WATER-DISPERSIBLE MAGNETITE NANOPARTICLES OBTAINED BY CO-PRECIPITATION AND THERMAL DECOMPOSITION METHODS.

Khadijat. O. Abdulwahab,[1†] Mohammad A. Malik[1] & Paul O'Brien[1,2]
[1] School of Chemistry, University of Manchester, Oxford Road, Manchester, M13 9PL, UK.
[2] School of Materials, University of Manchester, Grosvenor Street, Manchester, M1 7HS, UK.
[†]Department of Chemistry, University of Lagos, Lagos state Nigeria.
khidother@yahoo.co.uk

ABSTRACT
Water-dispersible magnetite (Fe_3O_4) nanoparticles were synthesised by the co-precipitation of iron salts (dual-source) and the hot injection thermolysis of iron pivalate complex (single source). The iron pivalate complex was thermolysed in a mixture of polyvinylpyrrolidone (PVP) as capping agent and triethylene glycol (TREG) as solvent at the boiling point of the solvent (285 °C). The co-precipitation method involved precipitating iron(II) and iron(III) salts with ammonium hydroxide at room temperature. This was then followed by the addition of polyallylamine hydrochloride (PAH).
The p-XRD patterns obtained for the nanoparticles revealed that magnetite was synthesised by both methods. TEM showed that the magnetite nanoparticles obtained from the thermal decomposition method are more monodispersed (4.1 ± 0.3 nm) than those obtained from co-precipitation method (7.0 ± 1.0 nm).
The nanoparticles were characterised by powder X-ray diffraction (p-XRD), transmission electron microscopy (TEM), high resolution transmission electron microscopy (HRTEM) and selected area electron diffraction (SAED).

Keywords: *Magnetite, Nanoparticles, Colloidal, water dispersible, Co-precipitation, Monodisperse.*

INTRODUCTION

Magnetite nanoparticles have attracted a lot of attention recently due to their unique magnetic properties. Magnetite has an inverse spinel structure in which the divalent cations occupy the octahedral site while the trivalent cations occupy both tetrahedral and octahedral sites.[1] Studies have shown that magnetite nanoparticles with diameters in the range of 5-20 nm are usually superparamagnetic.[2,3] This in turn has led to a wide range of applications including drug delivery,[4,5] magnetic resonance imaging (MRI),[4,6–8] hyperthermia treatment,[7,9] data storage,[10] ferrofluids,[11] environmental remediation[12,13] and catalysis.[14,15] Magnetite nanoparticles are well suited for biomedical applications because they have high saturation magnetisation values and can be functionalised with appropriate molecules for tagging biological specimens.[16,17] In addition, the phenomenon of superparamagnetism makes it possible for controlling the movement of these nanoparticles to specific targets when placed under an external magnetic field. More often, such applications require the magnetite nanoparticles to be monodisperse. As such, various synthetic and functionalisation methods have been employed to synthesise magnetite nanoparticles suitable for such applications. The co-precipitation method is commonly used for the synthesis of magnetite and other ferrite nanoparticles because it is easy to use and scalable.[12,13,18–32] However, nanoparticles obtained from this method tend to have a broad size distribution and poor crystallinity, hence, other non-hydrolytic methods have been employed to synthesise these nanoparticles.[33–35]

The biological methods have been used to synthesise water soluble iron oxide nanoparticles.[36–46] A major challenge with this route is that the success of getting monodisperse nanoparticles depends on environmental parameters such as temperature, redox potential and pH which are often difficult to control.[1]