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Studies on the density and surface area of nanoparticles from *Camellia sinensis*, A natural source

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ABSTRACT

Assessment of material properties of nanomaterial is as important as synthesis of such compounds. We report here the material characterisation of nanomaterials synthesised from the leaves of Camellia sinensis by Tap density and Specific Surface area measurements. Our findings demonstrate that this material possesses excellent potential to act as heterogeneous catalyst.

Keywords: Nanomaterials, *Camellia sinensis* leaves, Tap density, Specific Surface area.

INTRODUCTION

Nanomaterials exhibits unusual properties compared to their bulk counterpart due to the large surface area to volume ratio in the nanoscale. Naturally, their material properties and applications largely depend on size, distribution and morphology of the nanomaterial, essentially allowing them to exhibit completely new or improved properties[1-3]. Nanomaterials find applications to address technological and environmental challenges including of solar energy conversion, catalysis, medicine, and water treatment [4-7].

Actual application(s) of a new material can be properly ascertained, if the physical and material properties are unveiled. Keeping this in view and in our continued effort for the crux of advanced materials from natural sources, the present work documents the study of material properties of the nanomaterials obtained from biological sources.

EXPERIMENTAL SECTION

Synthesis of the Material

Synthesis and characterization by powder XRD of the nanomaterial has been recently reported by this group [8]. Briefly, 10 g of dry processed *Camellia sinensis* leaves were burnt in open air at 200^0 C. The white ash left after was taken out and analysed 'as obtained'. The yield was recorded (3.5 %). The material was characterised by powder XRD as reported earlier.

Characterisation of the material

The Tap density is measured by standard procedure. X-ray diffraction (XRD) study is carried out to identify the crystal structure. The Specific surface area (SSA) is calculated by using Sauter formula. The tap density of the material was recorded by the method recommended by WHO [9].

Measurements

Powder X-ray diffraction (XRD) measurements were carried out on a Bruker AXS D8-Advance powder X-ray diffractometer with Cu-Kα radiation (λ=1.54056 Å) with a scan speed 2^O/min.

RESULTS AND DISCUSSION

The synthesized materials were white and found to be stable in air for months. The yields of the synthesized nanomaterials were recorded to be in the range of 3.5%.

Measurement of Tap Density

The tapped density is obtained by mechanically tapping the synthesized material in a graduated vessel. The initial powder volume or mass is taken and then the vessel is mechanically tapped, and volume or mass readings are taken until no further volume or mass change is observed. The mechanical tapping is achieved by raising the cylinder or vessel and allowing it to drop, under its own mass.

The tap density of the synthesised material is found to be 0.229 g/cm^3

X-Ray diffraction studies

The X-ray diffraction pattern of the synthesized nanoparticles from processed *Camellia sinensis* leaves is shown in Fig.1.

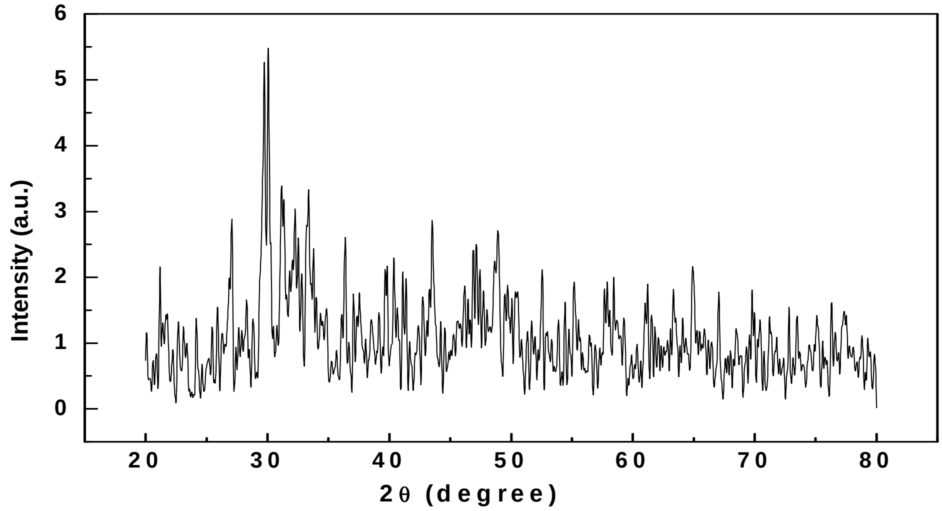

Figure 1. XRD pattern of nanoparticles from the *Camellia sinensis* leaves

Calculation of average crystallite size XRD pattern

The average crystallite size is calculated using Debye-Scherrer equation.

Debye-Scherrer's equation, $D = \frac{k\lambda}{\beta cos\theta}$

Where *D* is the crystallite size in nanometers, k is a constant known as Scherrer's constant. It is also known as the shape factor and its value is (0.89), λ is the wavelength of X-ray for this analysis (λ=1.54056 Å), β is full width at half maximum (FWHM) (in radian) of the particular peak and θ is the Bragg's angle. The average crystallite size calculated for the most prominent peak was found to be 8.46 nm.

Calculation of Specific Surface Area

Specific surface area (SSA) is a material property. It has a particular importance in case of adsorption, heterogeneous catalysis and reactions on surfaces. The Specific surface area (SSA) can be calculated by Sauter formula:

$$S = \frac{6000}{\rho \times D}$$

Where S is the specific surface area, D is the size of the particles and ρ is the density of the synthesised material [10]. The bulk density of a powder depends on how closely individual particles pack together. The tap density of the synthesised material is 0.229 g/cm^3 and the average crystallite size is 8.46 nm. Thus the calculated value of SSA of the synthesised material is 3097.02 m^2/g.The surface of the synthesized materials is found to be very large and hence the heterogeneous catalytic property of the material were tested and found positive response.

CONCLUSION

The paper documents the finding on some important material properties of nanomaterials obtained from *Camellia sinensis* Leaves. The tap density of the synthesised material is found to be 0.229 g/cm^3. Apart from fine average particle size, the specific surface area of the synthesized materials is found to be extremely large (3097.02 m^2/g) and hence it has high potential to function as excellent heterogeneous catalyst in suitable chemical transformations.

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