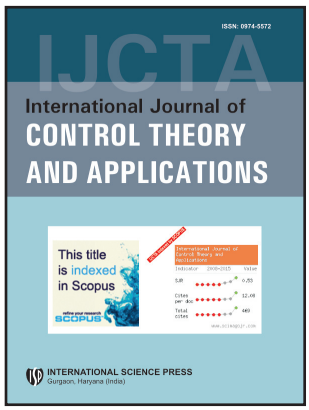

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Characterization of Silicon Carbide Nano Particulates Developed from Quarts

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Abstract:

Aim: SiC particles produced by high-energy planetary ball milling (Model: Retsch, PM 100, Germany) is a top down approach which is derived from quarts ore collected in the region of coastal area and hill side area of Tamilnadu, India. This machine has a stainless steel chamber using tungsten carbide and zirconia balls of Φ 10 mm and Φ 3 mm ball sizes respectively are used to mill the micro size to nano size particulates. Their structure, physical, chemical and mechanical properties are discussed in connection with the influence of the size effect. The instruments such as Transmission electron Microscope (TEM), Scanning electron Microscopy (SEM), FT-IR apparatus, Particle size analyzer (PSA) and thermal conductivity test apparatus are used to investigate the samples and explained by the way it has been used.

Materials and Methods: Many researches were adopted for finding the character of silicon carbide due its eminent application in engineering. High-energy planetary ball milling (Model: Retsch, PM 100, Germany) was used to produce nano particulate. Nano SiC particulate was produces from the ore of Quarts which was collected indigenously. Here the sample was taken from the coastal area and hill side area of Tamilnadu for the study. The instruments are used here most involved electrons, photons, or ions as a probe beam striking the material to be analyzed. The beam interacts with the material in some way, and in some of the techniques the changes induced in the beam (energy, intensity, and angular distribution) are monitored and study after the interaction..

Results: Silicon carbide (SiC) compound is constituted by silicon and carbon atoms, with a 1:1 stoichiometric relationship. Each Si and C atoms are bonded to form four atoms of the other element at closed form in a tetrahedral arrangement. The chemical bond between Si and C atoms are "polar covalent", constituted by sp3 hybrid orbital, with a bond distance of 1.89 A. By analyzing size of the silicon carbide using particle analyzer, so it is confirmed that milled SiC is a nanoparticulate having the average size of 117d.nm with intensity of 100%.

Conclusion: Thus SiC with smaller particle size can bring in higher tensile strength when placed under heat. Silicon Carbide is special in the way it breaks own. As it breaks down into smaller particles, the media will expose new, sharp

edges. However Nano silicon carbide particulates developed from indigenous sources are used in polymer matrix composite, metal matrix composite and ceramic matrix composite which is highly used in novel application such as aerospace, medical, automobile and industrial.

Keywords: *Synthesis, Polytypes, Nonoparticulate, Stoichiometric, Characterization.*

1. INTRODUCTION

Silicon carbide (SiC) powder used for this study was developed from quarts which were collected as mention above and procured from M/s Madras metallurgical laboratory, Chennai with an initial particle size of 12 μm. The reduction in particle size of SiC from micron level to the nano level was carried out by using a high-energy planetary ball mill (Model: Retsch, PM 100, Germany). It has a stainless steel chamber with tungsten carbide and zirconia balls of 10 mm Φ and 3 mm Φ ball sizes respectively. Babu Rao (2011) was used to produce nano particulates by this method.

The total duration of milling was 10 hours. The rotation speed of the planet carrier was 200 rpm. The ball mill was loaded with ball to powder weight ratio (BPR) of 10:1. Toluene was used as the medium with an anionic surface active agent to avoid agglomeration. The milled sample powder was taken out at a regular interval of every 2 hours of milling and dried with mechanical drier. Babu Rao (2011)

The silicon carbide nano particulates were characterized for further application. The instruments are most involved electrons, photons, or ions as a probe beam striking the material to be analyzed. The beam interacts with the material in some way, and in some of the techniques the changes induced in the beam (energy, intensity, and angular distribution) is monitored and study after the interaction.

R.A. Andrievski (2009) was used high resolution instruments. In transmission electron microscope (TEM), the source of illumination is a beam of electrons of very short wavelength, emitted from a tungsten filament at the top of a cylindrical column. Since the wavelength of electrons is 100,000 times shorter than visible light the electron microscopes have greater resolving power. They can achieve a resolution of 0.2nm and magnifications up to 2,000,000 x. The magnetic coils placed at specific intervals in the column acts as an electromagnetic condenser lens system. The specimen stained with an electron dense material and is placed in the vacuum. The electron beams are passes through the specimen and scattered by the internal structures. Also this is study were referred the articles from Katarzyna, Szot – 2012 and G.B. Basim, A. Karagoz, Z. Ozdemir (2013)

The scanning electron microscope (SEM) uses a focused beam of high-energy electrons to generate variety of signals at the surface of solid specimens. SEMs always have at least one detector (usually a secondary electron detector). The specific capabilities of a particular instrument are critically dependent on which detectors it accommodates. G.B. Basim, A. Karagoz, Z. Ozdemir7 (2013)

FT-IR Spectroscopy is a technique based on the determination of the interaction between an IR radiation and a sample that can be solid, liquid or gaseous. It measures the frequencies at which the sample absorbs, and also the intensities of these absorptions. The frequencies are helpful for the identification of the sample's chemical make-up. The concentration of component can be determined based on the intensity of the absorption. Arun.P.S, S. Sathish and C. Narendhar" (2014)

2. CHARACTERIZATION

2.1. Determining the Crystal Sizes of SIC Particles by TEM

Philips CM120 series transmission electron microscope (TEM) model was employed for measuring the size of the synthesized SiC particulates. TEM was operated at different accelerating voltages of 20, 40, 60, 80, 100 and

120 kSV. Samples were prepared by dispersing drop of colloid on copper grid, covered with the carbon film and the solvent was dried for determining the crystal sizes of SiC particles. Figure 1 shows the TEM image of SiC nano particulates which is sharp edges.

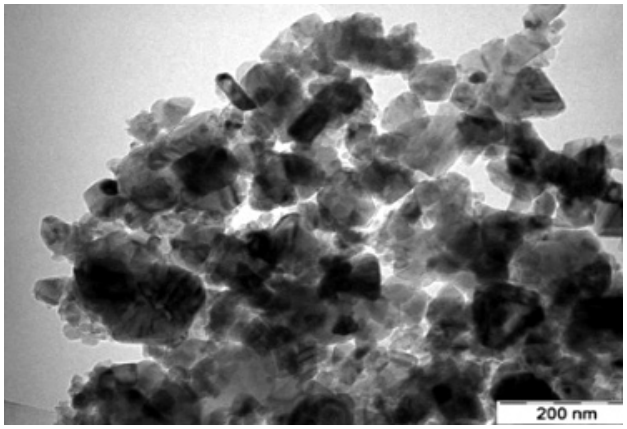

Figure 1: TEM image

2.2. Analyze the Chemical Compatibility by FT-IR

Samples were characterized with the help of FT-IR spectrometer in the wave number ranging from 4000 to 400 cm^{-1} for analyzing the chemical compatibility between stearic acid and nano particles.

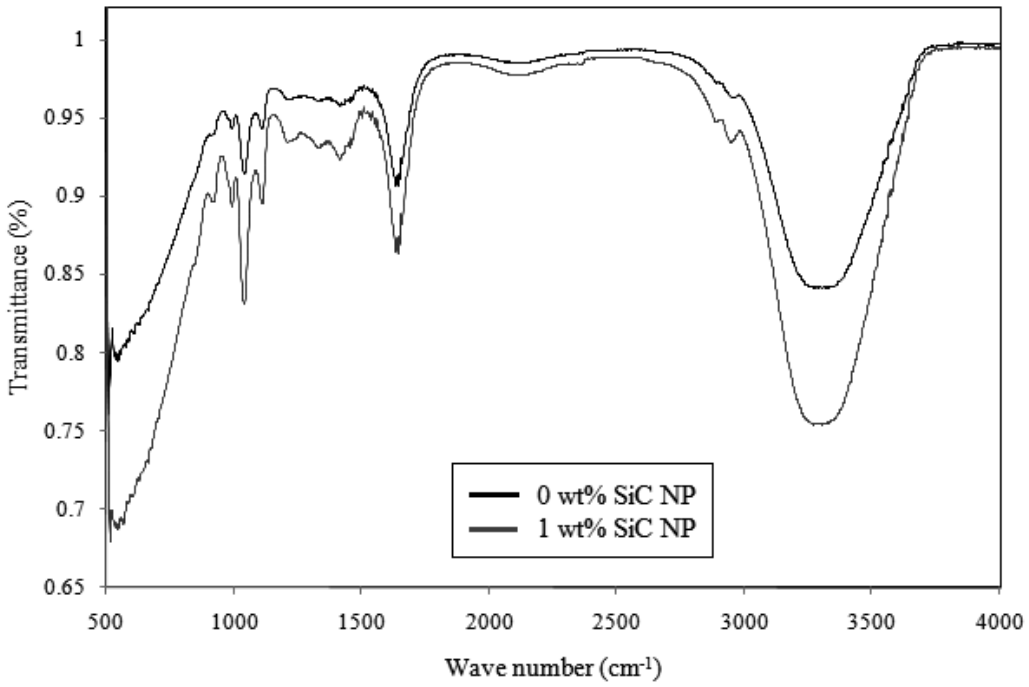

Figure 2: FTIR Chart

From the FT-IR test result it is confirmed that by adding nanoparticle to the 1D-dilute water, the transmittance increases without any chemical changes in a reaction process. FT-IR is used to show the exact change of transmittance percentage in a wave number. The results in Figure 2 shows the sample which is in 99.97 % purity.

2.3. Identification of the Elements, Inclusion Present in Sample by SEM

Scanning electron microscopy (Model: SEM-Quanta 400, FEI-Netherlands) with EDAX energy dispersive X-ray spectroscopy (EDS) was used in order to evaluate the morphological changes of certain phases observed in the fresh as well as nano structured silicon carbide particles.

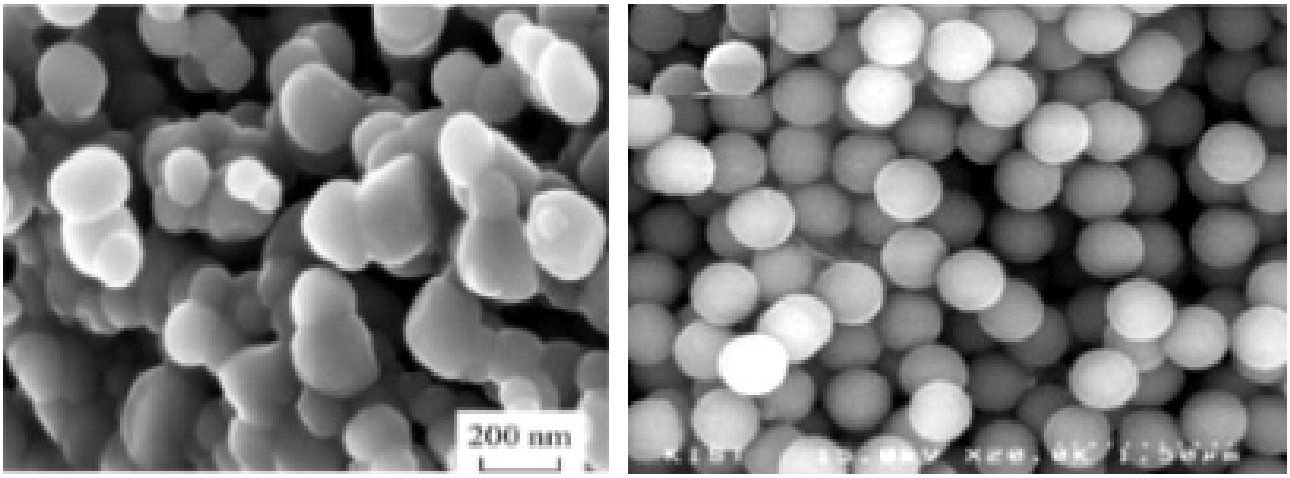

Figure 3: SEM images 1 and 2

The results are in the form of black and white images with our interpretation of their meaning. The images generated are black and white so differences in color are hard to detect but differences in atomic weight are easily seen.

2.4. Analyze the Spread of Size of Particle by PSA

Particle size analysis PSA technique is used to estimate the exact size or mean size of the nanoparticulate silicon carbide. By analyzing size of the silicon carbide using particle analyzer, so it is confirmed that milled SiC is a nanoparticulate having the average size of 117d.nm with intensity of 100%.

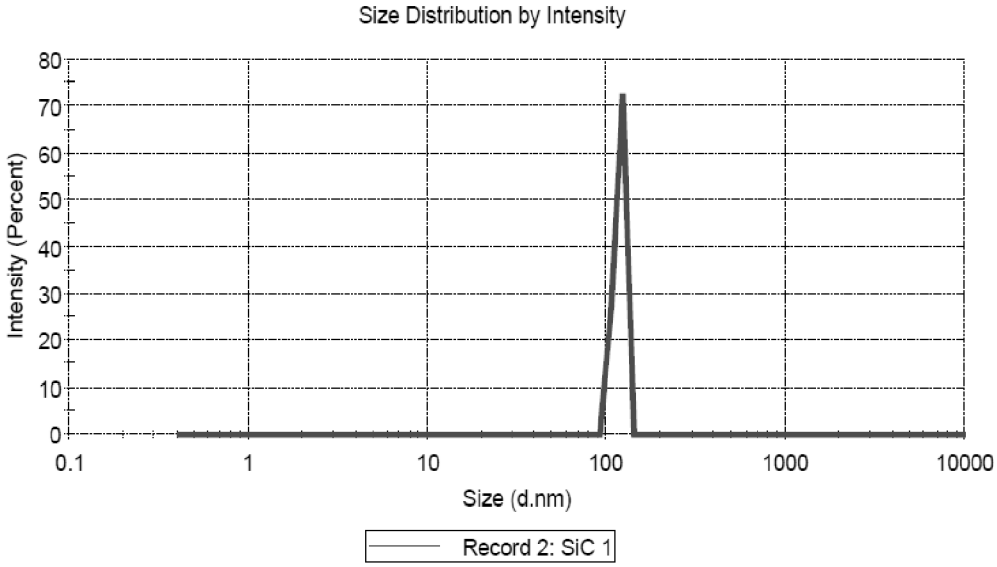

Figure 4: Sample and PSA Chart

Performing a particle size analysis is the best way to answer the question: What size are those particles? Once the analysis is complete the user has a variety of approaches for reporting the result. A better approach is to report both a central point of the distribution along with one or more values to describe the width of distribution.

2.5. Thermal Conductivity Test

Thermal conductivity is used to calculate the heat transfer in a fluid. By adding nanoparticle to the 1D-dilute water, thermal conductivity of the fluid increases rapidly with the proportional to the % wt of a nano particulates, according to the usage of the fluids.

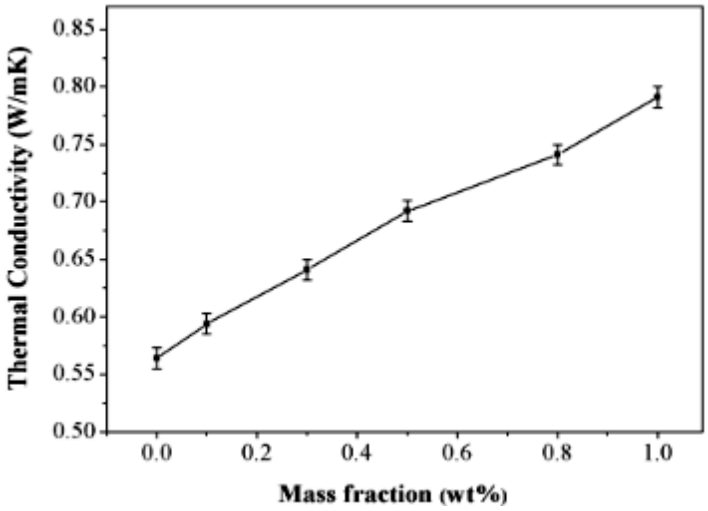

Figure 5: Thermal conductivity Chart

3. RESULTS AND DISCUSSION

Therefore from the analyzed discussion,

1. It is confirmed that the SiC nanoparticulate would increase the thermal conductivity of the material when it is combined other conductive material.
2. It is confirmed that by analyzing from various results of particle size analyser, FESEM, HR-TEM, FT-IR, Thermal conductivity test.
3. From PSA test it is clear that the SiC particles milled by ball milling machine having the nanoparticulate size which has the average size of 117 d.nm.
4. From TEM results, it is confirmed that nanoparticulated SiC has in crystalline spherical structure with sharp edges are observed.
5. From the SEM result it has spherical shape and it has slightly changes in its size and shape due to its agglomeration.
6. To know whether any changes in the chemical reaction in the process FT-IR spectroscopy test is used. 1D distilled water is mixed with nanoparticulated SiC, it only increases the frequency and not in chemical reaction.
7. Finally, to know the thermal conductivity of the nanoparticulate SiC, the Heat conduction is constantly increases.

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