

Appendix A

Supporting information

A.1 The brightfield microscopic micrographs of HEK-293 cells pre/post treatment for (a-g) $\text{Ni}_{0.75}\text{Zn}_{0.25}\text{Fe}_2\text{O}_4@\text{CoO}$; (h-n) $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4@\text{CoO}$ with metal concentrations variation.

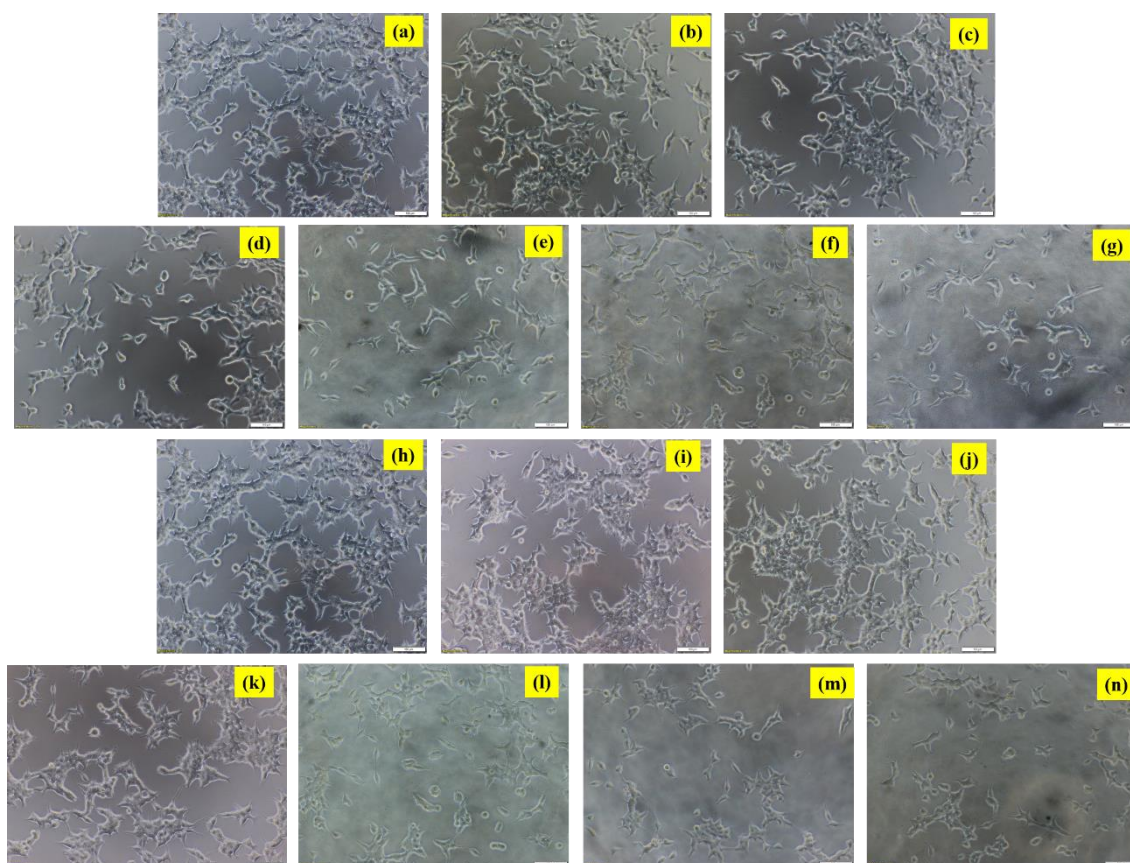


Figure A.1 The brightfield microscopic images of HEK-293 cells pre/post treatment for (a-g) $\text{Ni}_{0.75}\text{Zn}_{0.25}\text{Fe}_2\text{O}_4@\text{CoO}$; (h-n) $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4@\text{CoO}$ with metal concentrations variation.

A.2 The brightfield microscopic images of MCF-7 cells pre/post treatment for system (a-g) $\text{Ni}_{0.75}\text{Zn}_{0.25}\text{Fe}_2\text{O}_4@\text{CoO}$; (h-n) $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4@\text{CoO}$ with metal concentrations variation.

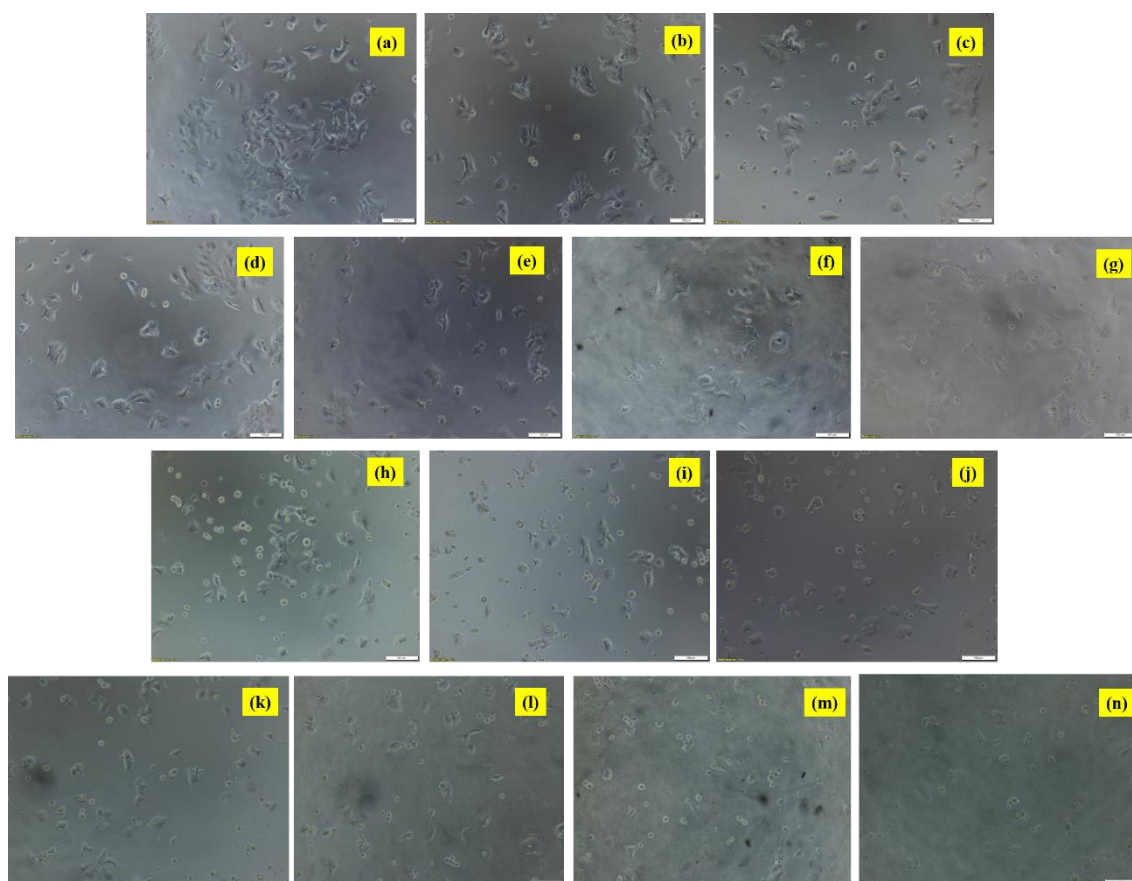


Figure A.2 The brightfield microscopic images of HEK-293 cells pre/post treatment for system (a-g) $\text{Ni}_{0.75}\text{Zn}_{0.25}\text{Fe}_2\text{O}_4@\text{CoO}$; (h-n) $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4@\text{CoO}$ with metal concentrations variation.

A.3 Dynamic Light Scattering (DLS)

In Figure A.3, the intensity distribution of hydrodynamic diameter is given for CEIZF, CEAIZF, CEZF, CSEZF, and HCEZF. The obtained hydrodynamic diameter is 2751 nm for CEIZF, 983.4 nm for CEAIZF, 624.9 nm for CEZF, 1407.2 nm for CSEZF, and 2166.2 nm for HCEZF. The respective polydispersity index is

obtained as: 0.2 for CEIZF, 1.13 for CEAIZF, 0.36 for CEZF, 0.48 for CSEZF, and 0.47 for HCEZF.

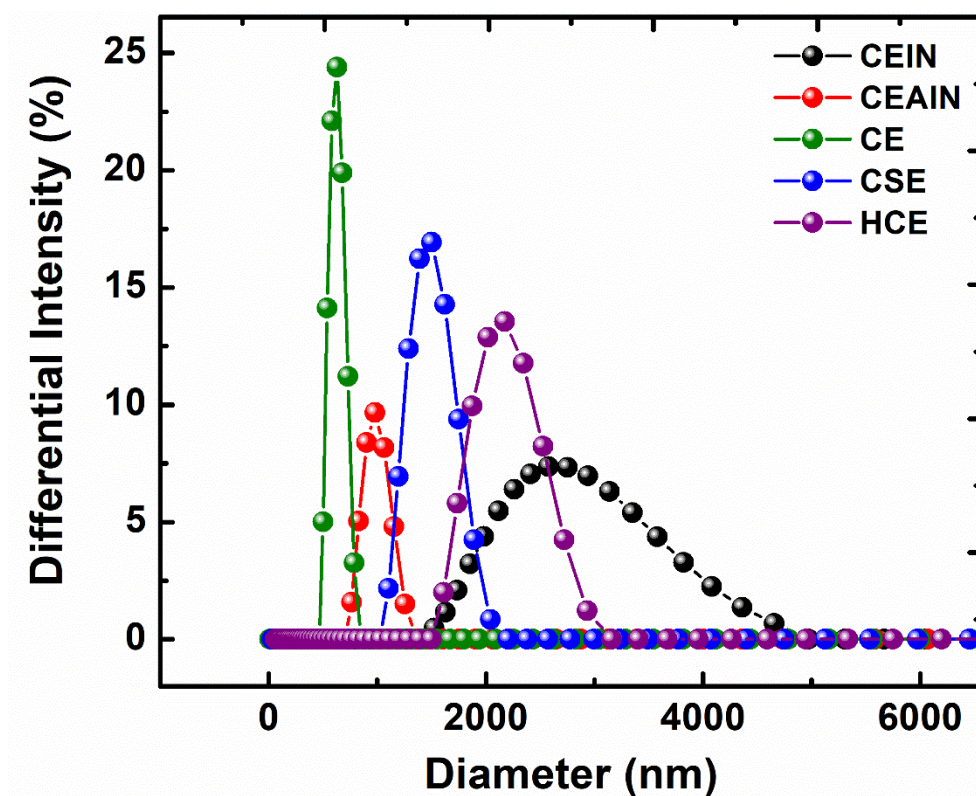


Figure A.3: Hydrodynamic size distribution plot obtained from Dynamic Light Scattering (DLS) of CEIZF, CEAIZF, CEZF, CSEZF, and HCEZF.

A.4 Fourier Transform infrared spectroscopy (FTIR)

Figure A.4 shows the FTIR plots for CE and HCE of zinc ferrite. The lower wavenumber peak at around 435 cm^{-1} is due to the octahedral mode for Fe-O vibration. The respective peak at 575 cm^{-1} is due to tetrahedral mode for Zn-O vibration. The rest two peaks at 1631 cm^{-1} and 3440 cm^{-1} is due to the O-H functional group of moisture content in the considered system.

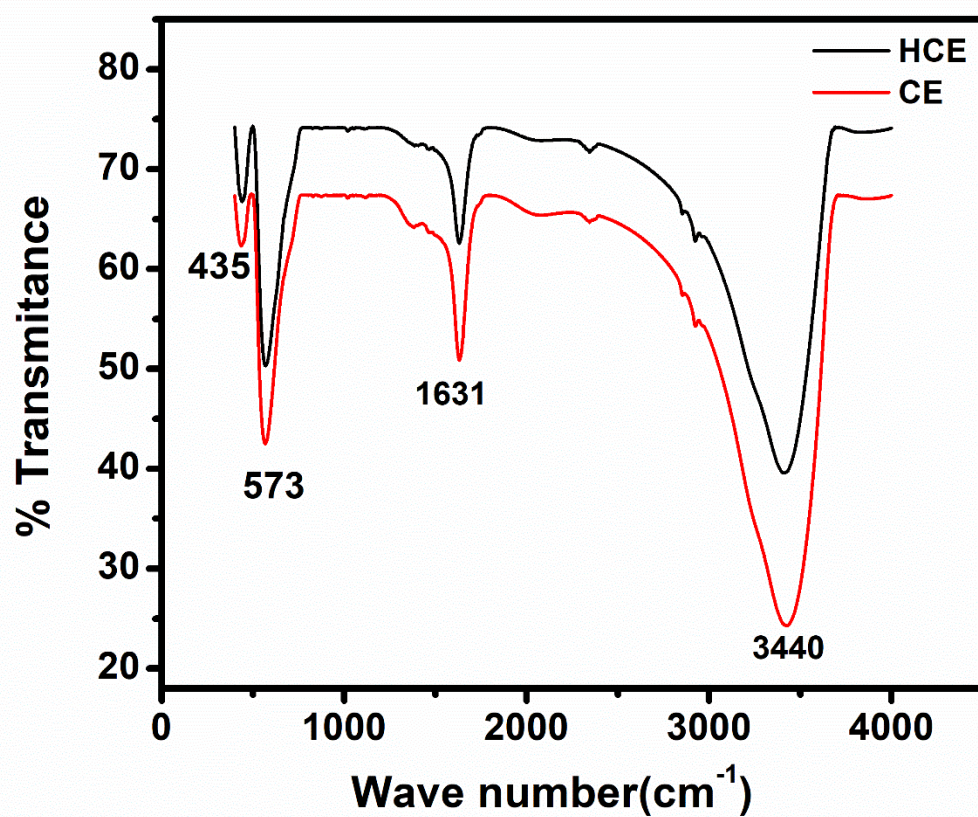


Figure A.4: FT-IR plots of CEZF (red) and HCEZF (black).

Appendix B

Publications

B.1. List of publications

Articles published in peer-reviewed journals (included in thesis)

- (a) **Konwar, K**, Kaushik, S D, Babu, P. D., Chaturvedi, A., Kumar, D., Chakraborty, R., Mukhopadhyay, R., Sharma, P., Lodha, S., Sen, D. and Deb, P. Integrative Modulation of Magnetic Resonance Transverse and Longitudinal Relaxivity in a cell-viable Bi-magnetic Ensemble, γ -Fe₂O₃@ZnFe₂O₄, *Langmuir*, 40, 3, 1793–1803, **2024**.
- (b) **Konwar, K.**, Bora, M., Kaushik, S.D., Chaturvedi, A, Kumar, D., Dutta, A., Mukhopadhyay, R., Babu, P.D., Sharma, P., Lodha, S., Sen, D., Ajayan, P., Deb, P. Ni_{1-x}Zn_xFe₂O₄@CoO (x = 0.25, and 0.50) Nanoparticles for Magnetic Resonance Imaging; *ACS Applied Nano Materials*, 6, 20440–20457, **2023**.
- (c) **Konwar, K.**, Sharma, N., Pranjali, P., Guleria, A., Kaushik, S. D., Dutta, A., Mukhopadhyay, R., Sen, S., Gao, W. and Deb, P. Structure-Correlated Magnetic Resonance Transverse Relaxivity Enhancement in Superparamagnetic Ensembles with Complex Anisotropy Landscape *Langmuir*, 38:11087–11098, **2022**.
- (d) **Konwar, K.**, Kaushik, S. D., Sen, D., and Deb, P. Dynamic spin freezing and magnetic memory effect in ensembles of interacting anisotropic magnetic nanoparticles. *Physical Review B*, 102:174449, **2020**.
- (e) **Konwar, K.**, Deb, P. et al., Hierarchical assembly of an interacting tri-magnetic nanosystem deriving robust magnetic resonance transverse relaxivity (Under Revision at *Langmuir* (1a-2023-031083), **2024**)

- (f) **Konwar, K.**, P Deb, et al., Non-ergodic quantum phenomena in cluster spin glass ensemble of two-dimensional nanoflakes and a dis-integrated framework (Under Communication)

Articles (outside thesis)

- 1) **K. Konwar**, P Deb, et al., *Colloid and Interface Science Communications*, 39:100319, 2020.

Patent:

- 1) **Antimicrobial conformal coating for preservation of perishable foods.** (Patent Application no. 202431002828) (Filed)

Conference Proceeding

- 1) **Konwar, K.** and Deb, P. Easy axes orientation dependent model for collective magnetic behaviour of zinc ferrite nanoparticles assembly, *AIP Conference Proceeding*, 2265 (1): 030548, 2020.

Book Chapter

- 1) **Konwar, K.** and Deb, P. A Review on Soft Computing Techniques in Nanomagnetism and Its Impact on Biomedical Applications, *CRC Press: Taylor and Francis Group*.

B.2. Papers presented in National and International conferences

- 1) **Oral presentation** on **National conference** on '7th Conference on Neutron Scattering (CNS-2021)', held on 25-27 November 2021 organized by 'Bhabha Atomic Research Centre'.
- 2) **Poster presentation** on '**International conference on Nano Science and technology**', held on March 5-7, 2020 organised by S.N. Bose National Centre for Basic Sciences, Kolkata. Title: An approach towards efficient super-

capacitive behaviour of Zinc Ferrite nanoparticles with varied organisation pattern. Authors: K. Konwar, N. J. Sharma and P. Deb.

- 3) **Poster presentation on national conference** on 'National conference on Progresses in Material Science Research (PMSR-2020)' held on 04-06 February, 2020, Department of Physics Dibrugarh University. Title: Effect of no-ionic surfactant on the growth of mesoporous carbon system., Author: K. Konwar, P. Deb.
- 4) **Poster presentation on International Conference** on 'Advanced Material (ICAM)-2019' held on 6-7 March, at Jamia Millia Islamia, New Delhi; Title: Collective magnetic behaviour of hierarchical assembly of Zinc Ferrite nanosystem, Author: K Konwar, S D Kaushik, and Pritam Deb.
- 5) **Poster presentation on '64th DAE Solid State Physics Symposium- 2019'** held on December 18-22 at IIT Jodhpur. Title: Easy axes orientation dependent model for collective magnetic behavior of Zinc Ferrite nanoparticles assembly. Authors: K Konwar, S. D. Kaushik, and P. Deb.

B.3 Achievement

- 1) Representing India as '**BRICS Young Scientist 2021**' in 'Innovative Idea' Category.

Konwar_Thesis

by Arnab Sarker

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STUDENT PAPERS

PRIMARY SOURCES

- 1 Korobi Konwar, Som Datta Kaushik, Debasis Sen, Pritam Deb. "Dynamic spin freezing and magnetic memory effect in ensembles of interacting anisotropic magnetic nanoparticles", *Physical Review B*, 2020
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 - 2 Korobi Konwar, Mayuri Bora, Som Datta Kaushik, Anamika Chaturvedi et al. " Ni Zn Fe O @CoO (= 0.25 and 0.50) Nanoparticles for Magnetic Resonance Imaging ", *ACS Applied Nano Materials*, 2023
Publication 1%
 - 3 Korobi Konwar, Som Datta Kaushik, Peram Delli Babu, Anamika Chaturvedi et al. " Integrative Modulation of Magnetic Resonance Transverse and Longitudinal Relaxivity in a Cell-Viable Bimagnetic Ensemble, γ -Fe O @ZnFe O ", *Langmuir*, 2024
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