Abstract

In view of intrinsic fundamental interests and manifold biological and technological application potentials of nanomaterial, the present research was undertaken to address synthesis, characterization and explore some properties of carbon nanomaterials and metal based nanomaterials.The emphasis of the research had been - utilization ofinexpensive and renewable plant based resources as precursors for accessing nanomaterial through convenient pathways. Simple pyrolysis,calcination, roasting and chemical vapour depositiontechnique were adopted which afforded carbon and metal based nanomaterials of various sizes and shapes. The content of entire thesis is distributedovereightchapters.Barring **Chapter 1,Chapter 2 and Chapter 8**, the **Chapter 3-7**, which discusses the work carried out in the present PhD program is a self-contained one with introduction, experimental, results and discussion, and references.

Chapter-1 of the thesis presents a general introduction to the field of nanomaterials. The chapter deals with the synthesis and properties of nanomaterials in relation to their size and shape. It also describes the need and importance of renewable plant based precursors for carbon nanomaterial (CNM) synthesis. A description of literature survey with regard to synthesis and applications of CNMs hasbeen provided with a view to provide a rationale of the proposed research.Theobjectives of the research laid in the backdrop of the introduction presented are clearly spelt out.

Each chapter from chapter 3-7 begins with a crispy note that in a nutshell describes the subject matter of the chapters.

Chapter-2 of the thesis entitled **Details of chemicals, materials and equipments**describes experimental methods, protocols, chemicals and materials, and details of the equipment used for chemical synthesis and physical measurements.

Chapter-3 of the thesis entitled **Synthesis of Multiwalled Carbon Nanotubes (MWCNT) and related carbon nanostructures**describes the synthesis of CNTs and CNWs from six plant based oils and animal fat. The catalyst free synthesis and catalytic synthesis by chemical vapour deposition at different temperatures were discussed. Spiraled carbon nanotubes and nanowhiskers from sesameoil, among

other things, are the highlight of the work reported in this chapter.Antioxidant activity and electrochemical behavior of some select material are also included herein.

Chapter-4 of the thesis entitled **Synthesis, antioxidant activity and electrochemical behavior of carbon nanomaterials from plant seeds**describes the carbon nanoparticles (CNPs) of various morphologies (nano spheres, nanocubes etc.) synthesised by pyrolysis in Chemical Vapour Deposition chamber from plant seeds available in North-Eastern Region of India. A total of eight plant seeds [Krishnachura or gulmohar *(Delonix regia),* Bean *(Phaseolus sp.),*Castor *(Ricinus communis),* Lai (*Brassica juncea*), Denga (*Amaranthus spinosus*), Chandan or Sandalwood (*Santalumsp*.), Kanchan (*Bauhinia acuminata*), Tishi (*Linum usitatissimun*)] and two seed coats [Castor *(Ricinus communis),*Mahogany (*Swietenia mehogoni*)] were used as precursors for the production of CNPs under catalyst free conditions. Antioxidant efficacy and electrochemical behaviour of a few select synthesised materials were monitored and results presented.

Chapter-5 of the thesis entitled **Synthesis of carbon nanoflakes and fibrous carbon nanostructures** deals withthe synthesis of carbon nanofibres and carbon nanoflakes by pyrolysis in a Chemical Vapour Deposition chamber from renewable precursors were discussed. A total of fourteen plant fibres [*Crassocephalum (Crassocephalum crepidioides),* Palmyraor taal *(Borassus flabellier*), Blady grass *(Imperata cylindrica),* Luffa or Purol *(Luffa cylindrica),* Pajanelia *(Pajanelia longifolia),* Daisy *(Tridax procumbens),*Eualia *(Eualia fastigiata),*Psyllium or Ishab gul (*Plantago* sp.), Papaya stem (*Carica papaya*), Honur (*Oroxylum indicum),* Paper flower (*Bougainvillea spectabilis),* Bontula (*Bombax insigne),* Thunga or Tak palong *(Spinacia oleracea*),Betel nut (*Areca catechu*)] were used as precursors for the production of CNFs under catalyst free conditions. Antioxidant efficacy, photocatalytic behaviour and electrochemical behaviour of a few select synthesised materials were studied.

Chapter-6 of the thesis entitled **Synthesis of carbon-silica nanocomposites from algae** describes the synthesis of carbon-silica nanocomposites from algal biomass by pyrolysis at relatively low temperature. A total of three algae (*Scytonema guyanense, Trentepohlia aurea, Spirogyra neglecta*) were used as renewable precursors for the

production of carbon-silica nanocomposites. Antioxidant efficacy of as synthesised materials was monitored using DPPH as free radical source.

Chapter-7 of the thesis entitled **Synthesis of metal based nanomaterials**describes the synthesis of metal based nanomaterials such as calcium sulphate and calcium carbonate by calcination and roasting of plant based precursors. A total of four plant based precursors (plant charcoal, waste bond paper, sissoo leaves, and krishnachura or gulmohar leaves) were used for the production of metal based nanoparticles. Antimicrobial efficacy, photocatalytic activity, electrochemical behaviour of the synthesised materials has alsobeen investigated.

Chapter-8includes a brief summary of the work embodied in the thesis. Collating the results of the work **chapters 3-7**, it can be concluded that different precursor materials derived from common plant material can be the ideal starting material for accessing carbon and other metal based nanomaterial. Variety of shapes and sizes of nanomaterial that were obtained during the course of the present research added a heuristic dimension to the synthesis. Properties such as antioxidant, electrochemical, antimicrobial and photocatalytic aspects of some of the synthesised material were noteworthy. The methodologies adopted to afford various nanomaterial as described in the respective chapters, however, need optimization and can be scaled up for mass scale production of such material.

References are cited chapter-wise in order of their appearance in the respective chapters.

List of research publications emanating from the research are appended at the end alongwith the copies of published/accepted papers. A total of four number of research papers have been published in peer reviewed journals. Some other papers are under communication.

Details of Conference/Seminar attendance wherein parts of this research work were presented are also incorporated.