Project report on the

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Abstract:

Title: Biocompatible nano-materials synthesis, characterisations and their applications

The major setback in the biological application of nanomaterials is their bio-compatibility. The quests of nano sized materials with such property have always been a challenge. In this report, synthesis and characterizations of such nanomaterials have been discussed. Also, green synthesis of gold nanoparticles (Au-NPs) by using a simple, faster, low-cost and eco-friendly technique have been carried out following the reported method. The biological application of the synthesised nanomaterials is still underway. We foresee to establish their applications in several biomedical applications, such as vehicle for targeted and controlled drug delivery, gene therapy, MRI contrast agents etc.

Keywords: bio-compatibility, drug-delivery, gene therapy, contrasting agents.

EXPERIMENT: 1

SYNTHESIS OF MAGNETIC NANOPARTICLES BY COPRECIPITATION METHOD

- Simplest and the most effective chemical pathway to obtain magnetic nanoparticles.
- Iron Oxide Nanoparticles (Fe_3O_4) are usually prepared by an aging stoichiometric mixture of ferrous and ferric salts in aqueous medium.
- The chemical reaction of Fe_3O_4 formation is:
  $FeCl_2$ (aq)+2 $FeCl_3$ (aq)+8MOH (aq) → Fe_3O_4 (s) + 8 MCl (aq) + 4 H_2O (liq)
  (where, M = Na^+, NH_4^+)
- The method consists of mixing ferric and ferrous ions in a 2:1 molar ratio in highly basic solutions at room temperature or at an elevated temperature.
- In order to avoid possible oxidation in air, this synthesis was carried out in anaerobic conditions (N_2 environment). The black precipitate was obtained as the final product.

Characterization:

The characterisation of magnetite was performed by field Emission Scanning Electron Microscopy (FESEM), X-Ray Diffraction (XRD) and Fourier-Transform Infra-Red (FTIR) spectroscopy.

- The average diameter of the nanoparticles came out to be 18 nm from FESEM.
- FTIR spectra indicated absorption peaks at 675.30 cm-1 corresponding to the Fe-O vibration related to magnetite phase.
- The positons and relative intensities of the reflected peak of Fe_3O_4 MNPs agree with the XRD peaks of standard Fe3O4 samples, indicating that the black-colored magnetic powder are magnetite nanoparticles.

EXPERIMENT: 2

SYNTHESIS OF GOLD NANOPARTICLES BY CITRATE REDUCTION METHOD

- The entire process carried out for the synthesis of Gold nanoparticles is divided into 2 parts:

    i) Preparation of Gold seeds.

    ii) Synthesis of Urchin like Gold Nanoparticles (Au NPs).

- There is a stepwise reduction of Au(III) to Au(I) by citrate (Step i) and then Au(I) to Au(0) by hydroquinone (Step ii).
- The growth of urchin like NPs was performed in water but at room temperature. Citrate also acted as the ligand , and both citrate and hydroquinone acted as reductants. Because of the weak reducibility of sodium citrate at room temperature , it could only reduce Au(III) to Au(I) rather than Au(0) as that at elevated temperatures. Meanwhile , Hydroquinone had a high selectivity in reducing Au(I) to Au(0) on the gold seed surface.
- The effect of Hydroquinone amount was studied by altering the amount of hydroquinone from 200 , 500 , 1000 to 2000 microliters. The growth duration of all samples was 30 minutes.

Characterization:

- The resultant gold nanoparticles were characterized by UV-visible absorption spectra , Dynamic Light Scattering (DLS) Study and Zeta Potential Distribution.

EXPERIMENT: 3

SYNTHESIS OF GOLD NANOPARTICLES USING GREEN TEA EXTRACTS

- This experiment involved the green synthesis of Gold Nanoparticles (Au-NPs) by using a simple, faster , low-cost and eco-friendly technique.
- The Green Synthesis of Au NPs was done by using fresh young leaves and leaf buds of tea (*Camellia sinensis*).
- Reduction of HAuCl4 by polyphenols present in young leaves and leaf buds of tea extract at elevated temperature (100 – 120°C) provides Au NPs [Au (III) → Au(0)].
- *Camellia sinensis* , commonly known as Green Tea , is the species of plant whose leaves and leaf buds are used for the production of Chinese Tea.
- The different Polyphenols present in Green Tea are Epicatechin , Epigallocatechin (EGC) , Gallic Acid , Epigallocatechin gallate (EGCG) etc.

Characterization:

The synthesized Au NPs were characterized by UV-visible absorption spectra, DLS study, Zeta potential distribution and powder XRD.

EXPERIMENT: 4

SYNTHESIS OF OLEYLAMINE COATED MAGNETITE NANOPARTICLES BY SOLVOTHERMAL METHOD

- Oleylamine coated Fe_3O_4 nanoparticles were prepared following a published procedure with some modifications , the reactants used were $Fe(acac)_3$, 1-octadecene and oleylamine . The reaction was carried out under inert N_2 atmosphere and vacuum conditions.
- The reaction was carried out in a heating mantle at 300 °C with heating rate of 20°C/min.
- The reaction was continued for 1 hour at this temperature and then it was cooled to room temperature. The Fe_3O_4 nanoparticles were washed with ethanol , followed by centrifugation and dispersed in chloroform at room temperature.
- The synthesized oleylamine coated Fe_3O_4 NPs can be used for several biomedical applications.

Characterization:

- Oleylamine coated Fe_3O_4 nanoparticles were characterized by FTIR and XRD.

EXPERIMENT: 5

SYNTHESIS OF MAGNETOLIPOSOMES BY THIN FILM HYDRATION TECHNIQUE

- Magneto-liposomes (MLs), i.e. magnetic nanoparticles coated in a lipid bilayer , provides a highly flexible system for biocompatibility , chemical functionality and drug delivery resulting in a synergistic treatment strategy.
- The objective of the present work is to synthesise and characterize magneto-liposomes, in which a stable aqueous ferro-fluid with magnetic nanoparticles covered with a surfactant was incorporated into liposomes.
- The reagent tested as surfactant was Soy lecithin (Soybean lecithin).
- The incorporation of these particles and synthesis of what are called magneto liposomes was carried out by thin film hydration technique using rotary evaporator.

Characterization:

The magneto-liposomes samples characterisation is still underway and shall be established by TEM, DLS, and FTIR spectroscopy.

FUTURE PLANS (For the next academic session):

1. Development of magnetic organogels as matrices for controlled drug delivery.

2. Study of biomedical applications of magnetic nanoparticles such as targeted drug delivery , gene therapy, MRI contrast agents etc.

3. Synthesis of Gold NPs using reducing agents such as $CrCl_2$

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