Indian Science Technology and Engineering facilities Map

(I-STEM)

Invites application for

1. **Partial financial support for using R&D facilities in other institutions through the I-STEM web portal to Users from Academic Institutions and Start-ups (Format-1)**

Format for requesting support for accessing and using facilities through the I-STEM web portal.

(i) Details of the Personal Information

a. Name of the Researcher/Faculty Member: **DR. SABYASACHI KHATUA**
b. Name of the Institution/Start-up: **YOGODA SATSANGA PALPARA MAHAVIDYALAYA**
c. Name of the Department: **CHEMISTRY**
d. Degree registered for/Product being developed (for start-up)
e. Mob. No. **8918695882** f. Email ID: **skhatua1@gmail.com**

(ii) **Project/Research topic Details**:

a. Project Title/Research Title:

Green synthesis of Ni–Zn ferrite $Ni_{1-x}Zn_xFe_2O_4$nanoparticles from Hibiscus extracts and investigation of its electromagnetic properties

b. Sub area: **Chemistry**

c. Area Description: **Nanoscience**

d. Aims & Objective (in Bullets):

- The aim of this project is to first prepare $Ni_{1-x}Zn_xFe_2O_4$ nanoparticles of varying compositions ($x = 0.2$ and 0.8) by green synthesis methods using Hibiscus flower and leaf extracts. Since sintering temperature has a profound influence on particle size, so we will study the structural behaviour of the nanoparticles over a wide temperature range – from 500℃ to 800℃. Also we aim to study the magnetic properties of these nanoparticles.

- The magnetic properties of the ferrites are mainly controlled by the cation distribution of Ni, Zn and Fe among the available tetrahedral and octahedral sites. In a spinel structure, zinc has a high degree of affinity for the tetrahedral sites whereas nickel prefers an octahedral site. We aim to investigate how the varying size of the spinel ferrites changes the cation preference.

e. Duration (MM/YYYY): **01 year**

f. Project Summary (1000 words):

(Separate page may be attached to justify the requirements)

I. Introduction

Green synthesis of nanoparticles uses mild reaction conditions and nontoxic precursors so that environmental sustainability is maintained. So in recent years it is emerging as an alternative method to the conventional chemical methods.

Nanostructured materials, often characterized by a physical dimension of 1- 100 nm and a significant amount of surfaces and interfaces, have been attracting much interest because of their unique properties compared to conventional ceramic materials. Novel nanocrystal properties arise from the large fraction of atoms which reside on the surface of the particles and from the finite number of atoms in each crystalline core. Studies have shown that most physical and chemical properties of solid matter change when the particle size is decreased to submicron regime. These properties include thermal expansion coefficient (1), specific heat (2), diffusivity (3), solute solubility (4), photoemission (5), optical absorption (6), magnetic susceptibility (7, 8), electrical conductivity (9), dielectric property (10), superconducting properties (11) etc. The unusual magnetic properties such as reduced magnetization (12), enhanced coercivity (13), higher curie temperature as compared to the bulk materials (14) and superparamagnetism (15) of the nanocrystalline ferrite materials have generated wide interest in these materials. Superparamagnetism is a unique feature of magnetic nanoparticles and has applications in modern technologies including magnetic resonance imaging contrast agents (16), data life time in high density information storage (17), ferrofluid technology,(18), magnetocaloric refrigeration (19), magnetic recording media (20), permanent magnets (21), magnetic fluid hyperthermia(22), magnetic drug delivery (23), cancer therapy diagnosis (24) etc.

References

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II. Objectives

a) The aim of this project is to first prepare $Ni_{1-x}Zn_xFe_2O_4$ nanoparticles of varying compositions ($x = 0.2$ and 0.8) by green synthesis methods using Hibiscus flower and leaf extracts. Since sintering temperature has a profound influence on particle size, so we will study the structural behaviour of the nanoparticles over a wide temperature range – from 500℃ to 800℃. Also we aim to study the magnetic properties of these nanoparticles.

b) The magnetic properties of the ferrites are mainly controlled by the cation distribution of Ni, Zn and Fe among the available tetrahedral and octahedral sites. In a spinel structure, zinc has a high degree of affinity for the tetrahedral sites whereas nickel prefers an octahedral site. We aim to investigate how the varying size of the spinel ferrites changes the cation preference.

III. Hypothesis

The phase formation will be identified by XRD. If the result become contrary to our expectation, then sol-gel method will be applied.

IV. Methodology

At first phase formation will be identified by XRD. Particle size of the samples will be identified by TEM. SEM of the samples will be done for shape, size and arrangement of the particle on the surface. Magnetic properties of the samples will be done by vibrating sample Magnetometer (VSM).

V. Research Gap

a) Although Ni–Zn ferrites have been widely studied before by various authors, very few have focused on green synthesis methods.

b) Very few studies focused on the correlation between the size of the spinel ferrites and the cation distribution.

VII. Theories that will be used:

In the absence of inhomogeneous strain, the particle size (D) can be calculated using Scherrer formula as

$$D = \frac{k\lambda}{\beta \cos\theta}$$

Here D = particle size vertical to the analyzed (hkl) planes; θ = diffraction angle; β = full width at half maximum (FWHM) intensity; k = Scherrer constant and λ = wavelength of the incident X-ray.

I. Year-wise Plan of work:

(a) 0-6 months: Further review of literature and continuing research in the area. Nanocrystalline Ni-Zn ferrite sample preparation by self-combustion and wet ferritization methods and characterization of these samples by XRD and SEM.

(b) 7-12 months: TEM, thermal analysis and Magnetic Properties of these samples will be studied, analysis will be performed and report will be prepared.

g. **Technical Details**

a. TRL

b. Methodology:

- The particles will be synthesized by self-combustion and wet ferritization methods. At first phase formation will be identified by XRD. Particle size of the samples will be identified by TEM. SEM of the samples will be done for shape, size and arrangement of the particle on the surface. The samples will also be characterized by FT-IR spectroscopic analysis and thermal analysis. Magnetic properties of the samples will be done by vibrating sample Magnetometer (VSM). Then the result will be compared with those obtained by other techniques.

c. Design & development

d. Facilities and Instrumentation required: **XRD, SEM, TEM, VSM**

e. Consumables (Scientific materials)

h. **Expected output and outcome**

i. **Industry/Institute CollaborationIf, yes**

(i) Name of the Collaborating Industry/Institute

(ii) Collaboration Details

(iii) Additional Details if any

j. **Funding required from I-STEM (with justification:**

Details of Requirements & Mode of the Engagement: (Attach the quotation for the consumables)

(i) Short term Engagement:

a. Usage of testing/characterization facilities across the country (Characterization Mode)

i. Testing Charges: **XRD, SEM, TEM, VSM: Rs. 1,00,000/-**

ii. Consumable charges **Hot Air Oven: Rs. 15,000/-**

Glassware: Rs. 15,000/-

Grand total: Rs. 1,30,000/-

iii. Travel Cost (Boarding and Lodging, if any)

b. Usage of fabrication and testing facilities across the country (Fabrication Mode)
   i. Fabrication and testing Charges
   ii. Consumable charges (if any)
   iii. Travel Cost (Boarding and Lodging, if any)

(ii) Medium term Engagement:
   a. Execution of project in any one of the Host Institution (Project Mode)
      a. Fabrication and or testing Charges
      b. Consumable charges (if any)
      c. Travel Cost (Boarding and Lodging, if any)
   b. Execution of project in Multi Host Institutions (Project Mode)
      a. Fabrication and or testing Charges
      b. Consumable charges (if any)
      c. Travel Cost (Boarding and Lodging, if any)

(Round-trip to the Host Institution by 2nd class (Non-AC) railway via the nearest route)

Details of User's Bank Account:

(Please send a copy of the cancelled cheque/copy of the passbook carrying all the information needed)

Beneficiary Name (User's name): **SABYASACHI KHATUA** PAN: **BPEPK9592K**

Bank Account No: **1067010384018** Name of the Branch: **PALPARA**

IFSC Code: **PUNB0106720**

Note: Proposed proposal must be executed within stipulated duration (max. 6 month) to avoid fund availability issues. Travel form will be provided by the I-STEM office. The users will submit the technical report, original invoice (duly signed by the Head of the Institution) raised by the Host Institution through I-STEM portal only along with a copy of the travel forms and original tickets through post to the Nodal Officer, I-STEM, Indian Institute of Science, Bangalore. A scan copy of all the documents may be sent in advance.