

# A Survey on Synthesis and Characterization of Nanomaterials

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## Abstract

Studies on nano-composite materials have been a most significant emerging research with the innovative methods of investigations through many processing techniques being attempted in the domains of science and engineering. The paper gives only the basic details that are already available in the literature for the preliminary survey of the properties with a few number of citations. The fundamental points in the processing techniques and basics of modulation of materials under the fabrication are elevated in the paper for the pre-investigation of materials. Generally chemical or physical modifying techniques enhance the performance of the materials. The review is emphasized on the method and fabrication techniques of nano-composite materials and corresponding electrical, magnetic and optical properties. Electro spinning method is very recently attempted technique in producing the efficient nano structures for many applications in mechanical and other domains of engineering. The paper concludes only the basic information of material characterization in its nano dimensions.

**Keywords:** *Nanomaterial, carbon nanomaterial, material characterization, properties.*

## 1. Introduction

The basic studies on the composite materials have been for the investigation of characterization of materials. The attempt of material characterization has been made by many researchers with various processing techniques. The ongoing research on materials is attracted towards the nano-field for making the system of material comfort for the wide range of applications in different domains such as engineering, scientific and medical fields. The material that undergoes the chemical modification at the level of nano-scale will be expected to attain the updated properties and therefore functional ability can be enhanced. The researchers are interested to produce the material suitable for the useful

application. The most of research is focused on the modification of material at the nano-scale. The composition of the material at nano levels generally attains enormous functional capacity with the drastic changes in its original characteristics. In the present review, properties, applications and variety techniques of processing methods that are attempted are focused. The review has been made on the various mechanisms of nano scale modification techniques and their efficiency in producing the outcome and properties of nanocomposite materials. The processing techniques of studying the mechanical, thermal optical, electrical magnetic properties require the basic chemical composition and atomic information of the material under investigation.

## 2. Preparation and properties

The formal methods of producing the materials at nano size have been made in the earlier research studies for the investigation of material characterization. In the recent past the non formal and innovative techniques have generally followed for producing the efficient materials. The very common recent methods that are followed have been briefly presented in the preceding sections with the properties.

### 2.1 Sol-gel Technique

Studies in the past were carried out with many techniques to produce nano materials. sol-gel method has been one of the versatile techniques in the process of synthesizing and fabricating the new materials, which include high ionic conductors. The

sol gel method became very popular because of mixing of starting compounds in the solution form at atomic level. This technique will fabricate various types of new materials like thin films and fibers etc., for different domains of scientific and technological applications. Therefore the sol gel method is an appropriate technique for the synthesizing carbon nanomaterials [1,2]

## 2.2 The Chemical Properties of Compounds

In the process of fabrication of nano-composite material for the applications, one has to be more careful in executing the method of fabrication and consideration of chemical properties. The efficiency of method of fabrication depends on the techniques and selected compounds and temperatures and other scientific configuration and modeling adopted in the process[3]. The modified characteristics of the nanocomposite materials have been found to depend on the properties of individual parents from which compounds are selected, and interfacial characteristics and morphology also exhibit the impact on the properties attained in the modifications. It is observed that modified properties are related to that already in previous original compounds that are involved in the fabrication of materials [4].

## 2.3 Electrical properties

The materials at nano scale will exhibit electric properties in a different way when it is compared to the dimensions at larger scale. A change in the structure at the atomic level causes a different environment in the material. Measurements of polarization and spectroscopic measurements may reveal the various interactions among spin and orbitals couplings to enable the materials to exhibit the material in different way. The composite and ceramic materials are recently fabricated with considerable changes in the various properties for many engineering and scientific applications. The recent synthetic techniques with electrospinning method generate more efficient nanostructures<sup>8</sup>. Nano-tubes fabricated in electro spinning techniques are observed to perform well in field of mechanical and thermal application [5,9]. The overall conducting properties nano carbon materials can be enhanced with the different modifying techniques. The synthesis and fabrication methods that follow innovative modern principles may produce the efficient materials of high conducting capacity.

The dielectric properties also show a significant role in the study and fabrication of nano-composite

material for enhancing the conducting properties. In the process of considering the electrical properties measurements are to be made for observing the strength of dielectric breakdown. The breakdown capacity also indicates the performance of the material with the improved properties in nano-scale size. The techniques of good dispersion also reported in the literature for enhancing characteristics of the material for the better performance.

## 2.4 Optical Properties

As there is a need of optical materials in different applications, the innovative research problems are executed for improvement of performance towards optical applications. The optical computing and fast performing optical switches play a vital role in the present scientific world and therefore there is a strong demand of research task for the optical enhancement in the functioning of the material. In the field of the optical communications a proper and efficient transmission of signal can be made with highly improved nano-scale materials [5]. One of the challenging issues in enhancing materials for optical applications is expanding the material characterization for efficient optical performance by perfect wave guides<sup>6</sup>. The recent synthesis and preparation techniques are focused on the fabrication of fast performing optical materials. The modified nano carbon materials can improve the performance to act as a efficient magnetic materials and solid state amplifiers<sup>7</sup>. The stability can also be enhanced for materials when they are synthesized into nano scale.

## 2.5 Magnetic Properties

The material undergoes a considerable magnetic transition when its dimensions are altered. The various facts that cause a change in the magnetic properties at microscopic level may be crystallographic disturbance, a change in atomic ordering and spin reorientation etc. Nano-carbon materials exhibit a different kind of magnetic properties when they are doped with compounds of various materials [10]. The nano-carbon materials are of tremendous importance in producing the magnetic fields for the various scientific requirements in the electronic applications [11].

## 3. The Measurements and Instrumentation

The investigations need to be applied on the materials reveal the interesting facts about the materials such as optical, magnetic and electrical

properties. The basic methods that measure crystal structure, optical properties and magnetic properties are XRD technique, SEM, TEM and Q-meters for dielectric polarization. The certain parameters are refined automatically so as to fit the observed Bragg reflection profiles and calculated reflection profiles for a better way of interpretation. The degree of accuracy in the measurements and precision of the parameters determined in the investigation are generally verified by the curve fitting technique [12].

#### 4. Conclusions and Discussion

The present paper shows only the basic details and previous techniques attempted in the study of nano-carbon materials. In the modern scientific world there is a huge demand in medical, engineering and commercial applications of fast functioning of materials. The paper reveals the basics of material modulation with various modification techniques. The properties of material can be mould in the directions of positive applications. The paper discusses the basic informative points already in the literature. The enhancement of electrical, magnetic and optical properties of the materials needs to be made for the wide range of applications in various domains. The nano-carbon materials need to be investigated for extraction of more number of applications. The different approaches may be attempted in the investigation based on the previous attempts so as to get efficient materials that can function at a faster rate in the domain of various applications. A wide range of survey needs to be carried out for the research of fabricating the materials of an immense potential in terms of its functionality for the various scientific and engineering fields. The accuracy and precision of measurements are to be carefully considered in the study of properties of the materials in order to draw the better conclusions.

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