Synthesis of calcite-zincite nano composite materials using sol-gel auto combustion method

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Abstract. Calcite-Zincite nano particles were synthesized by Sol–Gel Auto Combustion (SGC) technique. Modifying nanoparticles promote numerous advantages, such as, simplicity of synthesis, small heat for breakdown, regulation above the compound structure, small budget, dependability, repeatability, and moderate synthesis situations. One of interesting study on Sol–Gel auto Combustion technique has proven massive advantages as compared to other traditional methods. Presented work follow synthesized of novel nanoparticles. Research work was focused on characterized UV visible absorption spectroscopy and FTIR. The UV visible absorption spectroscopy shows an absorption band at 214 nm, 234 nm and 372nm due to calcite/zincite nano composite particles. FTIR spectra establishes a particular Calcite - Zincite nano powder obtained the characteristic peak of carbonate group at 1414 cm−1, 868 cm−1 (CaCo3) and 477 cm−1 (ZnO).

1. Introduction

Nanotechnology is one of the emerging filed of science and finds intensive applications in solving modern days problems. The promising way to enhance the base material is by changing the structure as well as the dimensions. By modifying the structure of the material unique properties can be achieved [1]. Adopting some of the modern materials such as hybrid metal oxide under the category of nanomaterials initiates researchers to think for adding value to conventional problems [2]. The first popular choice under nanomaterials can be considered as ZnO nanomaterials, which is due to its massive applications across various sectors such as ceramics, piezoelectric transducers [3], chemical sensors [4], anti-UV additives [5], photocatalysts [6], photoelectric fields [7] etc.

Further, noble metal doped ZnO by numerous techniques finds enactment in overall performance related to undoped version of ZnO nano composites [8]. While, calcium carbonate (CaCO3) is a restorable porcelain bio material that is progressively resorbed in the body. Meanwhile, mechanical resemblance with bone, corals able to use on behalf of bone grafts. Calcium carbonate has numerous medicinal applications, for example as gastric anti-acid and nutritious calcium enhancement. Similarly it acts as phosphate binder and is utilized to act towards the hypophosphatemia. In drugs developed, CaCO3 is being consumed just as idle plaster on behalf of drugs. While, CaCO3 is abundantly available material in earth's layer in form of limestone and chalk. Also, as a rich organic deposit it is present in recent and ancient oceans, approximately 10% of deposits. Creatures in seas, yield carbonate deposits and produce robustly Calcium carbonate. In addition, carbonates broadly exist in various regions of oceans where the temperatures are fluctuating from -2°C to 40°C. Aquatic creatures are the main cause for the creation of Calcium carbonate and key constituent in organic systems, for example shells of sea creatures, gems, and egg shells. CaCO3 of aragonite and calcite has melting temperatures around 825°C and 1339°C, respectively [9]. Outermost layer of teeth contains calcium with an average composition of 37%, which is extremely mineralized as well as avascular soft muscle of the dental crest. Calcium and phosphate are biominerals produced unnaturally or gained from natural sources has a significant task in avoiding demineralization and boosting remineralization of tough tissues of tooth sideways conservation and repairs the fitness of the tissue. Remineralization is a process where calcium and phosphate ions distributed as a cause of superficial just before the tooth to encourage ion admission keen on quartz cavities in demineralized surface, to yield remaining crystal improvement [10]. Zinc Oxides and calcium carbonate nano materials are very interesting topics for researchers from few decades. It has uses in various areas such as electronic and photonic maneuvers by way of catalysts in chemical industries and because of its biocompatibility it is widely used in dental applications. This study was aimed to synthesis the nano composite materials (Calcite-Zincite) by sol-gel auto combustion method and evaluates the characterization of nano composite material by Ultraviolet Spectroscopy, FTIR.

2. Methodology

In this work four products namely Calcium Nitrate Hexahydrate, Zinc Nitrate Hexahydrate, Glycine and Sodium Hydroxide were obtained from S D Fine Company. The aqueous solution is prepared by adding 0.75 molar weight of Calcium Nitrate Hexahydrate (Ca (NO3)2·6H2O) and 0.25 Molar weight of Zinc Nitrate Hexahydrate in 100 ml deionized water and stirred for one hour. Then 2 molar weight of Glycine (C2H5NO2) is added, the fuel ratio was taken according to stoichiometric proportion of metal nitrate to oxidizer ratio (1:2) and stirring is continued for 30 minutes. Then 0.25 Molar weight of sodium hydroxide (NaOH) in 25ml deionized water was mixed and simultaneously added drop wise to the mixture under magnetic stirring which acts as a precursor. The solution was heated till precipitated viscous gel was obtained. By increasing the temperature to 200^{o}C, viscous gel was initiated and thereby powder of the samples was collected. Finally the powder was transferred to the crucible and calcined at 500oC for 3 hours to form nano particles.

3. Results and discussion

The effect of amount of calcite/zincite nanoparticles on the optical absorbance was investigated using UV-Visible Spectrometer (Shimadzu UV-1800). Dimethyl sulfoxide (DMSO) and was positioned in UV spectrometer to get absorbance. The calcite-zincite nano powders were partially dissolved in Dimethyl sulfoxide (DMSO) Solution and sonicated before finding the UV absorption peaks on behalf of calcite-zincite nano powders. Calcite/zincite nanoparticles constituent solutions be situated in a quartz cuvette and positioned in the spectrophotometer to find the absorbance. Approximate wavelength of calcite has 3- characterized wavelengths are 213, 252 and 356.52 nm. Obtained spectra are as shown in Fig.9, Fig.10 have indicate peaks of the synthesized Calcite-zincite nanoparticles. The energetic absorbance crest accessed for calcite-nano powders existed in the range of 234 and 254 nms indicates calcite nano particles.

Further, absorption edges of ZnO are >400nm, which was obtained from Calcium Nitrate Hexahydrate [11] and Zinc Nitrate Hexahydrate [12].With the help of Fig. 1 and 2 a clear understanding can be developed. As the absorption edge wavelength of the powders is less than 400nm, which is because of the absorption edge of zincite 376nm.

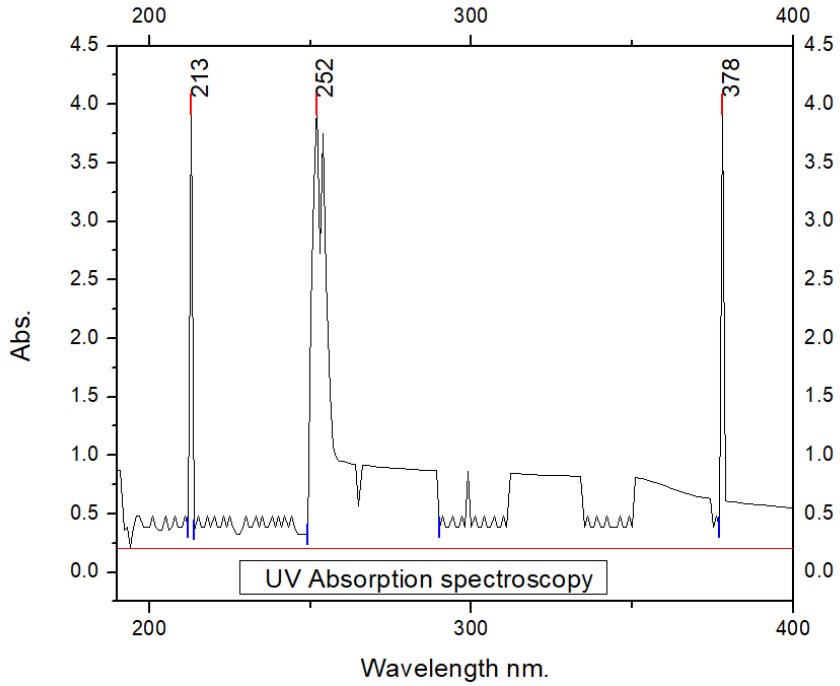

Figure 1. UV Absorption spectroscopy plot without calcination

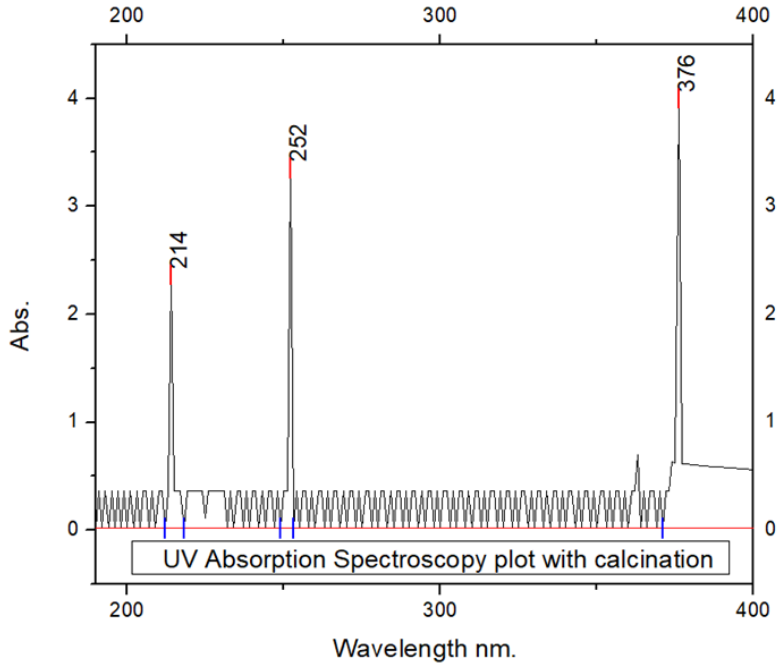

Figure 2. UV Absorption spectroscopy plot with calcination at 5000C

The surface analysis was performed using FTIR [13] (FTIR, PerkinElmer, Spectrum Two) at a range of 400cm-1 to 4000cm-1 before and after calcination was investigated using Fig. 3 and 4. It can be noted

that FTIR ranges of the CaCo3/ ZnO fine particles, which were developed in the array of 4000 cm−1 to 400 cm−1.FTIR investigation establishes a particular Calcite - Zincite nano powder [14] obtained the characteristic peak of carbonate group at 1408.32 cm−1 and 712.64 cm−1 and 462.85 cm−1 (ZnO) oxide group which confirms the presence of calcite/zincite nanoparticles [15].

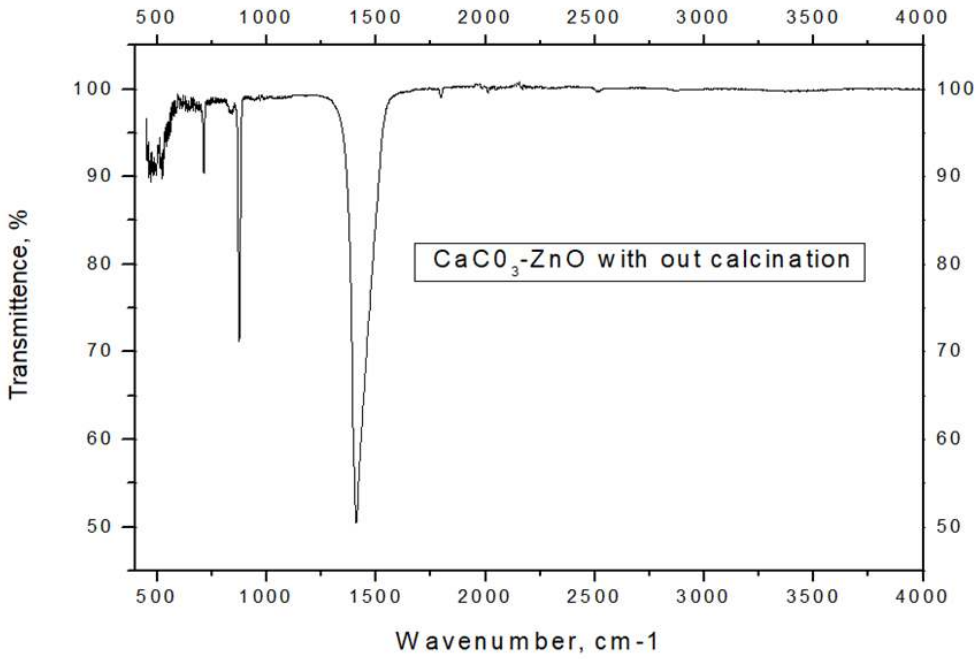

Figure 3. FTIR spectra of synthesized calcite-zincite nanoparticle before calcination

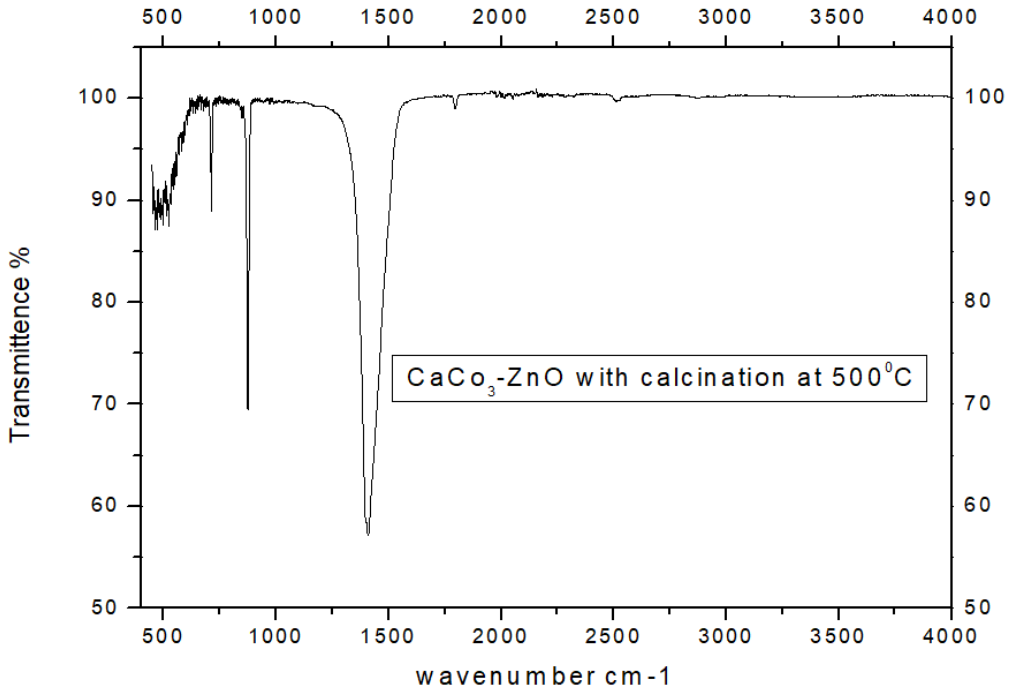

Figure 4. Spectra of synthesized calcite-zincite nanoparticle after calcination at 500oC

conclusion

CaCO3-ZnO nanoparticles were obtained by considering Sol-Gel Auto Combustion method. The crystalline structure of the synthesized CaCO3-ZnO nanoparticles exhibited hexagonal structure of hexagonal – Zinc oxide and Trigonal (hexagonal axes) Calcium Carbonate nanoparticles. The average Crystallinity of the synthesized calcite-zincite without calcination is 31.26% and with calcination 30.30%. The average crystal size of the nanoparticles was recorded without calcination 38.07nm and 39.31nm with calcination at 5000C for 3-hours.

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