© 2017 IJSRSET | Volume 3 | Issue 2 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

Preparation and Study of Magnetic Nanoparticles (Fe_2O_3 and Fe_3O_4) by Arc-Discharge Technique

Shaik Gulam Abul Hasan[1], MD. Aftabuddin Rasool[2]

*[1]Assistant Professor, Department of Mechanical Engineering, Vidya Jyothi Institute of Technology, Hyderabad, Telangana, India

[2]Department of Mechanical Engineering, Vidya Jyothi Institute of Technology, Hyderabad, Telangana, India

ABSTRACT

Magnetite Fe_2O_3 ultrafine powder was synthesised using novel arc discharge method. Which is a magnetic material with spinal structure. During the experiment the size and shape were influenced by the voltage between two metallic iron filaments.Based on the thermodynamic and kinetic theory, metal Nano powders by anodic arc discharging arc method can be obtained and the mechanism of the particles can be further investigated. In addition, the morphology, crystal structure and particle size and specific surface area of the Nano powder can be characterized by X-Ray diffraction, SEM and TEM.

Keywords: X-Ray diffraction, Scanning Electron Microscopy(SEM), Transition Electron Microscopy(TEM).

I. INTRODUCTION

In this paper, experimental method to produce the Nano powder, the study of the powder by XRD test and the crystal structure of the powder is discussed The setup is to be made to the smallest of size and in most comfortable way with normal lab equipment.Anodic arc discharge technique using different filaments with variety of compositions in varying concentrations of the electrolyte and influence of voltage and current on size and shape of the Nano powder will be investigated to optimize the process parameters to produce a Nano material with specific morphology and properties. It is envisaged to explore this simple synthesis technique to produce high entropy oxides for realizing multifunctional materials economically. The products were characterized by x-ray diffraction (XRD).

TIG (Tungsten Inert Gas) welding rods were used to produce Nano powder (electrodes in the experiment) here below are the Physical and chemical properties of

B. Deposited Chemical Composition % (Typical)

C = 0.10	Mo = 0.15	P = 0.012
Cr = 26.00	Mn = 1.70	S = 0.010
Ni = 21.00	Si = 0.50	

the rod. Application of the welding rods ER310 is used for the welding of stainless steels of similar composition in wrought or cast form. The weld deposit is fully austenitic and calls for low heat during welding. This filler metal can also be used for dissimilar welding.

A. Areas of application

The Magnetic Nanoparticles have a vast field of applications Magnetite and pigment application [1], [2], Ferrofluid [3], [4], Bioprocessing [3], [4], Information storage [3], [4], Magnetic refrigeration [3], [4]

II. METHODS AND MATERIAL

A. Methods for preparing Nanomaterials

There are many methods to produce but the major challenge is to Nano powder the major challenge is to find a economical method. Spray pyrolysis [5], Forced HYDROLOSIS [6,7,8], Oxidation and reduction of ferrous hydroxide [9], Microwave irradiation of ferrous hydroxide [10], Combustion of iron nitrate [11], Micro emulsion technique [12,13], Hydrothermal preparation technique [14,15], Novel arc discharge method

Material used as electrode is ER310(TIG welding rod)

C. Mechanical Properties (R.T.)

Yield Strength	57,000 psi
Tensile Strength	87,000 psi
Elongation	43%

III. EXPERIMENTAL SETUP

Novel Arc Discharge Method is used to prepare Nano powder[16]A 50hz alternating power supply was supplied to brine solution in a 100ml beaker [1mole $NaCl^{-1}$}.2 metallic iron filaments were used as electrodes distance between them being 3cm.Both electrodes were fixed and placed in the electrolyte. Voltage was adjusted using step down circuit, varied from 50-200 volts.50HZ Alternating Current Passed.

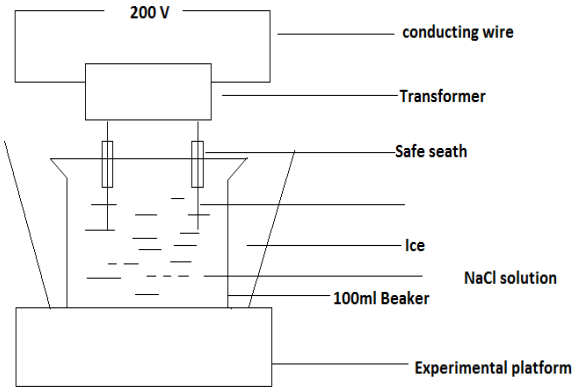

Figure 1. Experimental apparatus for preparation of nanoparticles.

Under certain voltage the electrodes melted in arc discharge due to strong exothermic reaction black magnetic particles were formed in electrolyte. Magnetic precipitate was taken out by magnet from electrolyte, Obtained powder was washed with distilled water and absolute alcohol, Oven dried at 150°C for 10min.

IV.RESULTS AND DISCUSSION

A. Proposed Mechanism

Metallic iron filament melted due to high heat generation which lead the formation for iron colloid. Iron colloid was quickly oxidised into Fe^{2+} which formed $Fe(OH_2)$ in aques PH solution and continued to be oxidised into $Fe(OH_3)$. Oxidation may be due to high temperature at the electrode and newly produced $Fe(OH_3)$ favoured the formation of stable Fe_3O_4 phase. The powders were characterised by X-ray diffraction.

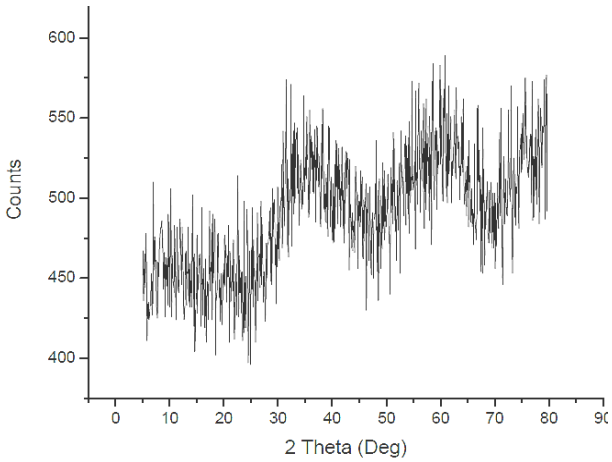

Figure 2. XRD result of ER 310@55volts

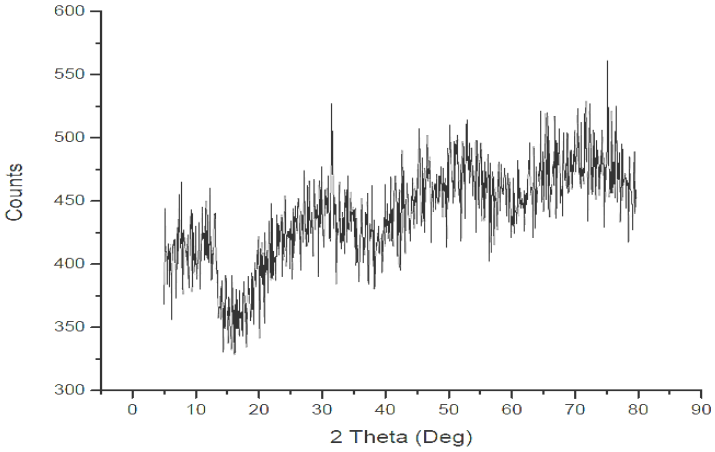

Figure 3. XRD result of ER 310@65volts

The above XRD analysis peaks are missing so we infer that the structure is amorphous.

s.no	Ampere	Time (in min)
1	2.5×2	0.30
2	2.6×2	1.00
3	2.7×2	4.40
4	2.8×2	5.40
5	2.9×2	6.40
6	3.0×2	8.00
7	3.1×2	8.50
8	3.2×2	9.50
9	3.3×2	10.40
10	3.4×2	12.50
11	3.5×2	13.10
12	3.5×2	14.00
13	3.6×2	14.30
14	4.0×2	15.00

Table 1. Experimental Observation of ER310 rod (as electrode) at 55volts

IV. CONCLUSION

The above XRD analysis showed amorphous structure of the particles this was mainly due to improper heat treatment of the powder. To convert amorphous structure from crystalline structure it must be heated to a crystalline temperature to get the expected results. The other tests were not carried out. As the effect of temperature on phase change is yet to be studied.

V. ACKNOWLEDGEMENT

The authors express their thanks to Head of the Mechanical Engineering Department, Principal, Director and Correspondent of Vidya Jyothi Institute of Technology, Aziz Nagar, Hyderabad for the help and support extended towards this work

VI. REFERENCES

[1]. R. F. Zido, E.P. Giannelis, B.A. Weinstein, Science 257 (10) (1992) 219–223
[2]. P. Williams, IEEE Trans Mag 24 (2) (1988) 1876–1879.
[3]. M. Kiyama, Bull Chem Soc Jpn 47 (7) (1974) 1646–1650
[4]. S.B. Cowling, S. Mann, J Chem Soc, Chem Commun (23) (1985) 1713–1715.
[5]. T. Gonzalez–Catteno, M.P. Morales, Mater Lett 18 (3) (1993) 151–155.
[6]. S. Hamada, E. Matijevic, J Chem Soc, Faraday Trans I 78 (7) (1982) 2147–2156.
[7]. S. Hamada, S. Niizrki, Bull Chem Soc Jpn 59 (11) (1986) 3443–3450.
[8]. G. Visalakshi, G. Sakata, J Colloid Interface Sci 165 (1) (1994) 244–252.
[9]. G. Visalakshi, G. Venkateswaran, Mater Res Bull 28 (8) (1993) 829–835.
[10]. D. Dong, P. Hong, Mater Res Bull 30 (5) (1995) 537–541.
[11]. K. Suresh, K.C. Patil, J Mater Sci Lett 12 (8) (1993) 572–574.
[12]. S. Bandow, K. Kimura, Jpn J Appl Phys 26 (5) (1987) 713–717.
[13]. V. Chhabra, P. Ayyub, Mater Lett 26 (1) (1996) 21–26.
[14]. Y. Qian, Y. Xie, Mater Res Bull 29 (9) (1994) 953–957.
[15]. Y. Li, H. Liao, Y. Qian, Mater Res Bull 33 (6) (1998) 841–844
[16]. C.Y. Wang, Y.Zhoub,,XMob, Materials Research Bull 35 (2000) 755–759