HETERO-ATOM INDUCED FERROMAGNETISM IN ANTIFERROMAGNETIC HEMATITE

IITM Technology Available for Licensing

PROBLEM STATEMENT

- **Transition metals**, such as **iron,** have been **extensively researched** due to their **unique properties like variable valences and photoluminescence.**
- Iron's three oxides, **Fe_3O_4, FeO, and Fe_2O_3, have magnetic properties,** but their **antiferromagnetic nature limits** their **potential applications**.
- Several methods are used for **synthesizing ferromagnetic α- Fe_2O_3,** with most resulting in magnetization of 1-4 emu/g, with some tedious methods like template assisted solution combustion synthesis.
- But it is **time-consuming** and **requires numerous intermediate steps** and chemicals.
- There is a need for the method of preparation thereof that overcomes some of the drawbacks of the existing methods.

TECHNOLOGY CATEGORY/ MARKET

Technology: Atom induced Ferromagnetism
Category: Pyrolytic synthesis
Industry: Materials Science,Energy Storage Industry
Application: Nanomagnetic devices, nanobiosensors, batteries, giant magnetoresistance device
Market: The global market size of magnetic materials market size was exhibited at **USD 27.85 billion in 2022** and is projected to hit around **USD 51.54 billion by 2032** with a registered **CAGR of 6.4% during the forecast period 2023 to 2032**.

INTELLECTUAL PROPERTY

IITM IDF Ref. 2333
Patent No: IN 539709

TRL (Technology Readiness Level)

TRL-4, Experimentally validated in Lab;

Research Lab

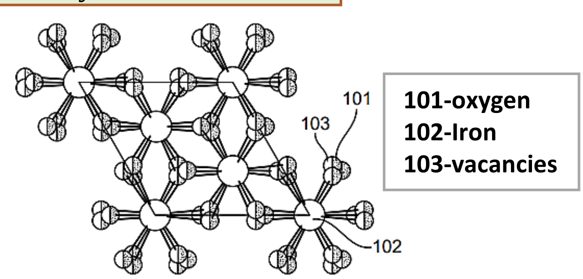
Prof. Ramaprabhu S,
Dept. of Physics.

TECHNOLOGY

- A **method** of **pyrolytic synthesis** of ferromagnetic hematite iron oxide composite, the method comprising:
- **Heating** a **composite admixture comprising** at least one **iron precursor** selected from
  - iron nitrate, iron chloride or iron sulphate, and
- at least **one heteroatom precursor** in a predetermined **weight ratio** to
  - a **temperature** between **400 °C to 750 °C** under
  - an **air atmosphere** to form ferromagnetic hematite iron oxide,
- wherein the **heteroatom precursor** is selected from
  - nitrogen, sulfur, boron or carbon precursors,
- wherein the **heat treatment** is carried out
  - for **2h to 3h**, and
- wherein the **predetermined weight ratio** of
  - heteroatom precursor to iron precursor is in the range of **2:1 to 1:2**.

Ferromagnetic hematite iron oxide crystal structure.

100



CONTACT US
Dr. Dara Ajay, Head TTO
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website: https://ipm.icsr.in/ipm/

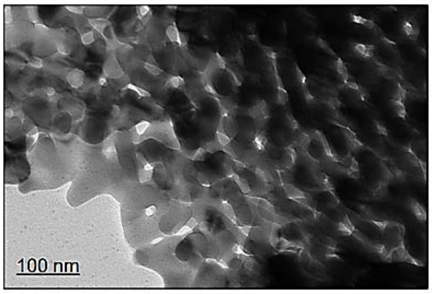
Email: smipm-icsr@icsrpis.iitm.ac.in
sm-marketing@imail.iitm.ac.in
Phone: +91-44-2257 9756/ 9719

IIT MADRAS
Indian Institute of Technology Madras

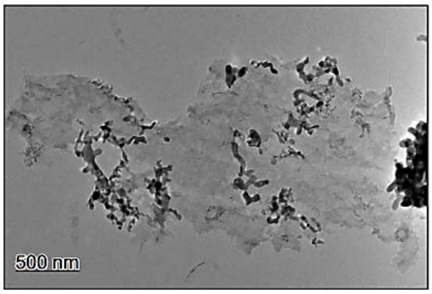
Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

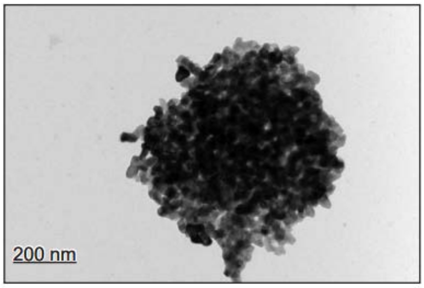
TEM image of magnetic α- Fe2O3/C



100 nm
By combustion



500nm
By solid-state pyrolysis using graphitic carbon nitride



200nm
By solid-state pyrolysis using antiferromagnetic α- Fe_2O_3 NP.

Key Features / Value Proposition

Hematite iron oxide Structure
- Rhombohedral crystal structure

space group
- R-3c

Process
- Pyrolysis is the chemical decomposition of organic material in the absence of oxygen

weight ratio of heteroatom precursor to antiferromagnetic hematite iron oxide
- 2:1 to 1:2.

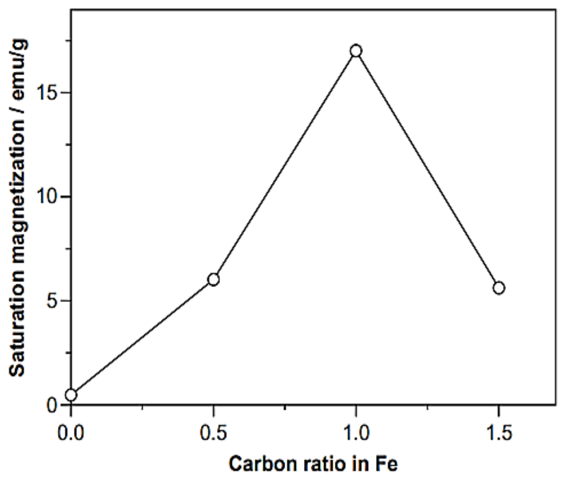
Carbon precursor
- Paracetamol, urea, melamine, graphitic carbon nitride, carbon nanotubes, graphene oxide, graphene, or carbon nanofiber.

Sulfur precursor
- Sulfur powder or hydrogen sulfide;

Solvent
- No solvent is used

Boron precursor
- Boric oxide, sodium borohydride or boric acid

Nitrogen precursor
- Sodium nitrate or ammonia.



The above graph illustrates the magnetization variation with change in C:Fe ratio.

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IITM TTO Website:
https://ipm.icsr.in/ipm/

Email: smipm-icsr@icsrpis.iitm.ac.in
sm-marketing@imail.iitm.ac.in

Phone: +91-44-2257 9756/ 9719