Research Proposal

Bio- route mediated synthesis of silver nanoparticles- preparation, characterization, and applications to sustainable energy production

1. Introduction

In my research, I will study applications and characterization of silver nanoparticles. In order to achieve this objective, I will prepare the desired metal nanoparticles using leaf extracts which will be in turn having surface functional groups and it also will provides a renewable source of energy by integrating nanotechnology thus leading to sustainable development. I will also use electrochemical methods, such as UV Spectroscopy, SEM, TEM, FTIR, XRD , EDAX to evaluate their morphology, size, functional groups, atomic and molecular structure etc and to understand stability of nanofluid which leads to energy production

2. Background

Water being an essential part in human life, the amount of wastewater generated from different sectors has been rapidly increased. The wastewater has been directly exposed to environment. Even though the wastewater is being treated before its release it is still being capable of introducing hazards to environment. Thus intelligent use of wastewater has become mandatory. Rather than recycling wastewater it can be used as a source of energy. Integration of nanoparticle and its technology into wastewater treatment and energy production found to be an efficient method. Wastewater serves to act as a renewable source of energy and converting waste into energy brings out an efficient method of waste management

Nanomaterials may provide solutions to technological and environmental challenges in the areas of solar energy conversion, catalysis, medicine, and water treatment .Nanomaterials often show unique and considerably changed physical, chemical and biological properties compared to their macro-scaled counterparts .The noble metals, especially silver and gold, have attracted great attention due to their innumerable applications in various branches of science, namely catalysis, photonics, photography, chemical sensing, Surface Enhanced Raman Scattering (SERS), and most importantly, in the medicinal field as anti-microbial agents Colloidal silver is of particular interest because of its distinctive properties, such as good conductivity, chemical stability, catalytic and antibacterial activity. Silver nanoparticles have many important applications that include spectrally selective coating for solar energy absorption and intercalation material for electrical batteries, as optical receptors, polarizing filters, catalysts in chemical reaction, bio-labelling, and as antimicrobial agents. There has been an extraordinary

growth in nanoscience and technology in recent years, mainly due to both the development of new techniques to synthesize nanomaterials and the accessibility of tools for the classification and manipulation of nanoparticles. Production of nanoparticles requires understanding the

fundamentals of nanoscale chemistry and physics, as well as the know-how to commercialize them. Broadly speaking, there are two approaches to nanoparticle production: top-down and bottom-up. The former makes a material decrease its size from large to nanoscale, whereas the latter produces nanomaterials by starting from the atomic level(Tavakoli *et.al*). Generally, metal nanoparticles can be prepared and stabilized by chemical, physical and biological methods; the chemical approach, such as chemical reduction, electrochemical techniques, photochemical reduction and pyrolysis and physical methods, such as Arc-discharge and physical vapor condensation (pvc) is used. Living organisms have huge potential for the production of nanoparticles/nanodevices of wide applications.

Nanofluids

Nanofluids are a new class of fluids engineered by adding nanoscale particles in low volumetric fractions to a base fluid inorder to enhance or improve their mechanical, optical and thermal properties. The base fluid can be any liquid such as water, oil , ethylene glycol or conventional fluid mixtures. Important feature of using nanofluid include : (i) Enhancement in thermal conductivity far beyond the level any theory could predict (ii).Strong temperature dependence

3. Preliminary Results

The first part of my proposed research is to prepare biological production of nanosilver

To prepare biological synthesis of silver nanoparticles, I used leaf extracts. Our group has previously shown that silver nanoparticles can be prepared from plant extracts.

My first objective, therefore, was to optimise the synthesised leaf extracts, and that the resulting stable nanofluid which possess antimicrobial activity and further turning the nanofluid to act as renewable energy source.

Biosynthesis of nanosilver and optimisation of synthesis conditions

The preparation of silver nanoparticles is carried out in two steps: First, preparation of plant extracts are carried out and secondly preparation of silver nitrate solution. This warm extract solution changed colour again after adding $AgNO_3$ solution. Color changes are possible because some of the Ag ions begin to be reduced due to the effects of heat and produces Ag^+ complex. This complex was responsible for changing color from brownish yellow to

grayish brown. The Ag nanoparticles synthesized in each extract solution was analysed using UV-Vis spectroscopy. This was done to determine the characteristics of the peak spectrum of the Ag nanoparticle wavelength prepared for each different $AgNO_3$ concentrations. The characteristics of Ag nanoparticles normally appear at a wavelength interval of 400–600 nm [26]. UV-Vis spectra of Ag nanoparticles synthesized evince the blue shift of the absorption band with increasing $AgNO_3$ concentration. This information shows that the Ag nanoparticles have formed in the extract, where the Ag^+ has been reduced to Ag^0.

Characterization of Ag Nanoparticles. Reduction of pure Ag+ ions was monitored by measuring the UV-Vis spectrum of the reaction medium after diluting a small aliquot of the sample into distilled water. +ve colour change in the reaction mixture was recorded through visual observation. UV-Vis spectral analysis was done by using UV-Vis spectrophotometer UV-1800 (Shimadzu) at the wavelength of 200– 800 nm. JEOL JEM-1400 Transmission Electron Microscope (TEM), operating at 120 V and an acceleration voltage of 15 kV, was used to analyze the morphology and size of Ag nanoparticles. For TEM measurements, extract samples containing Ag nanoparticles were dispersed on a copper grid and dried at room temperature. Nanoparticles are quite poly-dispersed and a layer of the organic material surrounding the synthesized Ag nanoparticles could explain the good dispersion of these nanoparticles in solution. Generally, the Ag nanoparticles synthesized using aqueous extracts are well dispersed although some of them were noted to be agglomerated. Notably, the majority of the particles in the TEM images are not in physical contact with each other but appeared separated by the organic layer. Therefore, TEM images clearly indicate the coating of Ag nanoparticles with an organic layer. +e presence of several polyphenolic components including flavonoids and terpenoids facilitated the reduction of Ag ions and also stabilized the surface of the resultant Ag nanoparticles. +ve Ag ions quantity influenced the size of the particles. When AgNO3 concentration is increased, an obvious change in the size distribution of nanospheres was observed

4. Proposed Research

My preliminary results show that metal nanoparticles can be prepared by plant extracts . Here, I propose my future research based on the above preliminary results.

Biological production of nanosilver

The fresh leaves of plants needs to be collected and washed with deionized water to remove dust and foreign articles. Proper drying and deionisation needs to be carried out and extract was taken and heating is provided at various temperatures for 15 minutes. After the boiling,

sample needs to be diluted in various proportions to check the optimised conditions optimizing its synthesis conditions. I will perform the characterisation techniques such as SEM, TEM, FTIR, XRD, EDAX etc and find the shape, size, functional groups, atomic and molecular structures.

Biological synthesis of stable nanofluid can be estimated by colour change , spectral analysis and study of antimicrobial activity of nano fluid and stability analysis of nanofluid can be further studied

Wastewater treatment and energy production

Wastewater generated can be converted to nanofluid in industries and thus can be integrated into solar energy generation systems which opens up into sustainable development. Hence the work offers the reuse of wastewater generated in society as a energy source to meet the power requirements

5. Summary and Conclusions

I propose the study of eco synthesis of silver nanoparticles aqueous extracts of plants can be used as bio reduction agents to produce Ag nanoparticles. The formation of Ag nanoparticles in the extract will be observed by the colour change. Color changes may indicate that occur indicate that Ag particles have formed. The particle size of synthesized Silver nanoparticles studied. Their characterizations can be done using XRD, SEM, EDAX and FTIR spectroscopic techniques. Investigation on the antimicrobial effect of nanosized silver against various microbes may reveals high efficacy of silver nanoparticles as a strong antibacterial agent and can be used in wastewater treatment. The work introduces a simple, fast, and economical biological method to synthesize silver nanofluid with wastewater as the base fluid. This method provides a clean, nontoxic and eco-friendly and efficient route for the synthesis of nanosilver with tuneable particle size, at room temperature conditions. The nanofluid produce is of stable nature and from recent studies integration of nanofluid with solar thermal plants can increase an efficiency of 10% and gives a much larger power input. Thus the wastewater generated can be converted to nanofluid in industries and thus can be integrated into solar energy generation systems which opens up into sustainable development. Hence the This study will allow us to offers the reuse of wastewater generated in society as a energy source to meet the power requirements.