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Nanoparticles Prepared by the Sol–Gel Method and their Use in the Formation of Nanocomposites with Polyaluminium Chloride

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Abstract: ***The sol-gel method is an alternative method to produce ceramic powers. In the present study deals with the synthesis and characterization of $AlCl_3$ nanopowders which can be a potentially utilized material for biocompatible implants. Based on sol-gel method, the synthesis started from different chemical nature precursor's inorganic aluminium chloride ($AlCl_3$) and inorganic sodium hydroxide (NaOH). The gel obtained after drying the gel were heat treated at 90^0 C and 48 hours. The X- ray diffraction was used in order to characterize the powers in terms of their crystalline degree and crystallite gel in different ratio of intensity is observed.***

1. Introduction

Nanoscience is the branch of science concerned with the development and production and uses of materials whose basic components are of nanoscale size, i.e. ~1 - 100 nm in size. Nanotechnology involves methods for transforming matter, energy and information based on nanometer scale (nanosized) components with particular defined molecular features and prescribed physical and chemical properties. It creates and uses structures that have novel properties because of their nanoscale small size. It is developing from the ability to control and manipulate at the atomic scale, which essentially means controlling situation Sather atomic and molecular level, far removed from normal processing of bulk materials in a typical laboratory or industrial process. The use of the scanning tunneling microscope allows us to 'see' individual atoms in an atomic or molecular lattice in a way that was inconceivable 100 years ago when the principles of atomic and molecular structure were being discovered[1-6]. The many applications of nanotechnology include the use of semi-conductors that only conduct electricity in specific conditions and allows the design of much very tiny 'devices' normal scale conductors, so the final product can be much smaller, enabling the design and use of faster smaller computers working at the molecular level. The advantage of these new materials is that they can be designed and built from the atomic level upwards to have specific properties of great use to material scientists; a good example is the ongoing development in the design and use carbon nanotubes. In nanotechnology, a particle is defined as a small object that behaves as a whole unit in terms of its transport and properties. Particles are further classified according to size in terms of diameter, coarse particles cover a range between 10,000 and 2,500 nanometers. Fine particles are sized between 2,500 and 100 nanometers[7-9]. Nanoparticles may or may not exhibit size-related properties that differ significantly from those observed in fine particles or bulk materials. Although the size of most molecules would fit into the above outline, individual molecules are usually not referred to as nanoparticles. Nanoclusters have at least one dimension between 1 and 10 nanometers and a narrow size distribution. Nanopowdersare agglomerates of ultrafine particles, nanoparticles, or nanoclusters. Nanometer-sized single crystals, or single-domain ultrafine particles, are often referred to as Nanocrystals [10-13]. In this investigation, the chemical and structural characteristics of Fe nanoparticles synthesized by high-energy ball milling have been explored. After the milling process the nanoparticles were collected using a magnetic field. The structure, morphology and composition of the powders were obtained using high-resolution electron microscopy. HREM images confirmed the nanoparticles' presence with approximately 2–4 nm in size. It was found that using this method allowed the formation of nanoparticles in a smaller size range than other synthesis methods. Also, it was confirmed by HREM images that the obtained nanoparticles were mainly of the FCC nature and some of them of the MTP type. Gas-phase flame synthesis is an attractive method for the synthesis of nanoscale metal oxides because of the great potential for large-scale production as evidenced by the production of fumed silica, titania, and zinc oxides at rates approaching millions of tons/year.While metal oxides have been synthesized using a number of flame configurations, a straightforward and readily scalable method utilizes a non-premixed jet flame, which is formed from the injection of a gaseous fuel (hydrogen or a hydrocarbon) into a surrounding flow of oxidizer (air or oxygen-enriched air). In this flame configuration, there is an abundance of oxygen at high temperature available for oxidation of the metal: the excess oxidant makes it difficult to control the final oxidation state of the product. The sol-gel process is a wet-chemical technique (also known as chemical solution deposition) widely used recently in the fields of materials science and ceramic engineering [14-16]. Such methods are used primarily for the fabrication of materials (typically a metal oxide) starting from a chemical solution(sol, short for solution) which acts as the precursor for an integrated network (or gel) of either discrete particles or network polymers Typical precursors are metal alkoxides and metal chlorides, which hydrolysis and polycondensation reactions to form either a network "elastic solid" or a colloidal suspension (or dispersion) a system composed of discrete (often amorphous) sub micrometer particles dispersed to various degrees in a host fluid. Formation of a metal oxide involves connecting the metal centers with oxo (M-O-M) or hydroxo (M-OH-M) bridges, therefore

generating metal-oxo or metal-hydroxo polymers in solution. Thus, the sol evolves towards the formation of a gel-like diphase system containing both a liquid phase and solid phase whose morphologies range from discrete particles to continuous polymer networks.

2. Material and Method

The reagent used in this study was all of analytical grade 0.01M Aluminum chloride (AlCl3) and react with 0.1M Sodium hydroxide (NaOH). All chemicals were used as received double distilled deionizer water was used. This reaction followed by the physical procedure. Temperature maintained in 90ºc, Resolution Rate 0.1ml/30s, Resolution RPM 1800, Age of the reaction 2 days.

Preparation nanoparticle from sol-gel method

In sol-gel preparation, a solution of the appropriate precursors (metal salts or metal organic compounds) is formed first, followed by conversion into homogeneous oxide networks (gel) after hydrolysis and condensation. Drying and subsequent calcinations of the gel yields an oxide product. Usually, for preparation of multi-component oxides, alkoxides are mixed together in alcohol. Components for which no alkoxides are available are introduced as salts, such as acetates. Hydrolysis is carried out under controlled temperature, *p*H and concentration of alkoxides, added water and alcohol. Hydrolysis and condensation to polymeric species are represented by the following reaction equations (use alkoxides as an example):

M (OR)z + H2O → M (OR)z-1 (OH) + ROH
2M (OR)z-1 + (OH) →M2O (OR) 2z- 1 +H2O
(OR)z+(OR)z-1 (OH) → M2O(OR)2z- 2 +ROH

Metal oxygen metal (M-O-M) bonds are formed in solution by self-condensation or by cross-condensation when different lakesides are used After calcinations, the organic group, R, is removed, leaving metal oxides.

Preparation of poly Aluminum chloride

All reagent used were analytically pure chemicals except water glass.Distiled water was used to make all solution. Poly aluminum chloride (PAC) prepared in our laboratory using inorganic (AlCl3) and NaOH as raw materials. Briefly, an inorganic NaOH solution (%NaOH) was slowly added to the solution (AlCl3) with strings at room temperature to obtain the desired of (b/w 2.0 to 2.2) of PAC. After addition of NaOH solution the mixer was stirred un till to bubbles formed and the solution become transparent then it was diluted with deionizer water to concentration of 0.01 M of Al and then it was allowed to rest for more than 2h before the all spices in PAC was separated and purified and the properties of the gel were examined. 0.01 M AlCl3 solutions was pleased in a beaker, and reacted with 0.1M NaOH solution for 2hours at room temperature. After reaction poly aluminum chloride solution is precipitated. As the chloride salt. Then the solution was filtered through filter paper and dried in 2 days for 90 ° c poly aluminum chloride gels is obtained. 0.01 M AlCl3 solutions was pleased in a beaker, and reacted with 0.1M NaOH solution for 2hours at room temperature. After reaction poly aluminum chloride solution is precipitated. As the chloride salt. Then the solution was filtered through filter paper and dried in 2 days for 90 ° c poly aluminum chloride gels is obtained.

3. Results and Discussion

X-ray diffraction spectroscopy basically used as common method to determine the purity of product. Nanopowders gel x-ray diffraction (XRD) is a most useful technique used to characterize the powder gel stricter, size and prepared orientation in powder obtained gel samples. X-ray methods of characterizing the sample as a whole they are an essential complement to other high resolution method which provide rather details information on only a few particles moreover based on XRD data, much on crystal gel size can be calculated using Scherer equation D= Kλ/β cosθ were D is the crystal size (nm) K present as sheerer which has a value of o.89, λ is the wavelength(nm), β is the observed peak width and θ is the diffraction angle with these crystals parameters one can analysis the influence of depends to boehmite crystal lattice.

X- ray diffraction is normally used to determine the phase purity of the synthesis bomite XRD patterns observed and all diffraction peaks were perfectly indexes to the XRD pattern of pure bomite XRD peaks represtently other crystalline phase that the nano crystal gel of the synthetic bomite exbited excellent crystalline and high purity.X-ray diffraction images for the powders obtained from different precursors, dried and heat treated for 2 hours at temperature values of 90ºC.

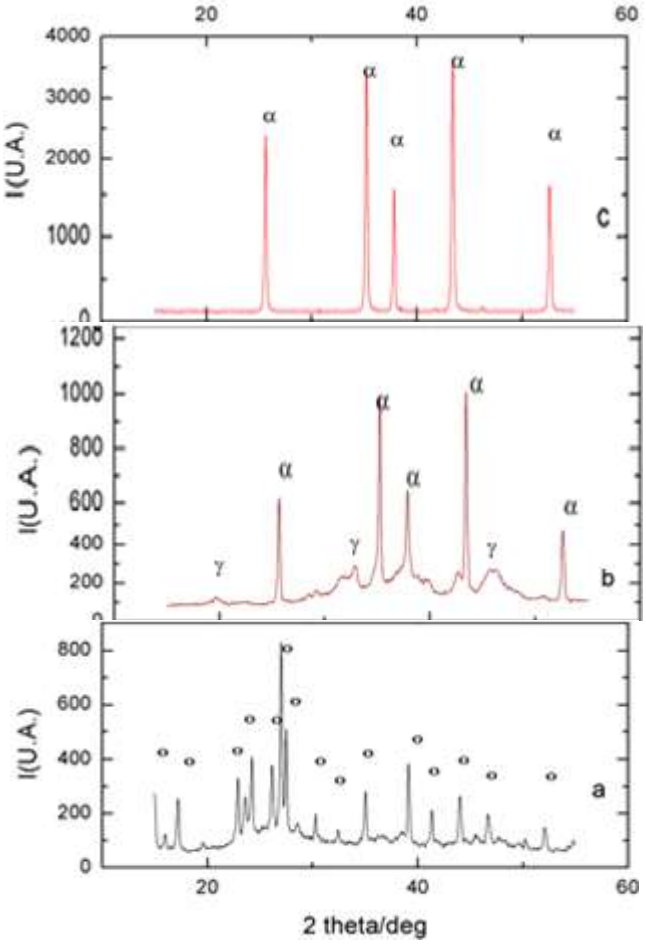

Figure 1: The XRD of alumina powder obtained gel by sol-gel method

It should be noticed that when AlCl3 was used as a precursor, the dried gel highlights the presence of AlCl3 ·6H2O crystal. Thermal treatment at 90oC for two hours leads to its decomposition with the formation of a mixture. Thermal treatment at 1000oC leads to the formation of a poly aluminum chloride having relatively low degrees of crystalline. Increasing the heat treatment temperature to and a higher crystalline .The heat treatment temperature increases, the crystallite size increases, this increase being more important in the case of the inorganic precursor. Irrespective of the precursor used thermal treatment at 1200^{o} C leads to crystallite sizes of approximately the same value. Plasmon absorption peak for the poly aluminum chlorides intensity ranging from 213,147,123,120,107,100 this high and sharp peak is observed in x-ray diffraction technique.

4. Conclusion

Poly aluminum chloride (PAC) nanoparticles were synthesized using sol-gel method was first employed to prepare high concentration PAC with high content aluminum chloride (AlCl3) and sodium hydroxide (NaOH). The nanoparticles were characterized by x-ray diffraction technique show the characteristic Plasmon absorption peak for the poly aluminum chlorides.

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