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Magnetic rod-based metal-organic frameworks metal composites for colorimetric detection of hydrogen peroxide (H_2O_2) and pollutant elimination

by

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Outline

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- ➢Motivation
- ➢Methodology
- ➢Results
- ➢Conclusion
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Introduction

- Nanomaterials have gained significant attention in recent years due to their unique size (1-100 nm) and outstanding properties i.e. surface area, optical properties, ease of synthesis etc. [*Roduner, 2006*]

- Potential applications of nanomaterials in various fields including biomedicine, gas storage, catalysis, environmental monitoring and remediation etc. [*Maurin et al., 2017 and Meteku et al., 2020*]

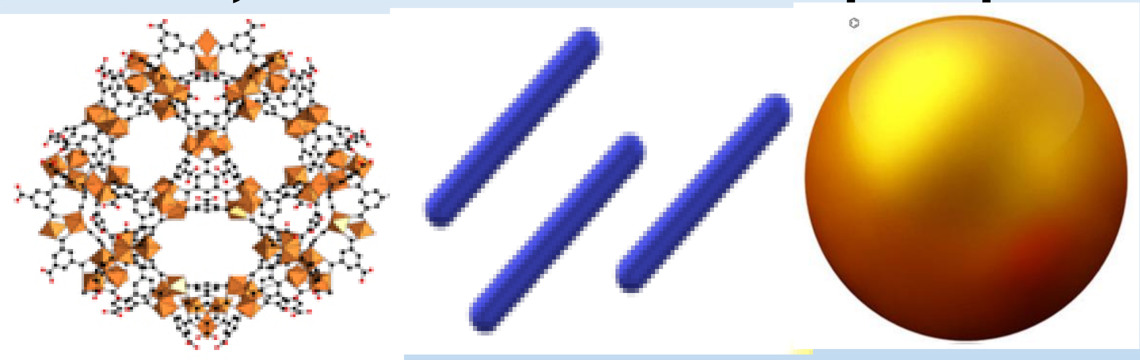
Introduction

- There is an increase in demand for hydrogen peroxide due to its green nature and is currently used extensively in the paper industry, dentistry, environmental remediation decontamination of PPEs etc. [*Beam et al., 2020*]

- Detection of hydrogen peroxide is of prime importance due to its cytotoxicity when concentrations are beyond a minimum threshold of 75 ppm. [*Sun et al., 2016*]

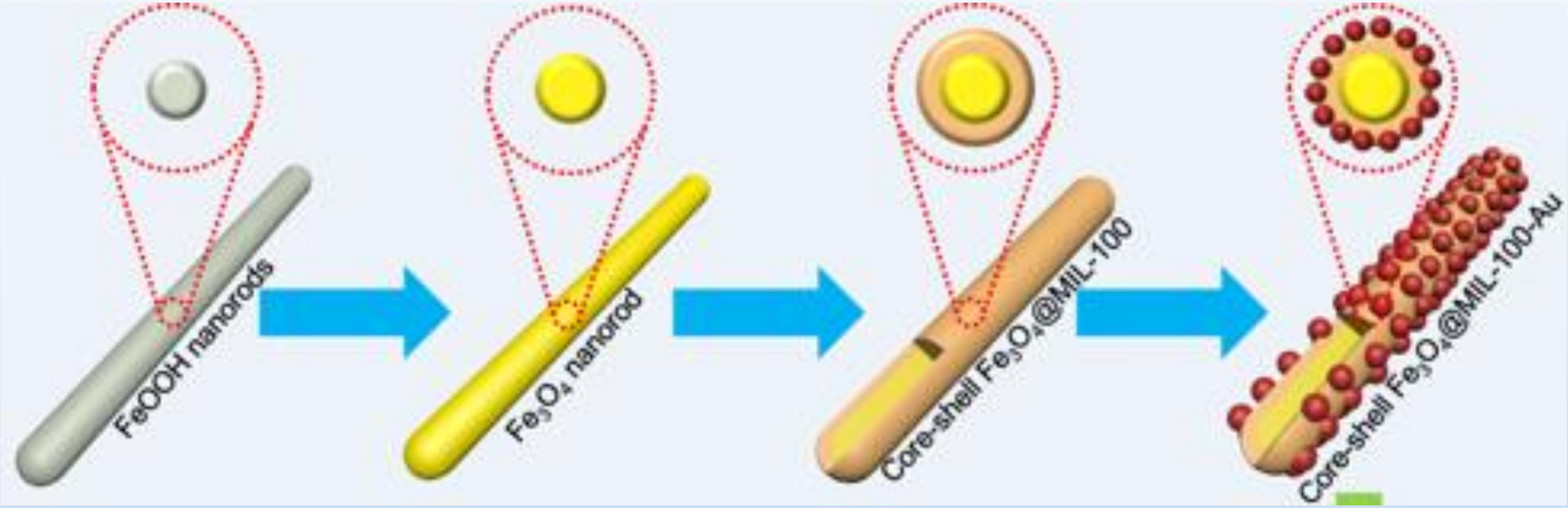
Motivation

Plausible synergistic effect between magnetite, MOF and Au properties



The need for enhanced detection of Hydrogen peroxide

Methodology



- CTAB assisted hydrolysis at 87ºC for 12 hrs to form β-FeOOH
- Reduction of β-FeOOH at 240ºC for 8 hrs under N_2 using PAA for morphology preservation
- MAA functionalization of nanorod followed by layer-by-layer growth of MIL-100(Fe) on magnetic rod
- Deposition of reduced Au on Fe3O4@MIL-100(Fe)

Methodology

- Colorimetric Detection of H_2O_2

Fe_3O_4@MIL-100(Fe)-Au (4 mg/mL, 100 µL)

+

Sodium acetate-acetic acid buffer solution (pH =4, 2400 µL)

+

TMB solution (1.55mM in ethanol, 480 µL)

+

H_2O_2(30%, 100 µL)

(Incubation for 5 min. followed by UV-vis analysis)

Methodology

- 4-nitrophenol reduction

4-nitrophenol solution (0.18 mM, 6 mL)

+

freshly prepared $NaBH_4$ solution (0.2 M, 4 mL)

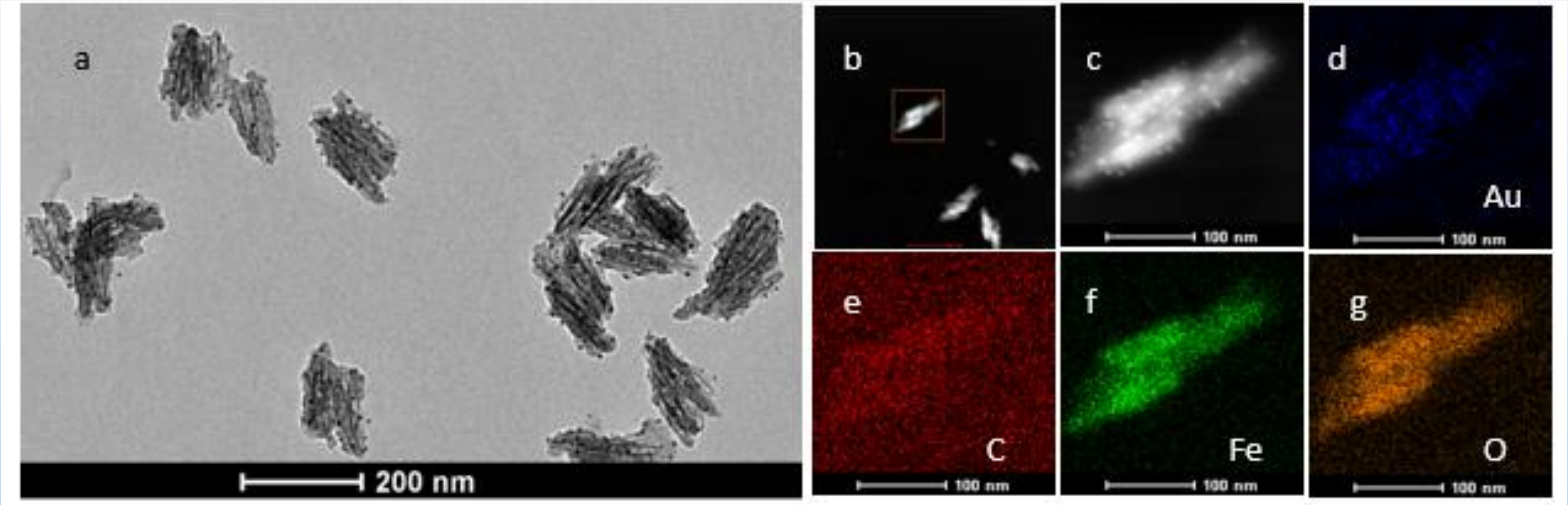
+

Fe_3O_4@MIL-100(Fe)-Au (4 mg)

- Bacteria adsorption

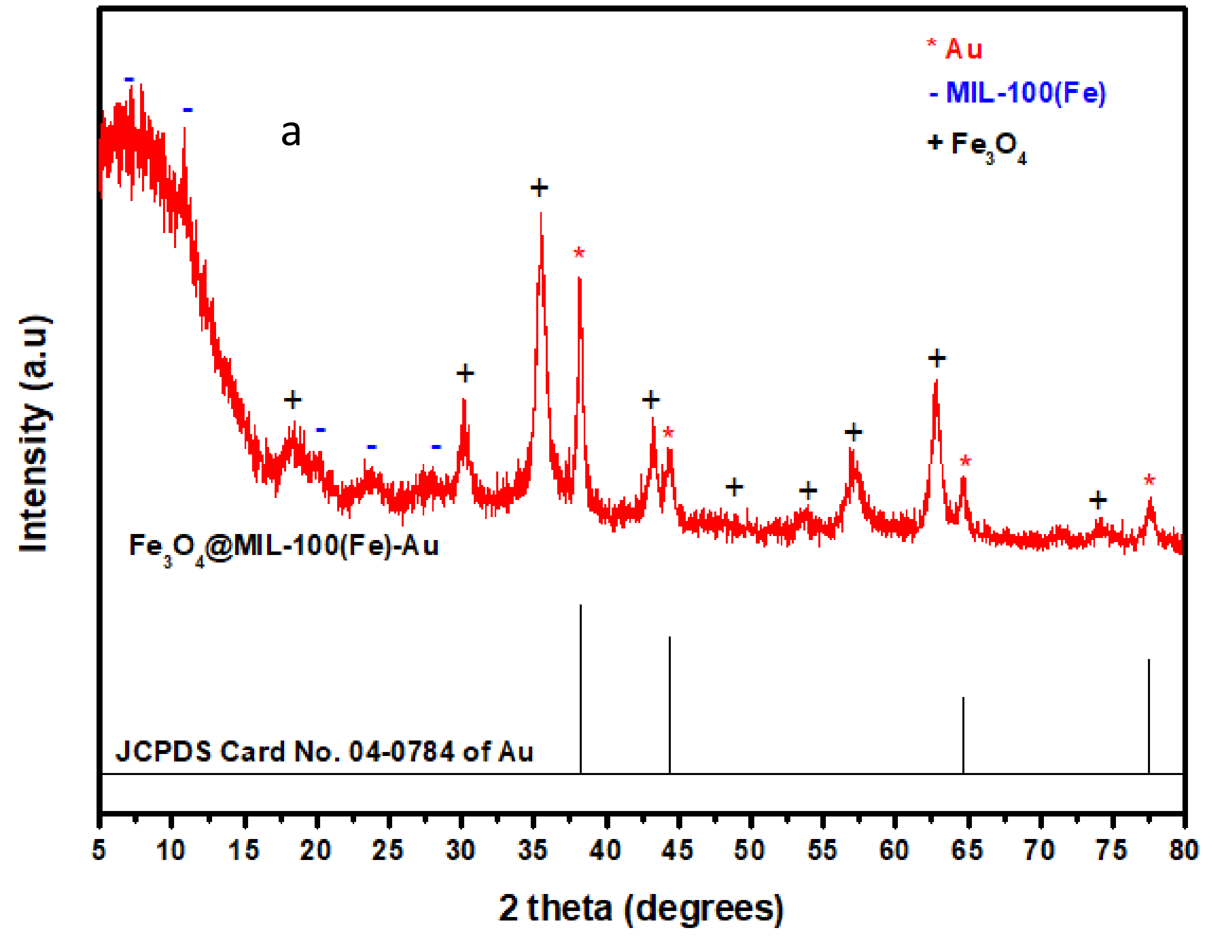
Composite conjugation with antibody followed by bacteria adsorption with/without magnetic field

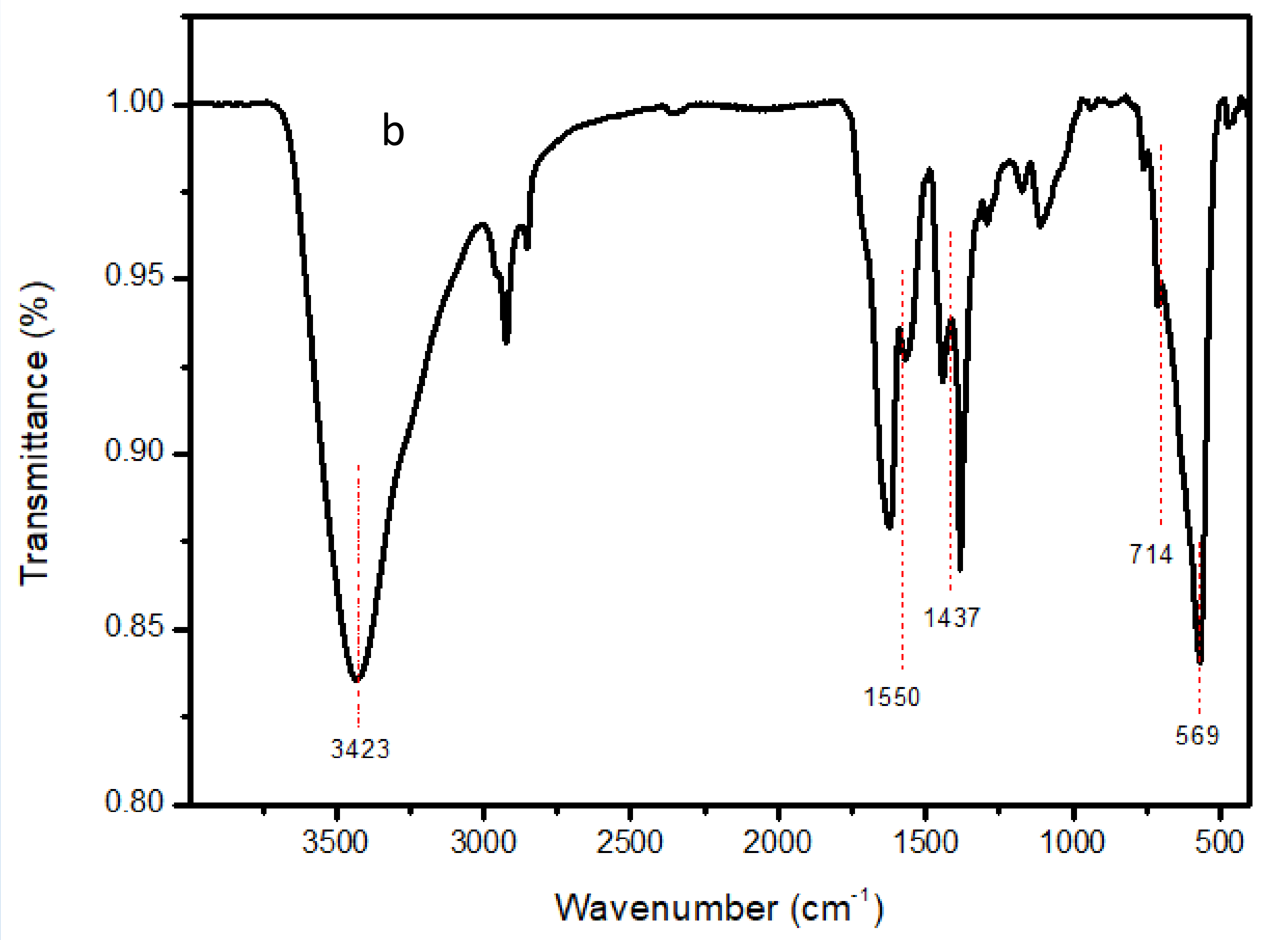
Results



a)TEM image of Fe_3O_4@MIL-100(Fe)-Au; b, c) STEM HAADF image of composite; Corresponding elemental analysis results d) Au; e) C; f) Fe and g) O

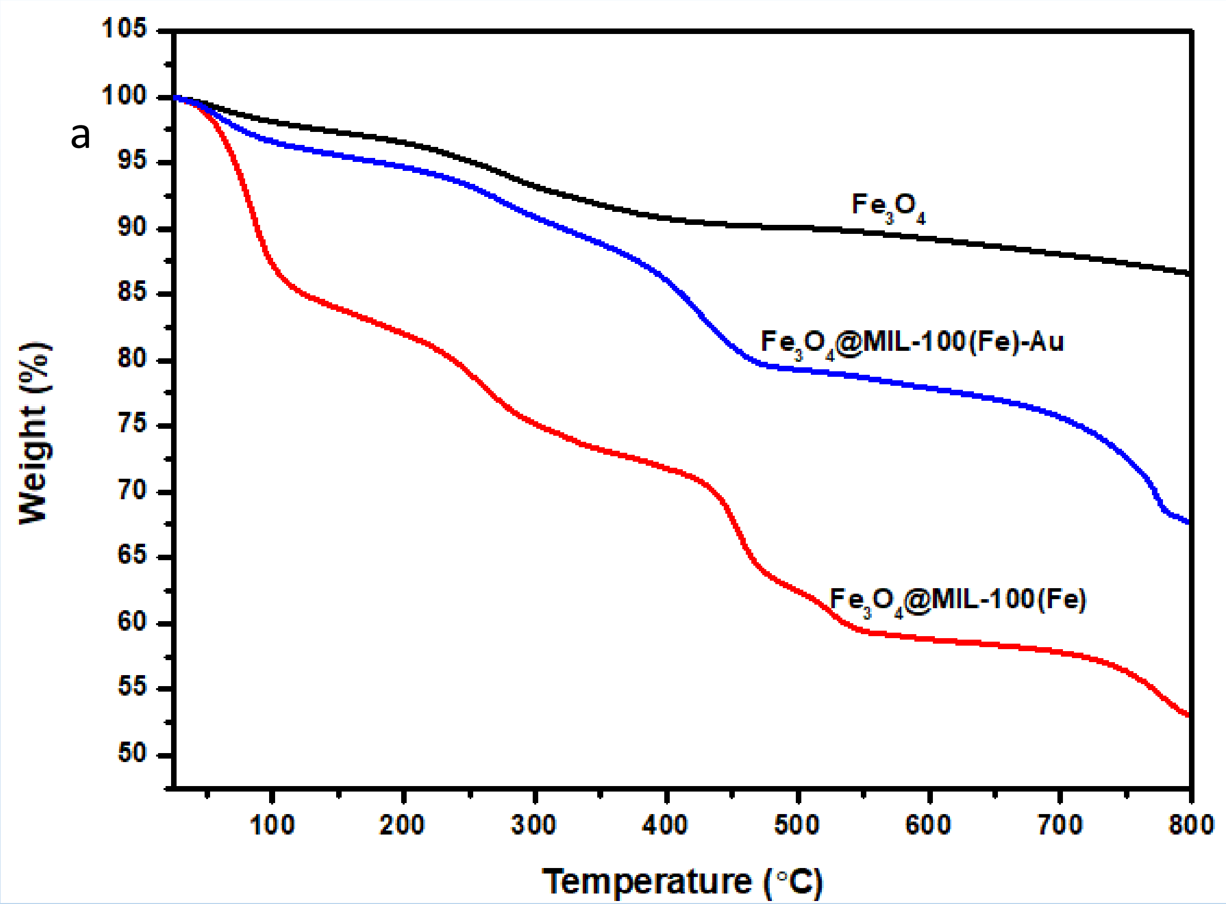
Results

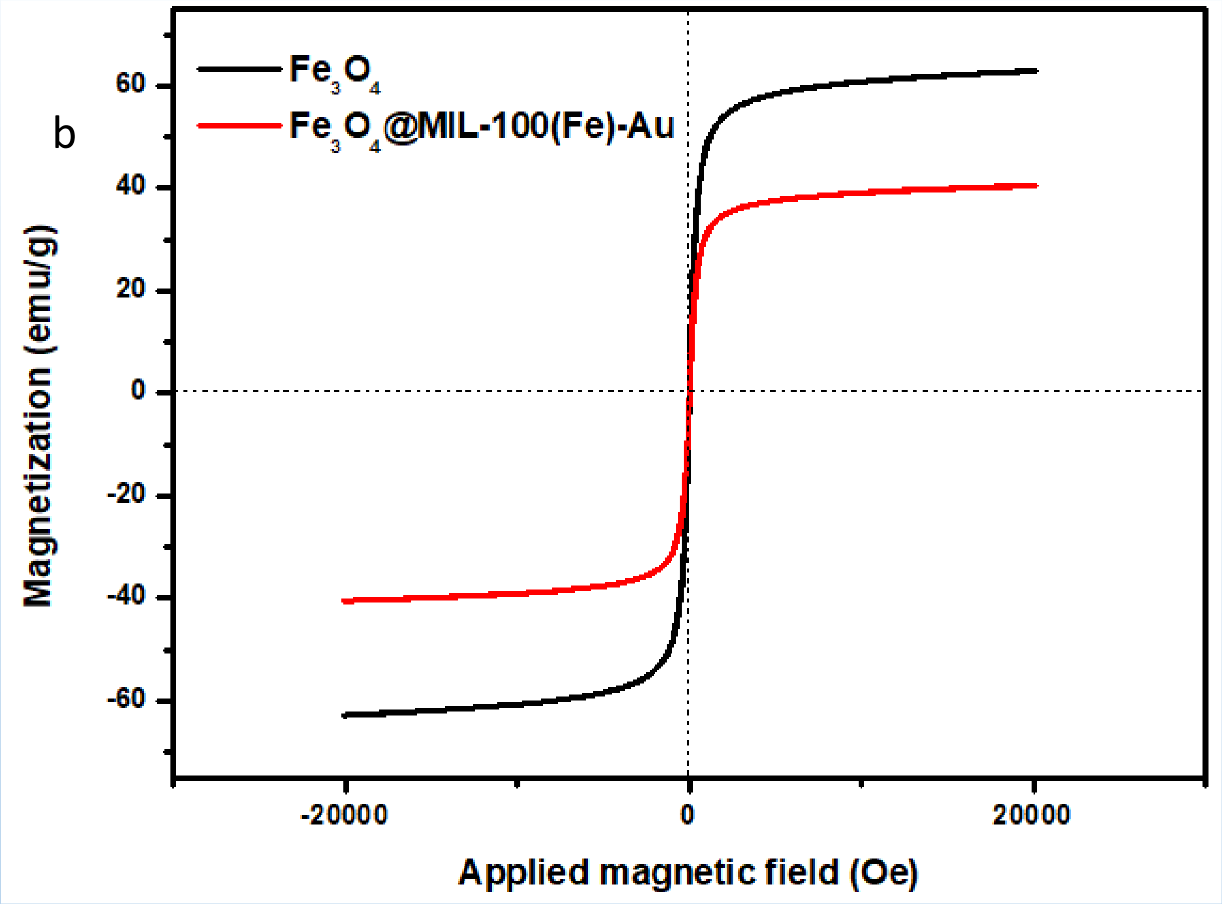




a) XRD for Fe_3O_4@MIL-100(Fe)-Au; b) FTIR of Fe_3O_4@MIL-100(Fe)-Au

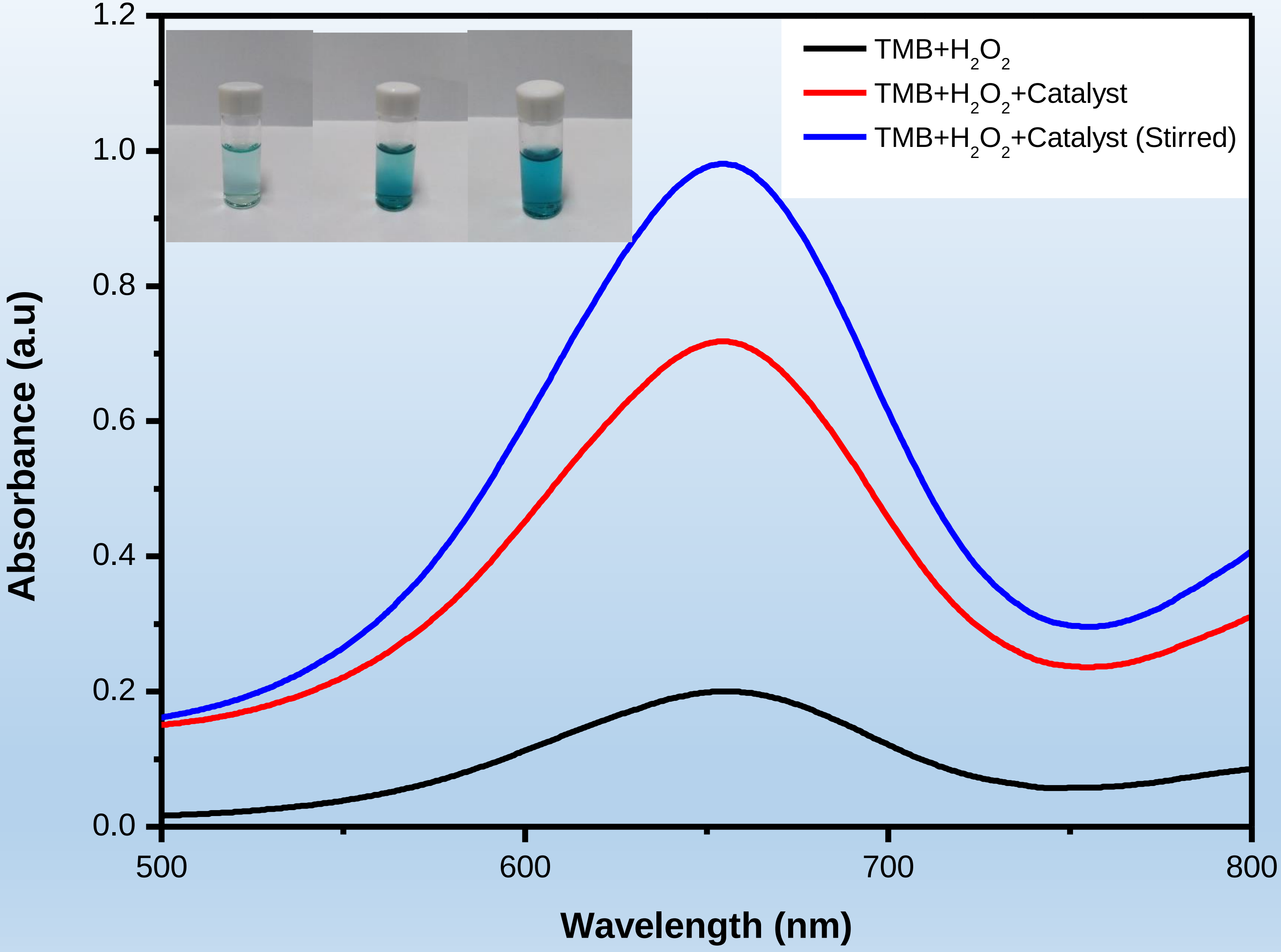
Results





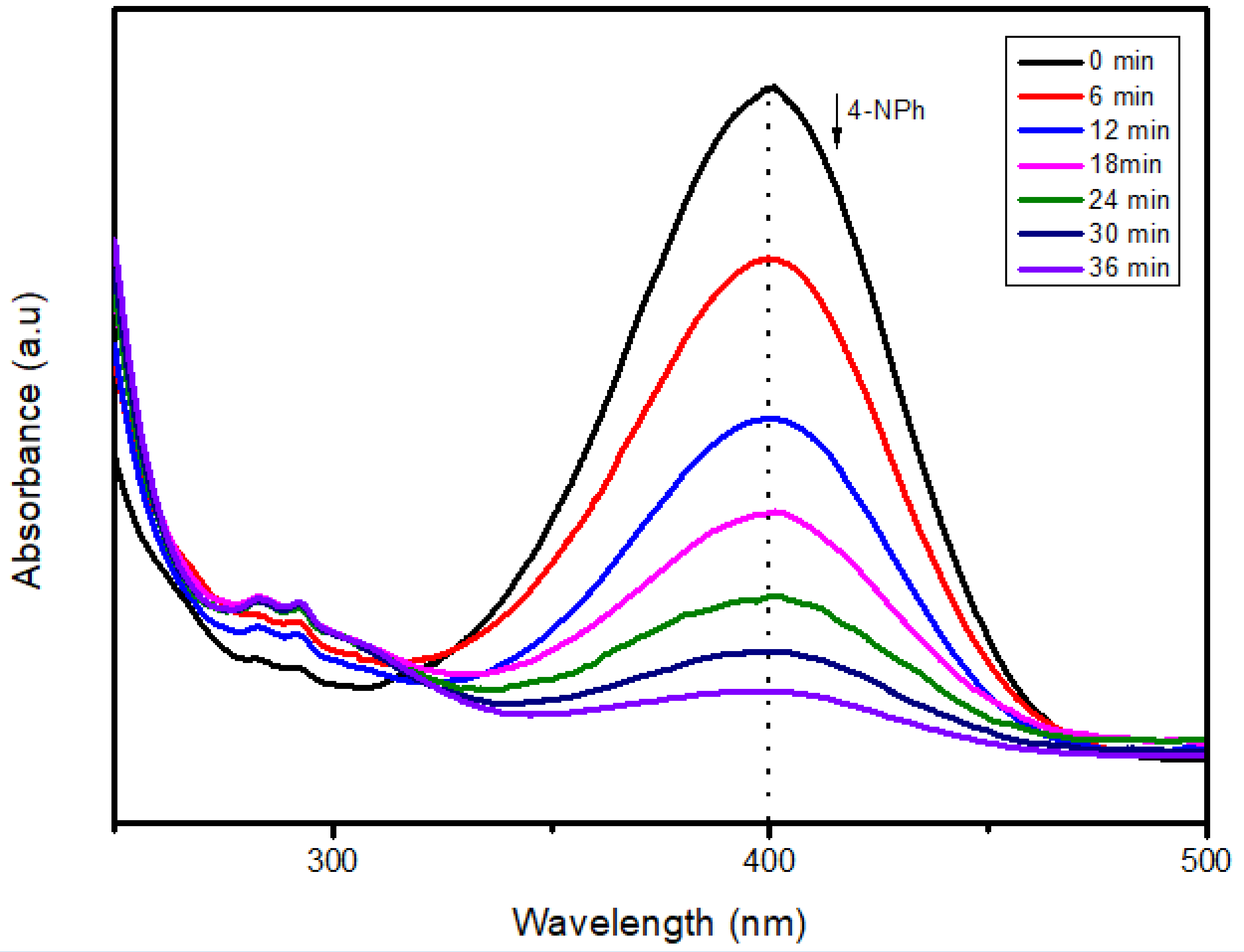
a) TGA of Fe_3O_4, Fe_3O_4@MIL-100(Fe), and Fe_3O_4@MIL-100(Fe)-Au;
b) VSM for Fe_3O_4 and Fe_3O_4@MIL-100(Fe)-Au

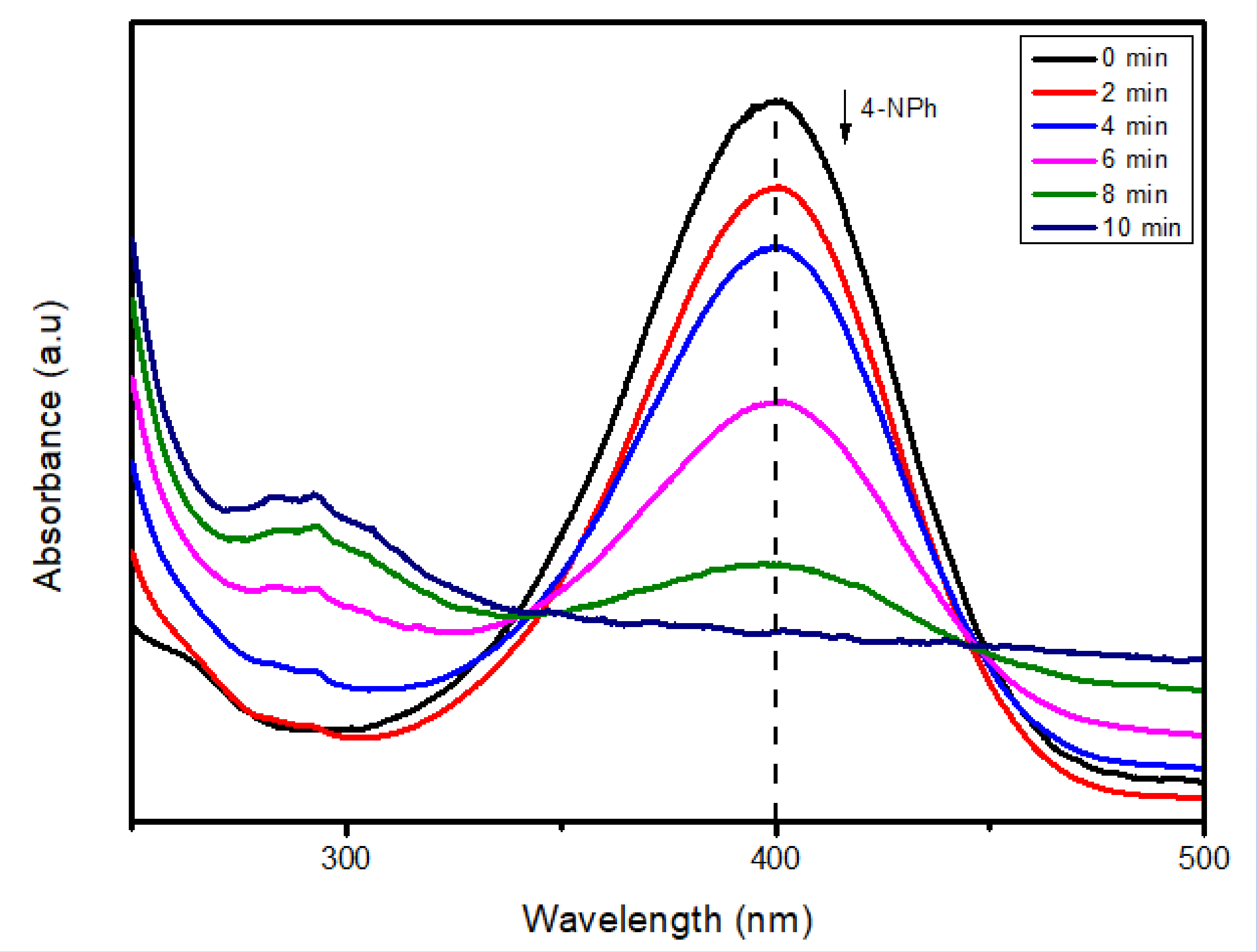
Results



UV-vis spectra for TMB oxidation with H_2O_2 without nanozyme (black), with nanozyme(red), and with nanozyme on a magnetic field (blue) (Inset picture: TMB+H_2O_2 (left), TMB +H_2O_2+Nanozyme (middle), and TMB +H_2O_2 + Nanozyme (on magnetic field) (right))

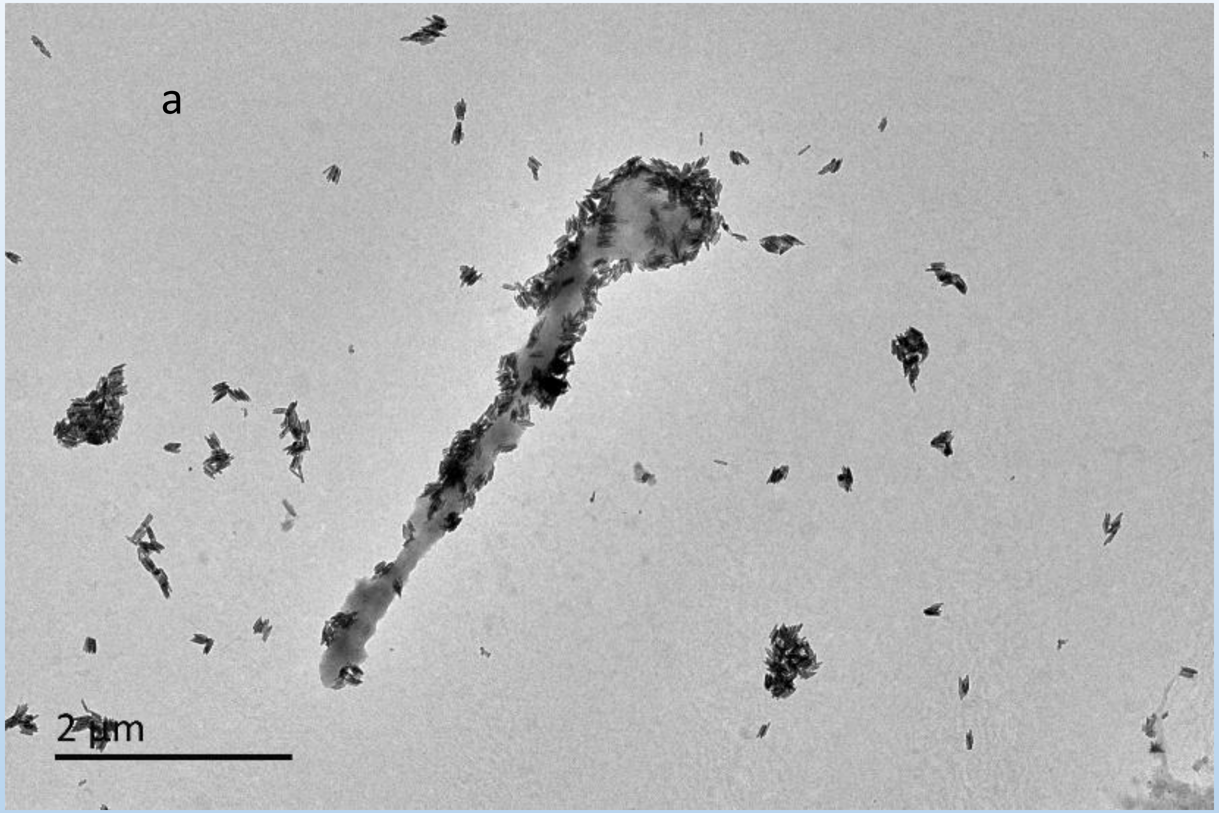
Results

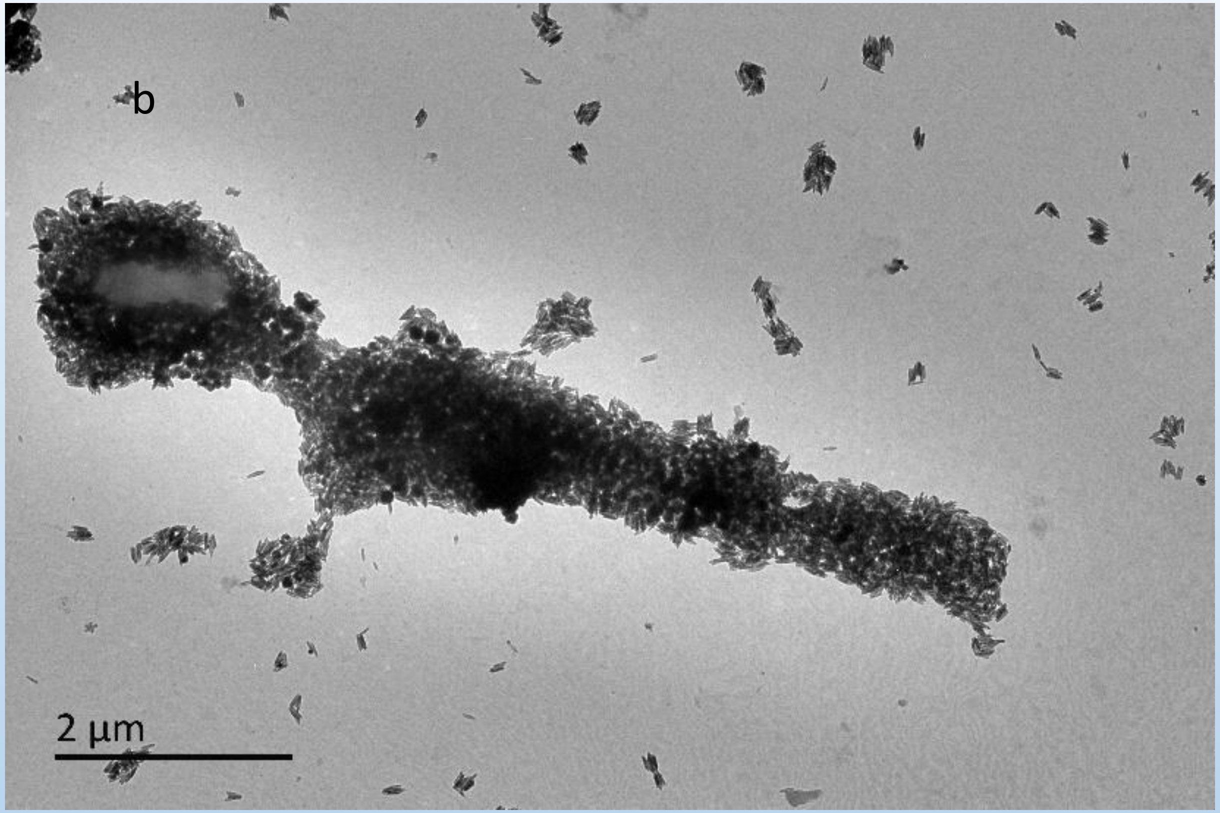




UV-vis spectra for a) Non-magnetic field-assisted reduction of 4-nitrophenol
b) Magnetic field-assisted reduction of 4-nitrophenol

Results





TEM of a) Non-magnetic field-assisted bacteria adsorption (capture)
b) Magnetic field-assisted bacteria adsorption (capture)

Conclusion

- Fe_3O_4@MIL-100(Fe)-Au was successfully used for the detection of H_2O_2 while the magnetic property of the Composite was further utilized to enhance the rate of detection

- The synthesized composite proved to be versatile and can be used for pollutant degradation and dye adsorption

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