spectroscopy** For the chemical characterization of nano materials optical spectroscopy is most extensively used. All types of optical spectroscopy methods can be classified into two general groups: vibrational spectroscopy and absorption and emission spectroscopy.

**Vibrational Spectroscopy** The vibrational methods of spectroscopy involve exchange of photons with specific particles in the sample resulting in the transfer of energy either from the sample or towards the sample because of vibrational de-excitation or because of vibrational excitation. Information about the presence of chemical bonds in the sample under study is obtained by these frequencies generated by vibrations.

**Emission and Absorption Spectroscopy** On the other hand information about the electronic structure of crystals, atoms, molecules or ions is gathered through the excitement of electrons of the sample under study from the ground to excited states known as absorption or it can be executed vice versa consisting of excitement of electrons of the sample under study from the relaxation of excited particles to the ground states known as emission.(Guozhong, 2004).

**Photoluminescence (PL)** The term luminescence is normally referred to as the phenomenon of the emission of some amount of light from some kind of material being studied, this emission occurs through some external process which is exclusively different from blackbody radiation. Different types of stimulations can cause emission of light from the surface of any material which can be used to accurately assess its chemical characterization. If such emission of light results as a result of stimulation induced by electronic manner, it is called Cathode luminescence (CL).

For Photoluminescence study of chemical and physical characterization of some materials excitement of electronic state of system of material under study is generated the photons. The resulting optical emission is analyzed until the state of material system comes back from excitement. Packets of high energy light are induced on the surface of the sampler to bring it in state of excitation simultaneously luminescence which is emitted as a result of it is gathered with the help of a lens. The collected luminescence is further passed from an optical spectrometer that leads it to the photon detector. The probability of electronic transition from the sample becomes the basis for quantitative as well as qualitative evaluation about sample regarding its energy transfer, chemical composition, kinetic process, structure, Optical absorption and impurities. time dependence of the emission and nature of spectral distribution are related to development of photoluminescence spectra. This technique is usually used for miniaturized nano crystals of semiconductor for the purpose of characterization

**Infrared Spectroscopy.** Atoms or ions connect together by chemical bonds to form crystals and molecules. Such systems emerging out of chemical bonding can be brought to vibration, the extent of unique vibrational frequencies of various chemicals can easily determined by the bond strengths and atomic weight of its components. Certain vibrational frequencies are induced by some oscillations under the experiment, all this causes the matter to be agitated and thus it becomes possible for it to couple with incident beam that is of infrared electromagnetic radiation. As the frequencies come in resonance exchange of energy takes place. The exact extent of excitations of vibrations occurring in the chemical bonds being studied can be found by all of the absorption frequencies (Guozhong, 2004).

**Raman spectroscopy** Coupling of visible light as source of high-frequency radiation with the natural vibrations within the chemical bonds of materials under study is another type of vibrational technique which is most commonly used for chemical characterization. For the correct study of arrangements of chemical bonds, strength and bond lengths of a material Raman spectrum is known for high sensitivity for correctness of result. ON the contrary it is less sensitive when intentions of investigation are only focused to the study of chemical composition. (Guozhong, 2004).

### *Electron Spectroscopy*

Electron spectroscopy is learning composite that integrates underlying principals, methodologies and basics of X-ray Photoelectron Spectroscopy (XPS), Energy Dispersive X-ray Spectroscopy (EDS) as well as the fundamentals of Auger Electron Spectroscopy (AES). The unique energy levels of the material are studied which are caused by the emission of electrons or photons (X-ray), the result of electron spectroscopy relies heavily on measurement of this ejected band from the atoms being studied. Each element has its characteristic and unique formation of X-ray and Auger spectral lines. Thus by applying this methodology an accurate estimation of a material’s chemical compositions is possible and results depend on correct measurement of the energies of the X-rays and Auger electrons which emit as a result of it. (Guozhong, 2004).

### *Ionic Spectrometry*

Dependable chemical characterization in case of very low concentrations is possible with the engagement of any kind of ionic spectrometry. Out of many methods following two are most popular for the determination of chemical composition of various concentrations in the material being studied.

1 Rutherford Backscattering Spectrometry (RBS)

2 Secondary Ion Mass Spectrometry (SIMS) (Guozhong, 2004).

## Physical Properties of Nanomaterials

The nano materials are known to display several extraordinary explicit properties which are found to be significantly distant from their bulk materials. This phenomenon is typically observed as materials experience condensation of size range. Variations in the physical properties when materials come to nano scale size stem out of four major origins:

(i) Availability of considerably large fraction of surface atoms,

(ii) Amazingly enhanced surface energy,

(iii) Surprisingly small spatial confinement of components and

(iv) Compactness that results in reduced imperfections.

***(1) Melting points and lattice constants***: As the bulk materials undergo miniaturization of their size they experience increased number of surface atoms as compared with the total available amount of atoms. Due to this new distribution the nano materials tend to have considerably lesser melting point or if stated otherwise lower phase transition temperature. The same change is visibly seen in appreciably reduced lattice constants of nano materials as compared to their bulk counterparts.

***(2) Mechanical properties***: There is an inverse relation found in the extent of mechanical properties of materials and the miniaturized size of their component particles. Thus it can be stated that mechanical properties of materials increase with their reduced sizes. The new enhanced mechanical performance may reach to the new levels of the theoretical strength. It is notable to state that the increased mechanical properties exhibited by the nano structures of the bulk materials are one or two level of degree higher than the same properties found in single crystals when these are studied in the bulk form.

***(3) Optical properties***: Nano materials exhibit significantly changed optical properties as their size is reduced when compared on same optical properties with their counterpart bulk crystals. Nano systems become highly confined which paves path to the increased energy levels in this new state. This variation is responsible for the new shift in these materials. The second major reason to explain the reason behind the shift found in optical properties of materials when these are in nano form is surface plasmon resonance. Thus these both are major sources who can explain the phenomenon of witnessing change in optical properties. Surface plasmon resonance explains the reason behind experiencing variation in color as the particles are condensed, so same material can be used to yield different color as it undergoes shift in its components to nano scale.

***(4) Electrical conductivity***: Nanostructures and nano materials show very complex changes on their ability of electrical conductivity due to the reduction in size. The property of electrical conductivity is gauged to decrease with a reduction in the physical dimension. This can also be reasoned by increased surface scattering. The changes in electrical conductivity occurring in nano scales of bulk materials is explained by distinct mechanisms On the contrary this electrical conductivity can enhance appreciably in the nano materials based on improved ordering in condensed microstructure.

***(5) Magnetic properties***: Nano structured materials exhibit distinctly different magnetic properties from that of their counter bulk materials. As materials reach their nano scale they lose their ferromagnetism as found in bulk phase. The disappearance of ferromagnetism is also accompanied by the phenomenon of its transfers to superparamagnetism when the materials are in nanometer scale. Presence of huge surface energy explains this shift of properties.

**(6)** ***Effect of microstructure*** Nanostructures and nano materials showcase an amazing quality of self-purification due to some intrinsic thermodynamics. With the reduction in size increased perfection is achieved which is shown as a significant impact on the physical and chemical properties of the materials. Conclusively it can be said that one can considerably simply tune physical and chemical properties of nano structured materials just by adjusting their size, same can be obtained with variation in shape or change in the extent of agglomeration (Guozhong, 2004).

## Conclusion

Nanotechnology is witnessed by world as product of very advanced complex technological activity and gradually it is replacing traditional technology and has the potential to sweep the world. Nanotechnology has many aspects, it is equally concerned with the new designing, miniaturized fabrication and at the end successful application of nanomaterials or nanostructures. The concept of nanotechnology also deals with the basic knowledge and phenomena of how physical properties and material dimensions are related to each other. Future nanotechnologies in the vast field of textiles will be seen in two differently focused activities, at one hand efforts will be pooled for bringing improvement in the existing performances and functions of materials found in textile and simultaneously the other focus will be on evolution of advanced technology. Adoption of technology does not imply the need to discard current competences or that they will necessarily be destroyed. Interestingly, the new technology can be incorporated into the firm’s existing knowledge base and technology portfolio and be used to create new products or considerably enhance the value of existing products. This is not to suggest that firms with specific competences cannot jump on to the emerging technology bandwagon. Instead, they need to focus their attention on developing networks of customers and suppliers, engage in collaborative R&D, partnering and alliances in order to build new technological capabilities and to create new products that meet the requirements of customers. For both small and large textile firms, collaboration, partnering and alliances are an important element in the technology adoption and commercialization strategy. An enormously promising future is waiting for textiles in nano level explorations (Horne, 2012). There are endless possibilities of innovation with the application of nano technology; some may include development of smart textiles, proposing functional finishes and advancement in manufacturing of ultra fine fibers. Currrently textiles have just stepped in the amazing arena of the application of nano technology and are yet to explore the magnitude of its unknown potentials.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