International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 11 | Nov 2019 www.irjet.net p-ISSN: 2395-0072

Synthesis and Characterization of Iron (III) Nitride Doped Molybdenum using CO Precipitation (Solution A)

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Abstract - *Now a days aviation, medical and all most every second firm is looking actively for reducing the cost effectiveness of their output in this competitive era. These trends have been continuing seeking for the development in fabrication technologies. In this modern era, spongy and porous materials are winning the race in terms of cost effectiveness and light in weight. This assignment describes the synthesis of Iron (III) nitride doped Molybdenum for essentially strong magnetic applications. Samples of the nanomaterial were prepared by following the Bottom up approach with Co-precipitation method. The scope for further research work in this area will be outlined.*

Key Words: **Iron (III) nitride, Bottom up approach, Co-precipitation method**

1. INTRODUCTION

Most firms demand the light weight magnetic materials to resolve their R&D again, which actually helping them hitting many targets at a single time frame and eventually leading to cost effectiveness. With nanomaterials alongside magnetic properties make the synthesis at a small scale with bottom up approach fractionally difficult but more often than not the end product make it convenient for the researchers taking interests making the material porous as well. The partially solid state (voids), slightly amorphous (upto 4 % here) at the microscopic level, is indeed effective during the doping process.

A head glance of previous assignments reveals that the present day aeromechanical and pharma materials and their machineries are effectively bulky and dense in nature and neither are cost effective. Light weight (porosity), with hint of magnetic properties as ceramic sponge would create an impactful advantage to an industry. Efforts towards fabricating lightweight sponge indeed more efficient in comparison with present day lightweight ceramics.

The current work contrasts in enhancing the use of Iron (III) nitride doped Molybdenum for essentially strong magnetic applications, which possesses an outstanding string of arrays of characteristics. Calcined and Un-calcined samples of the nanomaterials were synthesized by opting the bottom up approach, with CO precipitation method (Solution A). These samples were further being came across to X-ray diffraction, Fourier-transform infrared spectroscopy and other experiments for detailed analysis at different time frames and techniques. This paper is projecting the 1/3 way to synthesize the specified material by various approaches. The other two solutions would be revealed soon in the further sequences.

The specified porous nanomaterial compares well with the properties, which are being exhibiting by the currently active ceramics in terms of hardness, strength to weight ratio, eliminated the use of the corrosion resistant coating etc., hence reducing the cost effectiveness of the product to a significant number. The synthesis and the detailed characteristical analysis of the sponge are further outlined.

This void like structures exhibit a continuous frame of empty space, which shows eventually a wide range of versatile applications in Aerospace and Biological industries. Electromagnetism, Induction for Aircraft maneuver systems; moreover Electromagnetism for electrocardiogram, electroencephalogram machines to detect body's electrical currents for MRI as well. Iron (III) nitride doped Molybdenum make a contribution via. Following results in the mentioned firms.

Nomenclature

NH_3	Ammonia
FeN	Iron (III) nitride
Mo	Molybdenum
C_2H_5OH	Ethanol

2. SYNTHESIS OF IRON (III) NITRIDE DOPED MOLYBDENUM

Chemistry for synthesizing Iron (III) nitride doped Molybdenum to obtain the simplex geometry as follows:

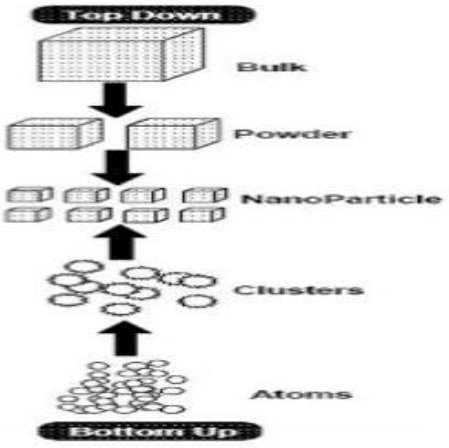

Fig – 1: Nano material processing description Sample Table format

Here, the couple of process had been opted. (A) Un-calcined; (B) Calcined

Prior to each step, it involves the synthesis of Iron nitride at the desired temperature of 363.15 K through the bottom up approach. Processes (A) and (B)

Initially, step A involves the doping of Molybdenum at 773.15 K in the excess presence of oxygen

$$2\,Fe + 2\,NH_3 + 2\,C_2H_5OH \xrightarrow{363.15K} 2\,FeN + 4\,CO_2 + H_2O + 3\,H_2\uparrow$$

$$2\,FeN + 3\,H_2 + Mo \xrightarrow{773.15K} 2\,FeN.Mo\ (Un\text{-}calcination)$$

Followed by the calcination process (B), which involves doping of Molybdenum at 873.15 K in vacuum.

$$2FeN + 3H_2 + Mo \xrightarrow{873.15K} 2FeN.Mo\ (Calcination)$$

3. CHARACTERSTICS OF IRON (III) NITRIDE DOPED MOLYBDENUM

Characteristics	FeN.Mo
Magnetic order	Ferromagnetic
Phase	Partially solid
Granule size (nm)	0.268
Boiling point (K)	5231
Melting point (K)	2981
Hardness (Vickers)	675
Porosity (per mole)	3.35 %
Solubility in HCL at (K)	333.15
Thermal conductivity (W/m.K)	91
Density (g/cm3)	6.35
Strength to weight ratio (kN.m/kg)	269.74
Tensile strength (MPa)	1700.52

The end product after the process (B) involves the dopant of 40.71 % in the entire stoichiometry. The results are essentially have a major impact as it the product is a compact combination of both the compounds. The following are the properties of the light weight material.

3.1 Fourier-transform infrared spectroscopy of Iron (III) nitride doped Molybdenum

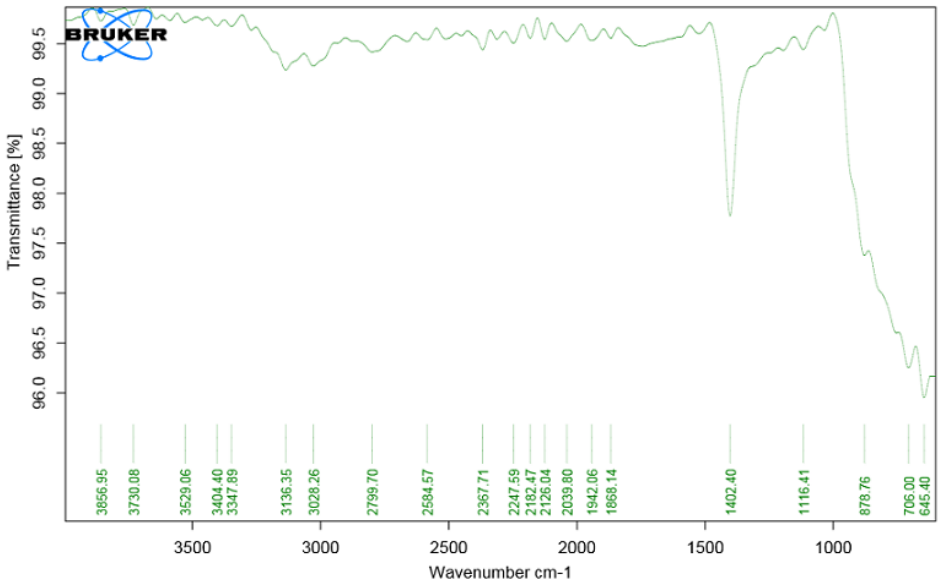

Fig – 2: FTIR analysis

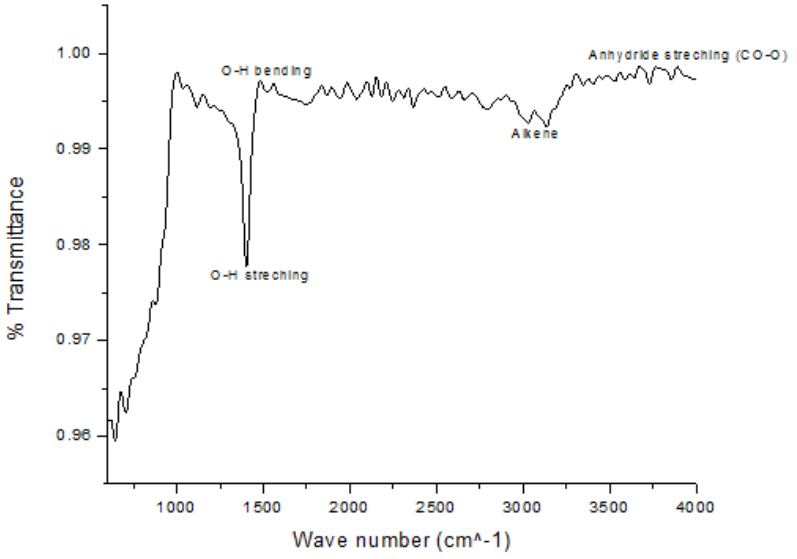

Fig – 3: Illustration of FTIR analysis

Figure (2), (3) showing FTIR analysis of the compound. Bringing the granule size alongside the van der wall forces, which helps in binding the stoichiometry of the structure. At every level of magnification, it is having certain level of porosity. At the end, which is critical and playing its part in maintaining the light weight behaviour of the compound. Gradual peaks demonstrates the different functional groups (Alkene, O-H bonding and Alcohol present in some fraction amount) in this case (Fig.3.).

Moreover, the amount of transmittance varies generally with the UV light passes through the specimen. At the same time (Fig.2.), as soon as the wave number increases, the amount of transmittance bizarrely touches the rock bottom.

3.2 SEM analysis Iron (III) nitride doped Molybdenum

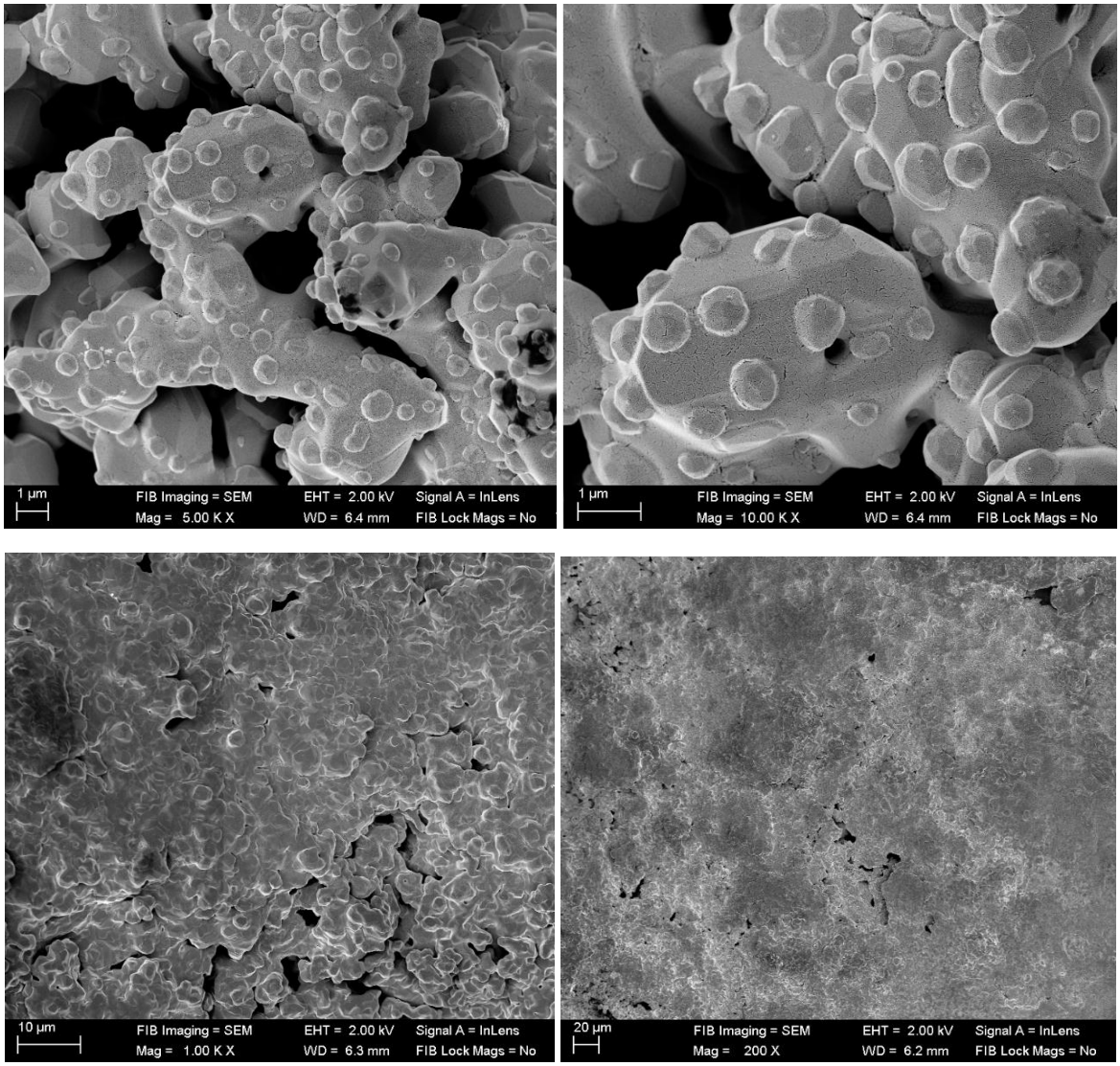

Fig – 4: Illustration of SEM analysis

Figure (4) showing SEM images of the Iron (III) nitride doped Molybdenum. As per the characterization, it is demonstrated clearly about the granule size and described itself about the van der wall forces. Being a binding force thoroughly the structure from the molecular level. From the figures at 1 µm level, the magnification showing the trailer of the porosity of 3.35 % originates from every adjacent molecules. Again, the magnification has gradually been increased to demonstrate more about the binding force eventually strengthens the material from the micro level. Moreover at 10 µm and 20 µm, the surface is showing some optimum amount of density and consists of optimum amount of porosity at 20 µm. Smooth surface at 20 µm with some fraction amount of voids at magnification at 10 µm, but in the nutshell the overall picture of the material makes its own identity in the current day scenario.

3.3 X-Ray diffraction analysis Iron (III) nitride doped Molybdenum

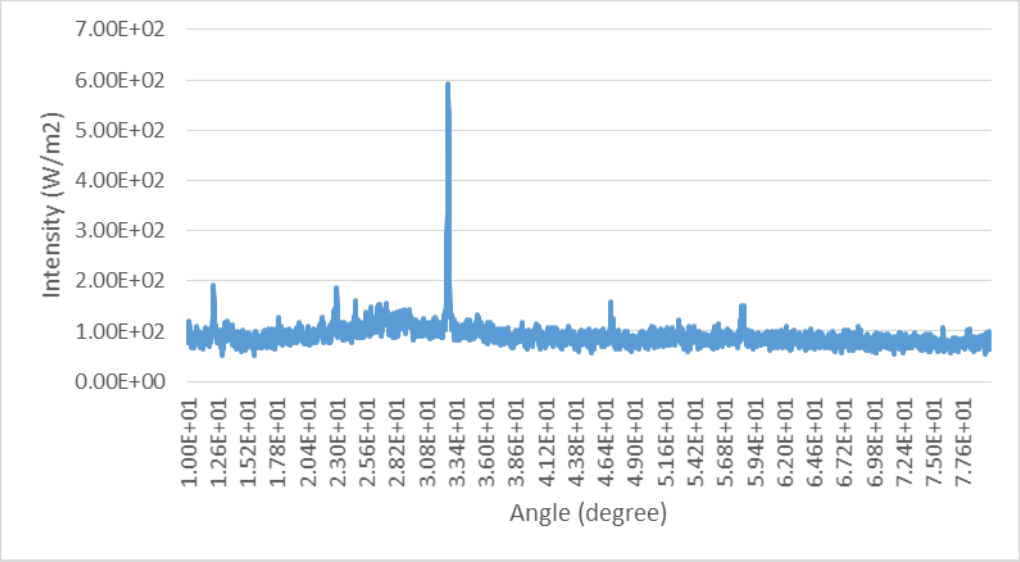

Fig – 5: Illustration of X-Ray analysis

Generally, a matter or a substance in nature is stable. Likewise Iron (III) nitride doped Molybdenum, by virtue of the results considered to be stable. The atoms here are highly packed in a steady manner with a pinch of porous nature when the lattice takes its desired structure. Hence the stability has been demonstrated via. XRD analysis of the compound. Fig.5. comprises of not many tall peaks in this case, which contributes to the light weight behaviour. Less dense solid is also give rise to the amorphous structure.

In the nutshell, for the different angular variation, between 31.8 to 34.2 degrees the peak rises shows the porous behaviour of the light weight material. Rest the analysis has been done 10 to 77 degrees to thoroughly study about the characteristics of the magnetic porous material for the different applications as mentioned earlier.

4. CONCLUSION

This segment of work (Solution A) Synthesis and Characterization Iron (III) nitride doped Molybdenum using CO precipitation. Meanwhile the other solutions i.e. the synthesis using the Sol gel methodology and Hydro-thermal process are actively under the process followed by the detailed characterization of the same lightweight material. Nevertheless, with this attempt the intension is to consider it for the various manufacturing applications. Some detailed analysis have been demonstrated to bring the overall picture of van der wall forces and the FTIR to filter out the functional groups that are being attached to Iron (III). However, the curiosity ahead will be to bring out the other couple of solutions.

ACKNOWLEDGEMENT

I am very grateful to the supervisor Prof. Suresh. R, Prof. Siddharth Mohapatra, Prof. Kushal Singh, Parents, one of my friends Utkarsh Nigam for their valuable guidance, motivation and technical support. Jamia Millia Islamia University for the technical support.

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