NTA2022

2nd International Conference on
Nanotechnology: Theory and Applications,
Cairo, 19 – 21 Dec., 2022

Ref. 061

# Recent trends in magnetic nanomaterials: synthesis, properties, and their environmental and bio-applications

**Mona Sayed[1*], Mohamed Abbas[1,2] and Salma Naga[1]**

[1]Ceramics Department, National Research Centre, El-Behouth Str., 12622 Cairo, Egypt
monasayed382@yahoo.com, mohamed_abbas83@yahoo.com, salmanaga@yahoo.com
[2] Faculty of Chemistry, Jagiellonian University, Ul. Gronostajowa 2, Krakow, 30-387,
Polandabbas@chemia.uj.edu.pl

## KEYWORDS

Magnetic nanomaterials (MNMs), Magnetism, Synthesis approaches, Bio-medicines applications; Environmental applications

## SHORT SUMMARY

*Over the last half-century and till now, magnetic nanomaterials (MNMs) have gained considerable interest due to their tremendous prospects in various applications such as electronics, catalysis, energy, and biomedicine. The origin of the magnetism properties and its classification of diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism and superparamagnetism will be discussed. The recent approaches in the different chemical, physical, and mechanical synthesis processes and the biological synthesis methods of magnetic nanomaterials will be discussed in detail. The being used characterization techniques for magnetic nanomaterials will be explained in the recent review. Notably, the high specific surface area, the abundance of active sites, the adsorbent capacity, low cost and easy recycling properties make the magnetic nanocomposites promising materials for several environmental protection applications as adsorbents and catalysts materials (i.e., wastewater treatment from organic dyes, heavy metals and catalytic reduction reactions as well as value-added chemicals). The recently reported studies for using various functionalized magnetic nanomaterials and their composites in diverse bio-medicines and environmental applications are reviewed. In this review, the objective is mainly to provide a thorough assessment of the recent synthesis routes and the state-of-the-art for bio-medicine and environmental applications for magnetic nanomaterials and their composites.*

## EXTENDED ABSTRACT

For almost the last half-century and until now, magnetic nanomaterials (MNMs) have acquired enormous attention because of their tremendous prospects in different applications. The recent approaches of progress in the various chemical syntheses (i.e., hydrothermal, co-precipitation, sol-gel, sonochemical, polyol and thermal decomposition), physical synthesis (i.e., microwave irradiation, pulsed laser method, Gamma radiation and chemical vapor deposition), mechanical synthesis routes (i.e., mechanical grinding, high-energy ball milling, mechanical alloying (MA)) and biological synthesis methods of magnetic nanomaterials will be debated in details [1-6]. The being used characterization techniques for the thorough analysis of magnetic nanomaterials such as X-ray diffraction (XRD), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Vibrating-sample magnetometry (VSM), Fourier Transform Infrared Spectroscopy (FTIR), will be explained [7]. It is to be stated that the properties of the magnetic nanocomposites as well as their low-cost production candidate them for several environmental protection applications as adsorbents and catalysts materials (i.e., for wastewater treatment from organic dyes and heavy metals as well as catalytic reduction reaction of $CO_2$ and CO gases to fuels and value-added chemicals) [8,9]. The recently reported studies for using various functionalized magnetic nanomaterials (MNMs) and their composites in diverse bio-medicines are reviewed [10-13]. Indeed, the unique properties of easy manipulation through remote, magnetic fields have opened the way for particular and interesting biomedicine applications such as targeted drug delivery, hyperthermia and in vivo applications. The main objective of our review is to provide a thorough assessment of the recent synthesis routes and the state-of-the-art of bio-medicine and environmental

applications for magnetic nanomaterials (MNMs) and their composites.

## REFERENCES

[1] Habibi M H, Fakhri F. Hydrothermal synthesis of nickel iron oxide nano-compositeand application as magnetically separable photocatalyst for degradation of Solar Blue G dye. J Mater Sci: Mater Electron, 28:14091–14096 (2017).

[2] Mohammadi H, Nekobahr E, Akhtari J, Saeedi M, Akbari J, Fathi F. Synthesis and characterization of magnetite nanoparticles by co-precipitation method coated with biocompatible compounds and evaluation of in-vitro cytotoxicity. Toxicol Rep., 8, 331-336. (2021).

[3] Hasany S, Ahmed I, Rajan J, Rehman A. Systematic Review of the Preparation Techniques of Iron Oxide Magnetic Nanoparticles. Nanosci. and Nanotech., 2 [6], 148–158 (2012).

[4] Takai Z I, Mustafa M K, Asman S, Sekak K A. Preparation and characterization of magnetite (Fe3O4)nanoparticles by sol-gel method. Int. J. Nanoelectron. Mater., 12, 37–46 (2019).

[5] Ali A, Shah T, Ullah R, Zhou P, Guo M, Ovais M, Tan Z, Rui Y. Review on Recent Progress inMagnetic Nanoparticles: Synthesis, Characterization, and Diverse Applications. Frontiers in Chem., 9, 1-25 (2021).

[6] Gandhi A. C. Synthesis and Characterization of Functional Magnetic Nanomaterials. Coatings 2022, 12, 857.

[7] Al-Jabri, M.T.K., Devi, M.G. & Al Abri, M. Synthesis, characterization and application of magnetic nanoparticles in the removal of copper from aqueous solution. Appl Water Sci 8, 223 (2018).

[8] Asim Ali Yaqoob , Tabassum Parveen, Khalid Umar, and Mohamad Nasir Mohamad Ibrahim Role of Nanomaterials in the Treatment of Wastewater: A Review Water 2020, 12, 495

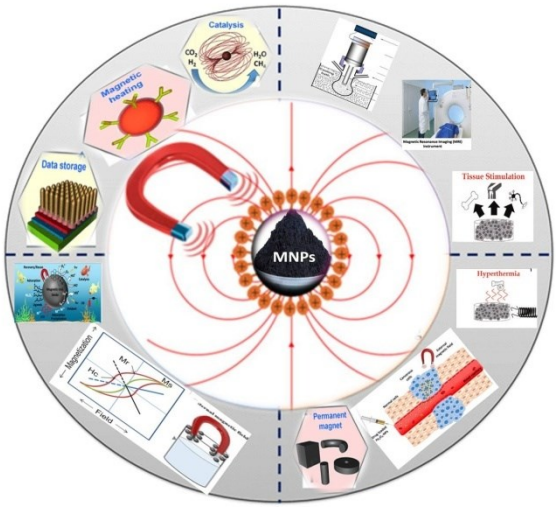
[9] Moeng Geluk Motitswe, Kassim Olasunkanmi Badmus, Lindiwe Khotseng. Development of Adsorptive Materials for Selective Removal of Toxic Metals in Wastewater: A Review . Catalysts 2022, 12(9), 1057.

[10] Gabriel Flores-Rojas G, López-Saucedo F., Vera-Graziano R., Mendizabal E. and Bucio E.Magnetic Nanoparticles for Medical Applications: Updated Review. Macromol, 2, 374–390 (2022).

[11] Anik M I, Hossain M K, Hossain I, Mahfuz A M U B, Rahman M T, Ahmed I. Recent progress of magnetic nanoparticles in biomedical applications: A review. Nano Select., 1–41 (2021).

[12] Lee, JH., Kim, B., Kim, Y. et al. Ultra-high rate of temperature increment from superparamagnetic nanoparticles for highly efficient hyperthermia. Sci Rep 11, 4969 (2021).

[13] Ansari S A M K, Ficiarà E, Ruffinatti F A, Store I, Argenziano M, Abollino O, Cavalli R, Guiot C, D'Agata F. Magnetic Iron Oxide Nanoparticles: Synthesis, Characterization and Functionalization for Biomedical Applications in the Central Nervous System. Materials (Basel),2, 12[3],465. (2019).




**Synthesis and applications of Magnetic Nanomaterials (MNMs)**