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Research Article

Comparison of ER70S-2 with ER309L in Synthesis of Magnetic Nanoparticles using Arc-Discharge Method

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Abstract

Iron-oxide based Magnetic nanoparticles were synthesized using Arc-discharge method in which ER70S-2 and ER309L weld wires were used as electrodes. In this experiment KCl salt is used as electrolyte due of its easy availability. While comparing KCl with any other salt, it is found that its reaction rate is high due to which good quantity of nanoparticles can be produced in very less time. Since the most widely used natural element on earth is iron, therefore it finds many applications in biomedical and in many other research areas when these particles are in nano form. Many experiments were carried out using ER70S-2 and ER309L weld wires as electrodes. The obtained size and chemical composition of the nanoparticles will be discussed briefly using XRD and EDAX characterization techniques.

Keywords*: Magnetic nanoparticles, Characterization, Salts, XRD, EDAX.*

1. Introduction

Materials at nanoscale, commonly known as “nano materials” or “nanoparticles” have always grabbed the attention of researchers. Among these different types of nanoparticles, magnetic nanoparticles have been the considered the most attention during the last two decades as evidenced by an unprecedented increase in the number of research papers focus on these particles. Iron oxide magnetic nanoparticles plays a major role in many phenomena’s like it is used in memory storing devices, loudspeakers and also in many electronic applications (Yan wei et al, 2012). Magnetic nanoparticles have many applications in biomedicine and bio-science and now this is a research field that attracts much attention by everyone. The nanoparticles used for biomedical applications, their surfaces are usually functionalized such that they bind to specific biomolecules.For example, in cancer treatment a local heating on tumor cells (Rodrigo et al, 2006) can be achieved by inserting magnetic material and exposing it to AC magnetic fields. By this surgery can be avoided. Another application of these magnetic nanoparticles in biomedicine is magnetic drug delivery, which is used to improve chemotherapy. In chemotherapy treatments (N.V.Tarasenko et al, 2012), the drug is distributed all over the body such that healthy tissue is directly exposed to side effects.

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The idea of magnetically targeted therapy is that the drug is attached to nanoparticles in a biocompatible ferrofluid, which is injected into the patient body. External high-gradient magnetic fields may then be used to concentrate the drugs at a target in the body. By this many side effects on healthy tissue may be reduced and the dosage in a tumor may be optimized. Magnetic resonance imaging (MRI) is a technique for imaging human internal organs without the use of ionizing radiation, and it has become essential for diagnostics. For example, MRI (Hisato et al, 2014) is indispensable for examination of the brain and spinal cord and it has also resulted in improved diagnosis and treatment of cancer. The technique monitors the decay of the magnetization of nuclei (typically protons of water molecules) in a strong magnetic field after they are excited by a series of radio-frequency magnetic pulses (Jimmy et al, 2017). The rate by which the signal decays depends on the density of the nuclei as well as on the local magnetic field. Variations in water contents between organs provide contrast in MRI images. This is utilized, for example, for the diagnostics of neural or brain diseases as these typically result in changes in the water content of the diseased area.

In this paper, we tried to highlight the major advantages and applications of magnetic nanoparticles in our daily life. There are many procedures like precipitation, co-precipitation (Teguh et al, 2016), Sol-gel, thermal decomposition, Arc-discharge method(Shaik et al, 2020), laser pyrolysis, carbon arc, hydrothermal synthesis and micro emulsion synthesis(Kashif et al, 2013). Out of these methods we always try to use the best method by which the good quantity and quality of particles can be obtained economically (Hasan et al, 2018) and eco-friendly. Magnetic nanoparticles use for biological applications is partially limited due to their potential toxicity, agglomeration and their chemical instability. Hence, the metal used for the synthesis of these nanoparticles is easily oxidized. Synthesis of these types of nanoparticles is relatively difficult, but these particles have advantageous magnetic properties. The protection of these nanoparticles against corrosion is only a difficult task for a researcher. To overcome this problem many scientists are putting their efforts all over the world.

Experimental Details

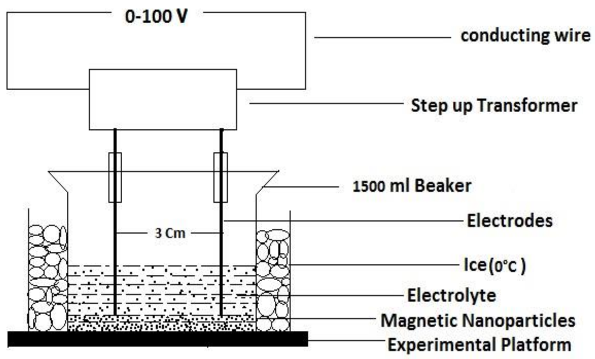

Figure 1: Experimental Set-Up

The magnetic Fe3O4, nanoparticles were synthesized using ER70S-2 and ER309L weld wires as electrodes in arc-discharge method (Prasad et al, 2015) as shown in fig 1. In this experiment we use a transformer of 2KVA and a variac of 20Amps to regulate the current supply.KCL salt along with water is poured into the 1000ml beaker and then we carry out different experiments using ER70S-2 and ER309L as electrodes. When we compare the size of nanoparticles obtained using ER70S-2 and ER309L weld wires using Debye-scherrer formula, both sizes matches nearly and the size is less than 50nm.There is no difference in size but the major differences is in the properties of the magnetic nanoparticles obtained. The elemental composition and size of these magnetic nanoparticles were known using XRD and EDAX techniques. The crystal structure study of the magnetic nano-crystallites was carried out by XRD technique.

Results

XRD results of Magnetic Nanoparticles using ER70S-2 and ER309L electrodes in KCl electrolyte

The above mentioned figures (2&3) represent the XRD patterns (Mahdi et al, 2015) of ER-70S2 and ER309L using KCl electrolytes.

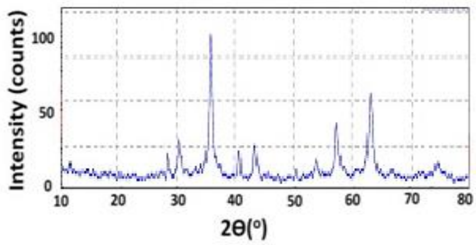

Fig.2 XRD results of ER70S-2 using KCl electrolyte

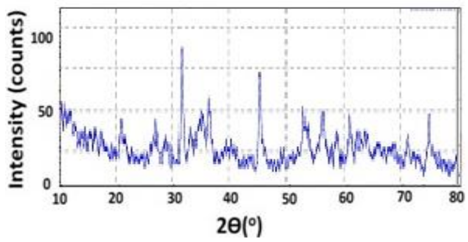

Fig.3 XRD results of ER309L using KCl electrolyte

We can notice that there are many strong peaks obtained in both the results obtained which represents that the rays passing from the material recognized the properties of the material. In ER-70S2 sample the 2θ values obtained are 28°, 30.16°, 35.53°,40.5°, 43°, 57.0° and 62.71° respectively . In ER309L sample results the 2θ values obtained are 21°, 27.6°, 32.3°, 37.8°, 44.11° and 53.71° respectively. In ER309L sample very less peaks represents the iron oxide composition which indicates the week formation of magnetic nanoparticles. The size of the magnetic nanoparticles is less than 30nm in both the samples.

EDAX results of Magnetic Nanoparticles using ER70S-2 and ER309L electrodes in KCl electrolyte.

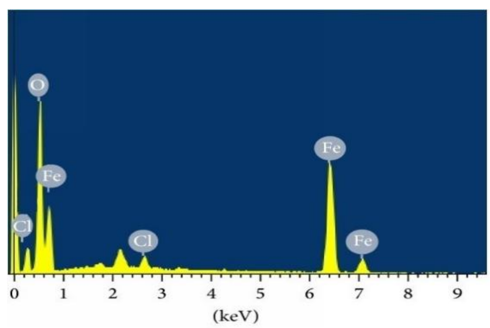

Fig.4 EDAX result of ER70S-2 using KCl electrolyte

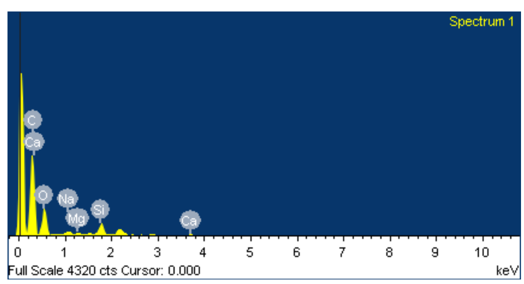

Fig.5 EDAX result of ER70S-2 using KCl electrolyte

The above mentioned figures 4 & 5 indicates the results obtained using EDAX analysis. The presence of Fe in fig.4 clearly indicates that the obtained nanoparticles are magnetic and in Fig 5 we can notice that there are no such peaks.it means the composition obtained using ER309L misses the iron oxide particles .hence by this results we can conclude that ER70S-2 gives a clear composition of magnetic nanoparticles when compared with ER309L (Luke et al, 2016).

Conclusion

After carrying out different experiments using the electrodes separately we came to a conclusion that the ER70S-2 weld wire can produce magnetic nanoparticles with high magnetization and also the chemical composition of the nanopowder obtained is perfect when compared with ER309L weld wire produced nanopowder. We use a constant voltage of 70V using KCl as electrolyte. The particles obtained using ER70S-2 were easily attracted by a magnet, but the particles of ER309L don't have much magnetization when compared. Also the Xrd peaks of both the samples were compared and it confirms that the chemical composition of ER70S-2 matches with the actual peaks of magnetic nanoparticles when compared with ER309L. The EDAX results also confirm that ER70S-2 contains all the elements which are to be present in a magnetic nanoparticles composition. When we compare the size of nanoparticles obtained using ER70S-2 and ER309L weld wires using Debye-scherrer formula, both sizes matches nearly and are less than 30nm. So by this we can easily conclude that to obtain magnetic nanoparticles with high magnetic properties ER70S-2 is preferable when compared with ER309L.

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