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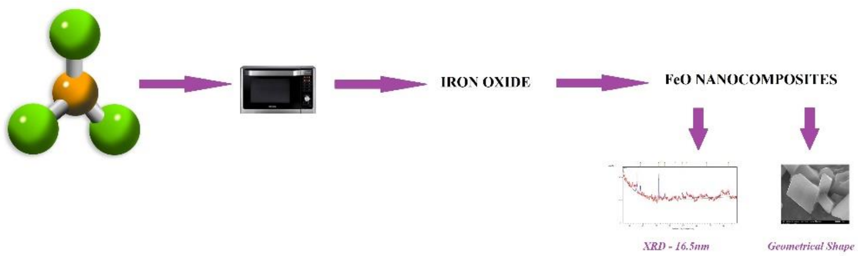
Abstract: *Nanoscience and nanotechnology have been acknowledged based on nanomaterials. More specifically, magnetic iron oxide nanocomposites are garnering more interest because of their intriguing characteristics. Due to their extensive polymorphism and fundamental features resulting from their multivalent oxidation states, iron oxide nanocomposites have drawn interest. This paper discusses the protein capped iron oxide composites structure and characterization.*

Keywords: **nanotechnology. iron oxide, morphology, protein**

Graphical Abstract



SYNTHESIS OF IRON OXIDE NANOCOMPOSITES

1. Introduction

Nanoparticles (NPs) are of rapid development in nanotechnology. Their exclusive size-dependent properties make these materials indispensable and superior in many human activities. Nanoparticles, nanocomposites, and nanofibers are all nanomaterials with distinct characteristics. Nanoparticles are small particles with dimensions in the nanoscale range and can be categorized into various classes based on their composition and dimensions. Nanocomposites (NC's), on the other hand, are multiphase solid materials in the nano dimension, consisting of more than one phase. Iron oxide is the most current transition metal in the Earth's crust, iron stands as the backbone of the current infrastructure. However, in comparison to group elements such as cobalt, nickel, gold, and platinum, iron oxides are somewhat neglected [1]. Iron and oxygen chemically combine to form iron oxides (compounds), with ~16 identified iron oxides. In nature, iron (III) oxide is found in the form of rust [2]. Generally, iron oxides are prevalent, widely used as they are inexpensive, and play an imperative role in many biological and geological processes [3]. The three most common forms of iron oxides in nature are magnetite (Fe3O4), maghemite (g-Fe2O3), and hematite (α-Fe2O3). These oxides are also important in the field of scientific technology [4]. Capping is done in nanocomposites due to their amount of application to the desired product. The use of different capping agents can control the material's particle size, agglomeration, morphology, and stability over time of nanostructures. Furthermore, the type of interaction of the capping agent on the surface of the nanoparticles influences the formed nanostructure [5]. In this study, protein is used to cap iron oxide nanocomposite and their structural properties are studied using different characterization methods. Proline is used as a capping agent. Proline is well known for its structural properties. Proline capped Iron oxide nanocomposites (Proline capped FeO NC's) are synthesized using microwave-assisted solvothermal method which is considered as a most effective method and a good time saver in research.

2. Synthesis

FeO nanocomposites were synthesized by microwave assisted Solvo-thermal method using ferric chloride as precursor.10 g of $Fecl_{3,}$ 9 g of Urea were dissolved in 15 ml of liquid ammonia, add 0.4 gram of proline stir the mixture thoroughly. The mixture should be heated on 300W for 10 minutes with a regular interval of cooling. The obtained crude (90%) was sun dried for a day and annealed in muffle furnace at 410°C. The percentage of Yield is 75 %.

3. Results and Discussion

3.1. UV Analysis

Figure 1 shows the absorption spectrum of proline capped FeO NC's which were synthesized by microwave assisted solvothermal method. Nanosized particles have their features under electromagnetic radiation. In UV – Visible range the prepared NC's display 292 nm. This result showed that the proline capped NC's were successfully formed.

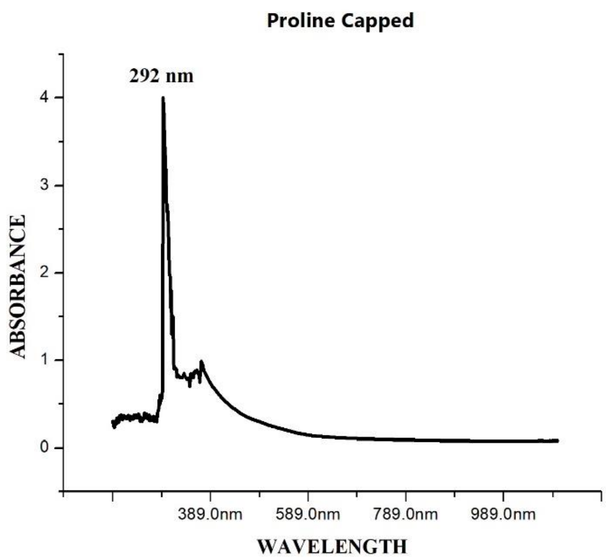


Fig. (1): UV Visible Spectra of Proline capped FeONC's

3.2 FTIR Spectrum

Infrared Spectroscopy provides more structural information by the presence or absence of main characteristic absorption bands that helps to detect the main functional groups in compounds. Herein the FTIR Spectrum were measured for proline capped FeO NC's and they are shown in figure 2. A characteristic peak from the Fe-O stretching band of iron oxide was observed at 988 cm^{-1}. The formation of Proline capped FeO NC's was confirmed by peaks from amide bands of protein . The Characteristic peaks at 3377 cm^{-1} and 1633 cm^{-1} were assigned to stretching vibration of OH and C = O [6]. The peak at 1541 cm^{-1} corresponds to bending vibration of NH group [7] and peak at 1700 cm^{-1} attributed to $CONH_2$ group [8].

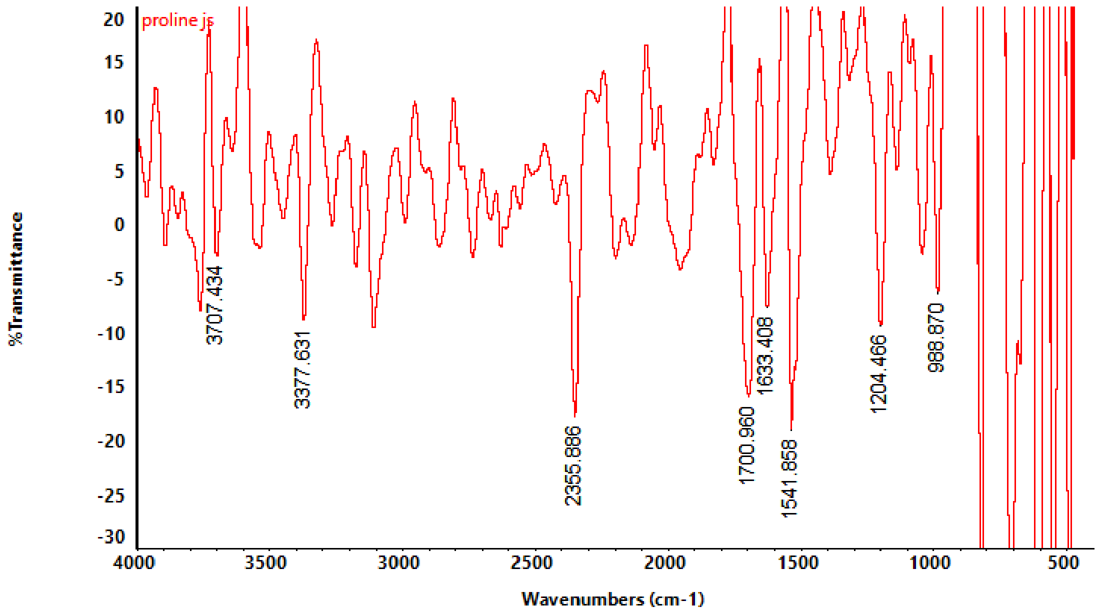


Fig. (2): FTIR Spectra of Proline capped FeO NC's

3.3. XRD Analysis

The inner structure of the magnetic nanoparticles was investigated by means of X-ray diffraction technique. Figure 3 shows the crystallographic structure of proline capped nanocomposites. The Proline capped FeO nanocomposites show the diffraction characteristic peaks of iron oxide at 2θ = 15, 18, 31,

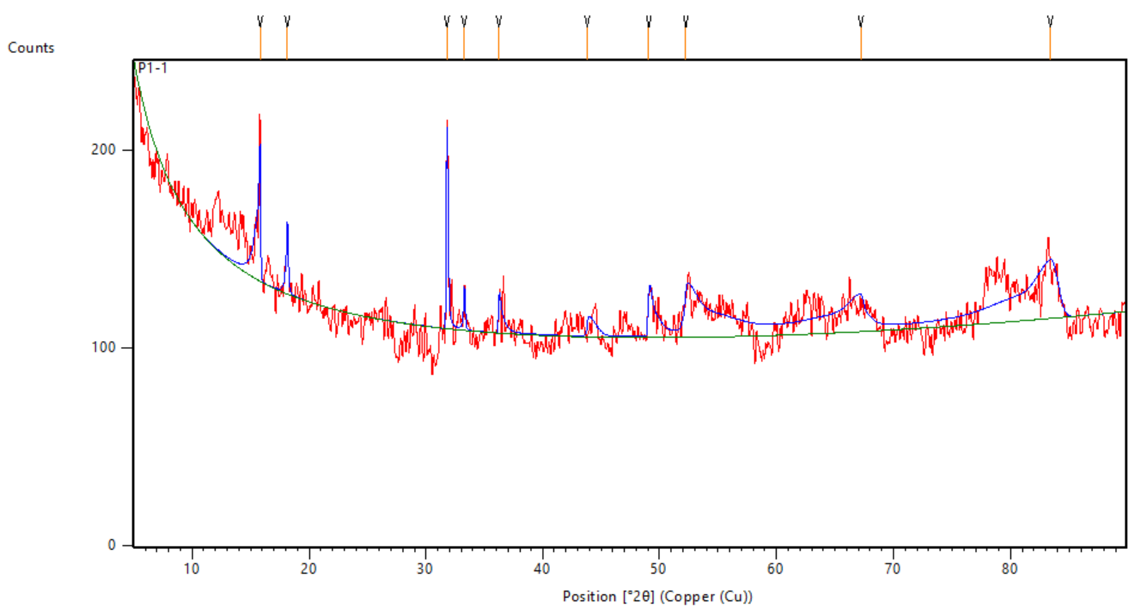


Figure (3) : XRD diffraction patterns of Proline capped FeO NC's

33,36, 43, 49, 52, 67, 83. And also the three corresponding diffraction peaks at 2θ = 30°, 33°, 43° which referred to the existence of a nanocrystalline spinel phase [9]. According to the Scherrer's equation, the average particle size of the proline capped iron oxide nanocomposites is 16.5 nm.

3.4 SEM Analysis

Figure 4 shows the SEM images of proline capped FeO NC's. The morphology of proline capped FeO NC's shows geometrical shape. It can be noticed in higher magnification.

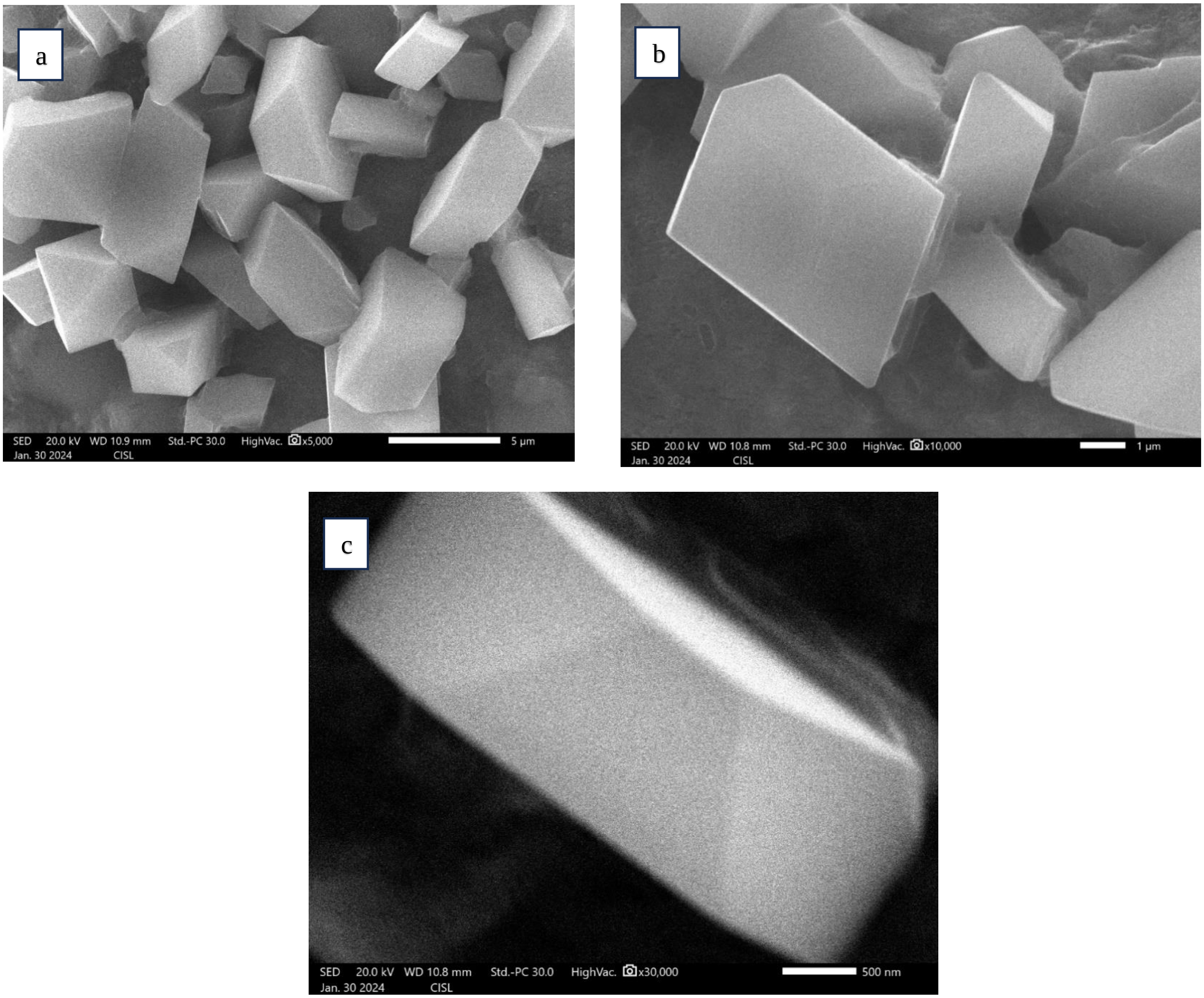


Fig. (4): SEM micrographs of Proline capped FeO NC's
(a) at 5k (b) at 10k (c) at 30k

3.5. AFM Analysis

The surface topology of proline capped FeO Nc's were characterized by using Atomic Force Microscope. The figure shows the topology of proline capped iron oxide nanocomposites and the formation of nanocomposites.

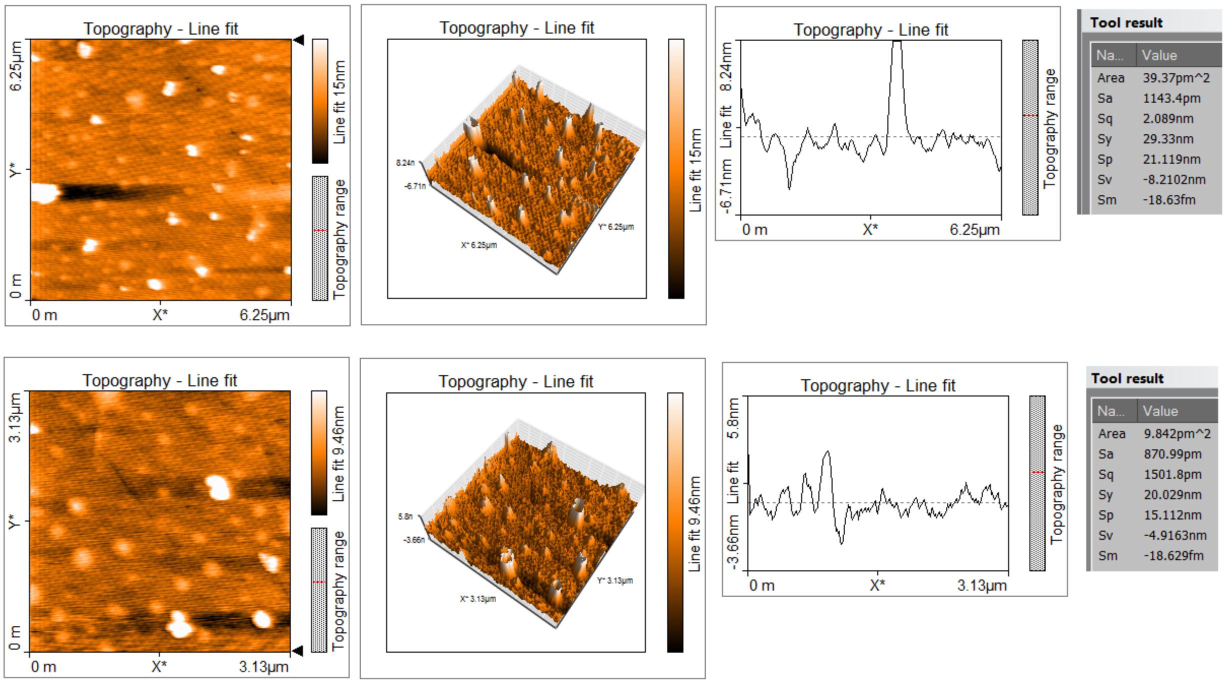


Figure (5) : AFM images of Proline capped FeO NC's

4. Conclusion

In this study, Proline capped iron oxide nanocomposites were prepared by microwave assisted solvothermal method. The chemical structure of proline capped FeO NC's were confirmed by Spectroscopic techniques such as FTIR and XRD Spectroscopy. The morphology and topology were discussed using SEM and AFM techniques. The synthesized nanocomposites show more stability and it could be used in various application of drug delivery.

5. Reference

[1] Salata, OV, "Applications of nanoparticles in biology and medicine JO", Journal of Nanobiotechnology., vol. 2, no. 1, (2004), pp. 3.
[2] Huber, Dale L. "Synthesis, properties, and applications of iron nanoparticles." Small (Weinheim an der Bergstrasse, Germany) vol. 1,5 (2005), pp. 482-501.
[3] Cornell RM, Schwertmann U. The Iron Oxides: Structure, Properties, Reactions, Occurrences and Uses. 2nd ed. John Wiley & Sons; 2006.
[4] Laurent, Sophie et al. "Magnetic iron oxide nanoparticles: synthesis, stabilization, vectorization, physicochemical characterizations, and biological applications." Chemical reviews., vol. 108, no. 6, (2008), pp. 2064-110.
[5] Cindy Vanessa Restrepo and Cristian C. Villa, "Synthesis of silver nanoparticles, influence of capping agents, and dependence on size and shape: A review", Environmental Nanotechnology, Monitoring & Management., vol., 15, (2021), pp. 100428.
[6] Liu, Minxue and Yu, Fengli and Yuan, Bing and Xie, Congxia and Yu, Shitao, "High-Selective Oxidation of n-Propanol to Propionic Acid Catalysed by Amino-Acid-Based Polyoxometalates", 2021.
[7] Jayaramudu, Tippabattini et al. "Chitosan capped copper oxide/copper nanoparticles encapsulated microbial resistant nanocomposite films." International journal of biological macromolecules., vol. 128 (2019), pp. 499-508.

[8] El-saied, Hend and Ibrahim, Ahmed, “Effective Fabrication and Characterization of Eco-friendly Nano Chitosan Capped Zinc Oxide Nanoparticles for PEfficient Marine Fouling Inhibition”., Journal of Environmental Chemical Engineering., vol. 8., (2020), pp. 103949.
[9] Nasef, Shaimaa and Badawy, Naguaa and Hafez, Fatma and Slim, Sabah and Nesr, Eman, “Preparation And Characterization of Magnetic Nanocomposite Based on Gum Arabic/2-Hydroxyethylmethacrylate Using Gamma Irradiation For Use In Biomedical Application”., Arab Journal of Nuclear Sciences and Applications., vol. 52, (2019), pp. 209-226.