Available online at www.sciencedirect.com

ScienceDirect

St. Petersburg Polytechnical University Journal: Physics and Mathematics 3 (2017) 333–338

www.elsevier.com/locate/spjpm

Experimental analysis and optimization of synthesized magnetic nanoparticles coated with PMAMPC-MNPs for bioengineering application

Adeyinka O.M. Adeoye, Joseph F. Kayode, Bankole I. Oladapo*, Samuel O. Afolabi

Department of Mechanical and Mechatronics Engineering, Afe Babalola University, Ado-Ekiti, Nigeria

Available online 3 November 2017

Abstract

Biomedical and biotechnological engineering applications of magnetic nanoparticles (MNPs) for sensors are found to be of great importance. MNPs have attracted a growing interest in the design and development of sensors and biosensors for other several fields of applications. This research dealt with a novel optimization of MNPs of precipitation method of Fe^{3+} in basic solution. Also, for a surface coat with a random poly [(methacrylic acid)-ran-(2-methacryloyloxyethyl phosphorylcholine)] (PMAMPC-MNPs) by the means of chelating carboxylic group in its structure. We proposed MNPs to be incorporated into the transducer materials used for (bio)sensor and be dispersed in the sample. These caused an attraction by an external magnetic field onto the active detection surface of the (bio)sensor. RPM AMD PC and iron atoms were used to find the optimum conditions needed to coat the surfaces of the sensor such as particle concentrations. Particle technique FT-IR and TEM techniques showed that the synthesized PMAMPC-MNPs were spherical in shape in the range of 10–60 nm coated with a polymer capable of enhancing dispersion and good stability. In addition, particles coated with polymers of this property remain stable as the catalysts in reactions allowed the colour changes. This would be able to enhance sensitivity and stability of sensors and biosensors. This can be applied to the PMAMPC-MNPs for biosensors measurement application.

Keywords: Magnetic nanoparticles; (Bio)sensor; TEM; Biomedical engineering; PMAMPC-MNPs.

Introduction

The nanoscale particles of iron oxide MNPs are particles that display magnetic properties. Magnets have the ability to respond to external magnetic fields faster. This has been an added advantage in many fields where it was applied, especially in the medical field, it has been so useful. Magnetic nanoparticles were applied in equipment delivery, controlled manufacturing of drugs and biomolecular techniques using known principles. This involved immunoglobulin and immunomagnetic separation (IMS) which works on the principle of using molecules as baits and also order measurement probes which immobilize particles [1–3]. In separating of biomolecules from samples, mixtures of biomolecules were observed to stick together and separated from the solution by providing a magnetic field using nano-sized particles. Iron oxide catalyst of high surface area to volume

* Corresponding author.
E-mail address: bioladapo@abuad.edu.ng (B.I. Oladapo).

https://doi.org/10.1016/j.spjpm.2017.10.003

ratio was used. A proposition by [3,4] postulated that nanoparticles of magnesium tight (Fe_3O_4) were better catalyst and changes the colour of the hydrogen peroxide substrate H_2O_2. The enzyme peroxidase horseradish peroxidase (HRP) caused changes in the colour of the hydrogen peroxide substrate to which it was applied. Biological sensors (biosensors) that can monitor the measurement of the analyte by easily tracking colour changes of the substrate [4–7] which is appropriate for magnetic nanoparticles' applications. Magnetic nanoparticles can be modified to be suitable for surface coating with small molecules or polymers, but recent research found that magnetic properties and catalytic properties to change the substrate colour were most useful characteristics of magnetic nanoparticles. Magnetic nanoparticles also can be coated with the subsequent changes in species such as polyethylene glycol (PEG) and silicon dioxide (SiO_2), these features were valuable and magnetic property can be reduced by an increase in the density and thickness of the enamel coating on the magnetic nanoparticle [6,7]. In addition, the development of magnetic nanoparticles for the detection of the specific target molecule is another important factor that affects the performance (efficiency), the specificity and the sensitivity of the sensor. A popular approach is predetermined to be used in the polymer thin film coating on the nanoparticles. Magnets were used in the fixation of biomolecules with the functional molecules for detection, called probes. The advantages of using polymers enable the design of the structure of the polymer to a particular functional group that is chemically stable. Organic molecules [8–10] attributed to the polymer have the volume and density of the functional groups in high doses. These made probe fixing or the number of moles of the probes on the area (mole of probes per unit area) in high doses possible as well as good measurement performance of the sensor (efficiency). The polymer was designed to have specific functional groups that can reduce the attraction between the probe and other substances different from the desired substance. Detection sensors can also help with the analysis of specific increase due to the use of a random copolymer of poly metallic acrylic acid and polymer. The design of the components of the polymer assumes the responsibility of fixing probes of PMA unit. The polymer truly helps to enhance the properties of biological compatibility (biocompatibility) and lower clamping is not the specific among phospholipid choline Enrile's PMPC unit. The study found PMAMPC can help optimize measurement performance both in terms of increasing the concentration in the latest developments of detecting (detection limit; LODs) target molecule and the ability to block the absorption without the specific [9–11]. The researchers therefore observed that the performance of PMAMPC copolymer can be used to improve the surface MNPs to be appropriate for the PM. The application is a sensor that can detect biological target molecule with the specific measurements and can be observed with the naked eye. The aim is to study the surface modification with a coating of MNPs with PMAMPC through the gelatin carboxylic group that is in the structure of PMAMPC. Atoms of iron were used to find the optimum conditions for the coating [10–12]. The main objective of this research is to propose a novel optimization of MNPs by precipitation method of Fe^{3+} in basic solution. To have a surface coat with a random poly[(methacrylic acid)-ran-(2-methacryloyloxyethyl phosphorylcholine)] (PMAMPC-MNPs) by the means of chelating carboxylic group in its structure. This help to integrate MNPs into the transducer materials use for (bio)sensor and be dispersed in the sample. These caused an attraction by an external magnetic field into the active detection surface of the (bio)sensor. RPM AMD PC and iron atoms were used to find the optimum conditions needed for coating surfaces of the sensor such as particle concentrations. Particle technique FT-IR and TEM techniques showed that the synthesized PMAMPC-MNPs were spherical in shape coated with a polymer capable of enhancing dispersion and good stability. This particle was analysed by Fourier transformed infrared spectroscopy (FT-IR) and transmission electron microscopy (TEM) to check the stability and the colour change of the substrate particles coated with the PMAMPC. These factors can prove the success of the coating of PMAMPC surface.

Material and methods

A PMAMPC synthetic polymer with a reactive process was available through a radical reaction mechanism. That is reversible; the addition fragmentation chain transfer (RAFT) of MA monomer and MPC (the ratio of the light alumni, 50:50) with 4-cyanopentanoic acid thiobenzoate (CPD) and 4,4′-azobis (4-cyanovaleric acid) (ACVA) as a chain transfer agent in (CTA) and radical initiator respectively. Weighing $FeCl_3 \cdot 6H_2O$ 8.00 g and $FeCl_2 \cdot 4H_2O$ 3.60 g ratio of 2:1 by melted water poured into 150 mL of distilled water filled to bottleneck and then connected to a condenser and agitation speed is 750 rpm. This