International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Synthesis and Characterization of Nanoparticles from Tea Leaves

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Abstract: ***The paper reports the synthesis of nanoparticles from tea leaves using a simple green and economical technique. The as obtained materials were characterised with XRD analysis and Optical Microscopy studies.***

Keywords: Tea leaves, Nanoparticles, XRD analysis

1. Introduction

Nanomaterials are very important because they have entirely different properties than their bulk counterpart. The change in properties is due to the large surface area to volume ratio in the nano scale [1-4]. As an example, carbon nanotubes are 100 times stronger than steel but six times lighter. Nano materials find wide applications starting from pharmacology to electronics. 1-10 nm particles are better in Tunneling effect, molecular recognition, catalysis, whereas, 0.1- 100nm particles are of interest in superconductivity studies. Nanomaterials may provide solutions to technological and environmental challenges including of solar energy conversion, catalysis, medicine, and water treatment [5-8]. Various chemical and physical methods have been used for the synthesis of silver and other metal nanoparticles [9, 10].

The present paper furnished synthesis of nanoparticles from dried processed tea leaves using a simple green and economical technique i.e., by roasting dried processed tea leaves in a Bunsen burner for 1½ hour. The as obtained materials were characterized with XRD analysis and Optical Microscopy studies.

2. Materials and Methods

2.1 Synthesis of the Material

Dried processed tea leaves were used as raw material for the synthesis. 10 g of dry processed tea leaves were finely crushed into powder and burnt in open air at 200^0 C using a Bunsen burner for one and half an hours. The carbon and other volatile oxidisable material volatilizes at that condition. The white ash left after was taken out and analysed 'as obtained'. The yield was recorded (3.5 %).

2.2 Characterisation of the Materials

X-ray diffraction (XRD) study is carried out to identify the crystal structure. The particle size of the nanomaterial is calculated by using Debye-Scherrer equation. Inter planar distance between the planes of the crystal lattice are calculated by using Bragg's equation. The morphology of the material was studied with optical microscopy.

2.3 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.

3. 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%.

3.1 Morphology Studies

The morphology of the synthesized materials was investigated through the optical microscopy studies. The optical microscopic images of materials obtained from roasting of processed tea leaves were presented in the Fig. 1(a), (b), (c) & (d). The images indicate the presence of spherical shaped particles.

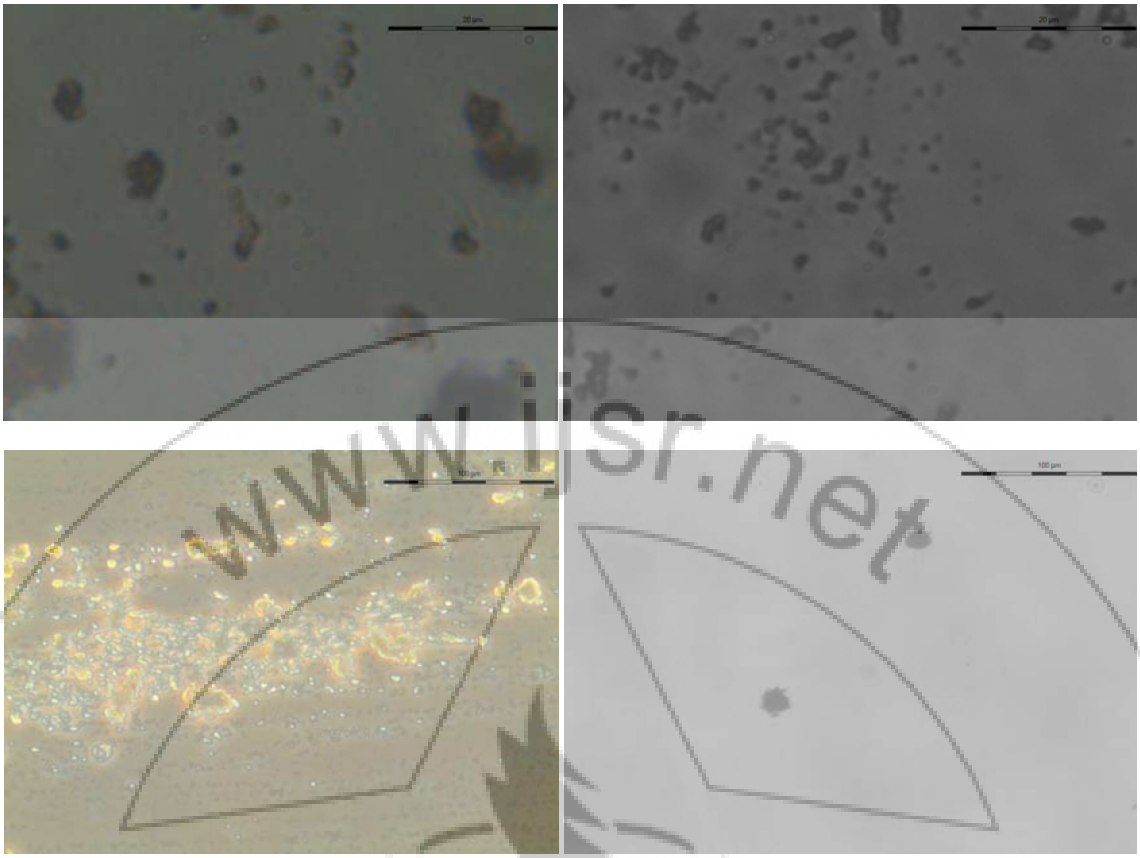

Figure 1:(a), (b), (c)& (d) Optical Microscopic images show the presence of particles of different dimensions.

3.2 X-Ray Diffraction Studies

The X-ray diffraction pattern of the synthesized nanoparticles from processed tea leaves is shown in Fig.2.

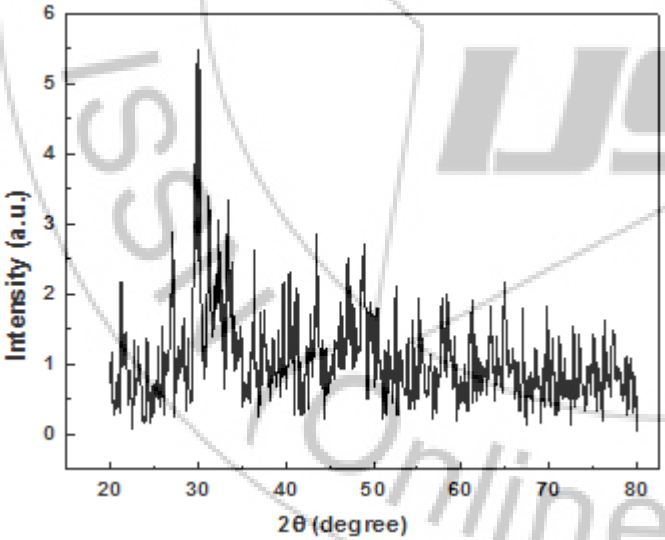

Figure 2: XRD pattern of nanoparticles from the roasted processed tea leaves

3.2.1 Calculation of lattice parameters and inter planar distance from XRD pattern:

The value of lattice parameters and inter planar spacing (d) is calculated using Bragg's Law,

$$2d\sin\theta = n\lambda$$

$$d = \frac{n\lambda}{2\sin\theta}$$

For 1st layer, $n = 1$

Therefore, $d = \frac{\lambda}{2\sin\theta}$

Where θ is the Bragg's angle, n is the no. of lattice plane, λ wavelength of X- ray used. The values are tabulated in Table 1.

Table1: XRD profile and Inter planar spacing(d) of the crystal lattice

2 θ of the Intense peak (in degree)	Inter planar spacing (d in nm)
21.05	0.421
29.87	0.298
46.94	0.193
64.78	0.143

3.2.2 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-rayfor 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 calculated values for each peak are tabulated in table 2.

Table 2: XRD profile and crystallite size (D) of the synthesized material

2 θ of the Intense peak (in degree)	FWHM (β) of Intense peak (in degree)	FWHM(β) of Intense peak (in radian)	Size of the Particle (D in nm)
29.87	0.9600	0.016755	**8.46**

The average crystallite size calculated for the most prominent peak was found to be 8.46 nm.

4. Conclusion

The nanomaterials have been conveniently synthesized by using cheap and eco-friendly precursor such as processed tea leaves at 200°C under normal laboratory conditions. The average particle size was found to be 8.46 nm and hence it has the potential to function as an extremely important heterogeneous catalyst in chemical reactions. This method can be scaled up and other plant source can be used for the synthesis of nanoparticles of desired dimension. Furthermore, this green synthetic strategy would a powerful tool for large scale synthesis of nanoparticles in a cost effective way.

5. Acknowledgements

The authors are grateful to SAIF, NEHU, Shillong, and S.S. College, Hailakandi for providing instrumental facilities.

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