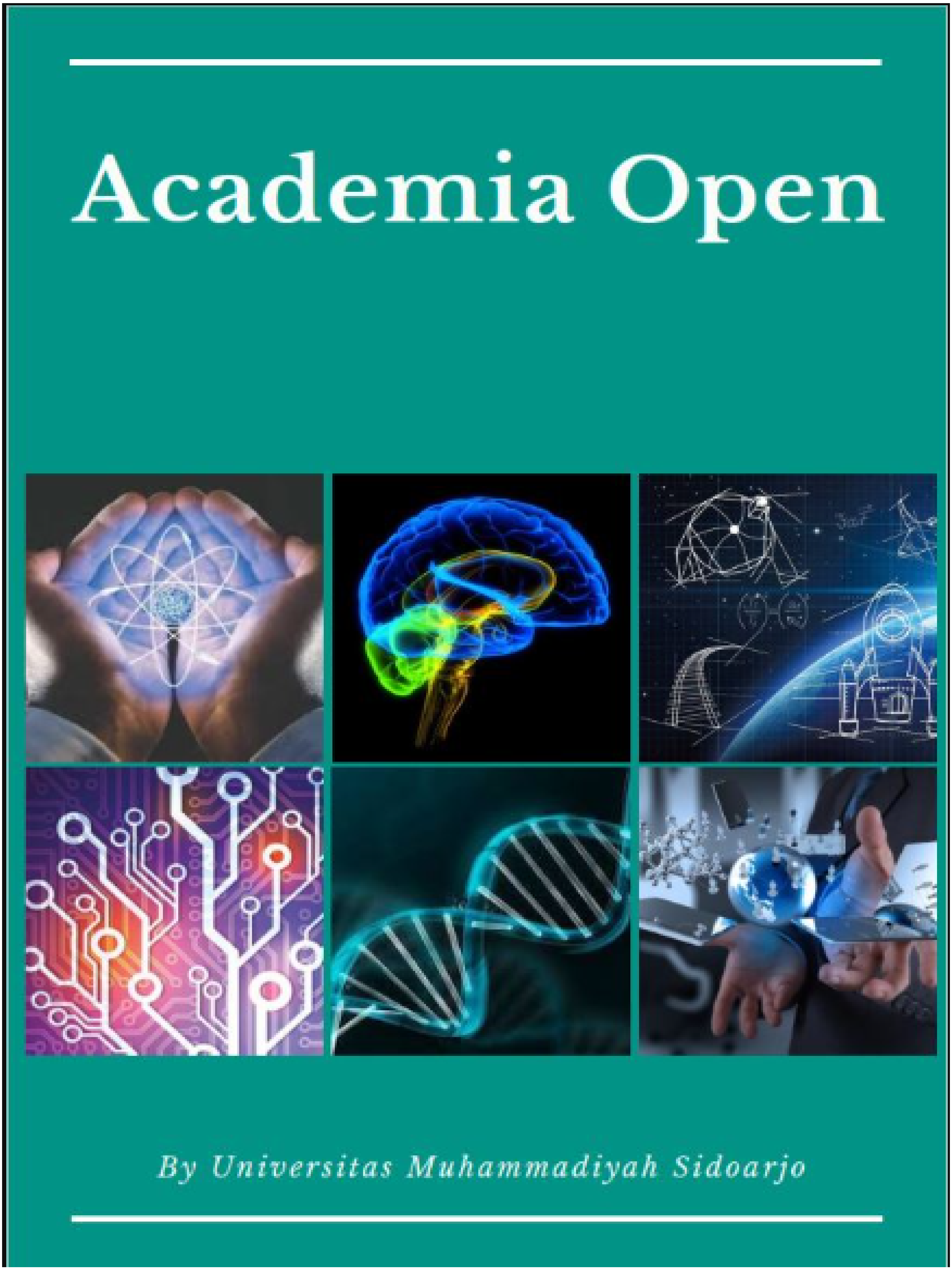
Academia Open

Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889



ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open

Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889

Table Of Contents

Academia Open

Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889

Originality Statement

The author[s] declare that this article is their own work and to the best of their knowledge it contains no materials previously published or written by another person, or substantial proportions of material which have been accepted for the published of any other published materials, except where due acknowledgement is made in the article. Any contribution made to the research by others, with whom author[s] have work, is explicitly acknowledged in the article.

Conflict of Interest Statement

The author[s] declare that this article was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright Statement

Academia Open

Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889

EDITORIAL TEAM

Academia Open

Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889

Article information

Check this article update (crossmark)

Check this article impact (*)

Save this article to Mendeley

(*) Time for indexing process is various, depends on indexing database platform

Academia Open
Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889

Study and Analysis of Nanoscale Properties of Nickel and Nickel Oxides Prepared Using Roselle extract

Safa Mohsen Shnain, SafaShnain85@gmail.com (*)
Al - Qadisiya Education Directorate, Ministry of Education, Qadisiya, Iraq

(*) Corresponding author

Abstract

General Background Nanotechnology continues to drive innovations across environmental remediation, energy storage, and biomedical engineering through sustainable nanomaterial design **Specific Background** Among metallic oxides, nickel oxide nanoparticles synthesized via eco-friendly plant extracts present significant advantages over conventional chemical routes due to lower toxicity and cost-effectiveness. **Knowledge Gap** However, the precise structural and morphological characteristics of nickel oxide nanoparticles synthesized using Roselle leaf extract remain insufficiently characterized. **Aims** This study investigates the green biosynthesis of nickel oxide nanoparticles utilizing Roselle leaf extract as an eco-friendly reducing agent. **Results** X-ray diffraction analysis confirms the high-purity crystalline structure of the synthesized nickel oxide, while field emission scanning electron microscopy reveals spherical, highly agglomerated clusters alongside single-dispersion rod-like morphologies. **Novelty** This work establishes a sustainable, single-step green synthesis path utilizing Roselle leaf phytochemicals without toxic external capping agents. **Implications** These findings demonstrate a viable eco-friendly strategy for producing highly crystalline nickel oxide nanostructures for advanced technological applications.

Key Findings Highlights

Highly crystalline nickel oxide nanoparticles were successfully biosynthesized using roselle leaf phytochemicals.

Structural characterization confirmed a high-purity crystalline phase with distinct diffraction profiles.

Morphological analysis demonstrated spherical clustered architectures with single-dispersion rod nanostructures.

Keywords: Green Synthesis, Nickel Oxide Nanoparticles, Roselle Leaf Extract, Crystalline Structure, Morphological Characterization

Published date: 2026-09-09

Introduction

Nanotechnology is among the very small technologies, it a new active and very fast- moving field of research and has gained great attention all over the world. The world is now witnessing a heated race between research centers and industry to employ nanotechnology in new industries and products. Nanoscience is the science of modifying molecules or atoms to make new products, this term is applied to any technology that works at the level of extremely small measurements, a nanometer represents one billionth of a meter and this scale reflects the size of the leap that this technology makes compared to microtechnology which produced computers, transistors, and all electronic equipment. Nanotechnology reduces dimensions by about 1000 times and thus reduces the area by about a million times, this leads to an increase in speed and a reduction in the energy consumption of these devices, Nanoscience and nanotechnology are not separate fields from science, rather they deal with the fundamental building blocks of matter: atoms and molecules, nanotechnology is at the heart of new scientific concepts, enhancing our understanding of interactions between atoms and molecules and the tools used to manipulate and synthesize new materials and devices.Nanotechnologyrelies heavily on integrating technology with interdisciplinary sciences such as engineering, biology, physic, medicine and chemistry , the application of nanotechnology in these fields has begun to advance these sciences, utilizing elements from these disciplines to build new and applied sciences, Nanotechnology is considered one of the future sciences that is in raising request in manufacture , medical with the transportation and communication sectors, this is due to its unprecedented application in all fields , Currently, nanotechnology applications are being developed in almost all industrial sectors including electronics manufacturing, energy production and storage and materials development, furthermore, it has promising applications in medicine and the healthcare , it is also worth noting that some consumer products, including cosmetics, utilize nanotechnology in their manufacturing , it is also utilize as a staple for styling novel weapons systems , what makes this field extremely important is the fundamental nature of this technology which relies heavily on human resources and natural resources , while simultaneously being relatively inexpensive thus enabling us to enter the nano-age [1,2].

DOI: 10.21070/acopen.12.2027.15889

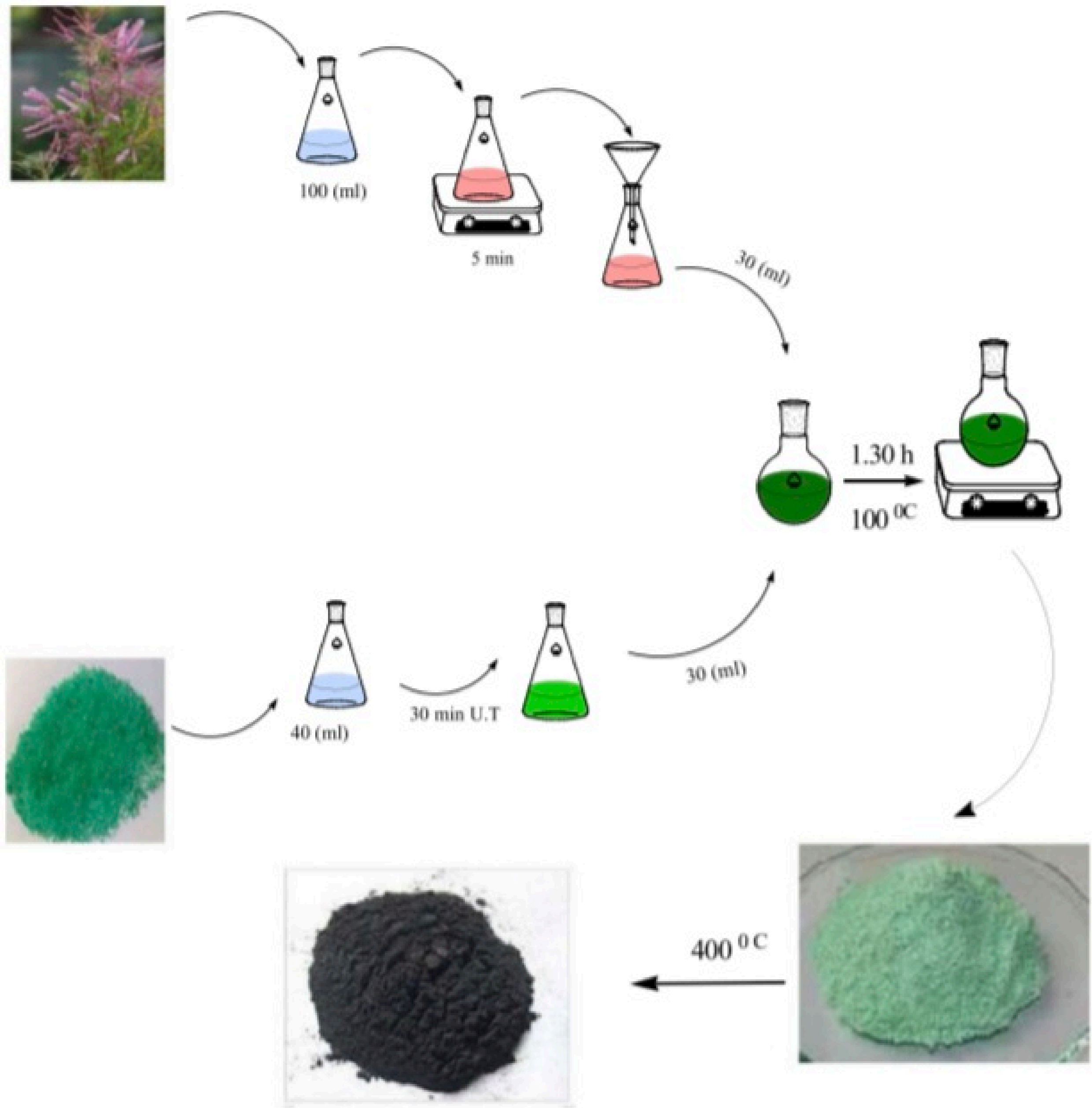


Figure 1.

Figure (1) Biosynthesis of Nickel Oxide nanoparticles [3]

Properties of nanomaterials

Nanomaterials have enormous applications in optoelectronic displays catalysis spin - electronics diagenetic and sensors due to their distinct size -dependent physical and chemical properties, If the size of the material is reduced to the nanoscale its properties change and become sensitive to shape and size [4].

1- Mechanical Properties

The mechanical properties of nanomaterials increases with decreasing size because smaller size reduces the likelihood of impurities, the particles become purer and more homogeneous as the material size decreases, the interfacial surface area of the material increases significantly, resulting in a defect – free surface and improved strength, which differs considerably from that of fine particles and bulk material, hardness, super plasticity , yield strength, porosity, toughness, and grain size

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

are significantly modified by manipulation, in the nano system ,a decrease in particle size leads to an increase in the particle boundaries within the material, A greater proportion of boundaries resists crack grown, thus increasing toughness.

2- Optical properties

The optical properties of nanomaterials depend on size, shape and structure, reducing size has a significant impact on optical properties because the quantum volume impact and the surface plasmon resonance effect, according to the quantum size effect the bandgap energy increases as the particle size decreases, thus different nanoparticles produce different colors when stimulated by ultraviolet light, the color of nanomaterials is determined by the wavelength of light they absorb, A nano mass of different sizes has a different bandgap and therefore different absorption spectra and consequently, different colors.

3- Chemical properties

Chemical reaction depends on the surface area available to the molecule, A large superficies area-to- size ratio of smaller nanoparticles provides the big superficies area for reaction with thus chemical reaction activity increases with decreasing volume.

4- Electrical Properties

The electrical properties of nanoparticles describe the fundamentals of the electrical conductivity of nanorod nanotubes and nanocomposites, As the particle size decreases below the bohr radius surface dispersion decreases and electrons become more confined, resulting in an increases in the band gap which enhances the electrical conductivity of the nanomaterial, due to its larger surface area nanoparticles can store more energy thus improving the electrical properties, similarly reducing the diameter of a nanowire increases the number of electron wave modes that contribute to electrical conductivity.

5- thermal properties

The thermal properties of a material depend primarily on the behavior of the photon , due to dimensionality reduction to the nanoscale the size of the photons free path and its wavelength due to photon capture and quantization transport of nanoparticles can be compared to the average photon, photon transport within nanoparticles changes significantly, thus altering the thermal properties nanoparticles have been found to have a low melting point, which decreases with particle size because surface energy increases with increasing surface area, the decrease in melting point can be attributed to the change in the ratio of surface energy to the size energy as a function of particles size.

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

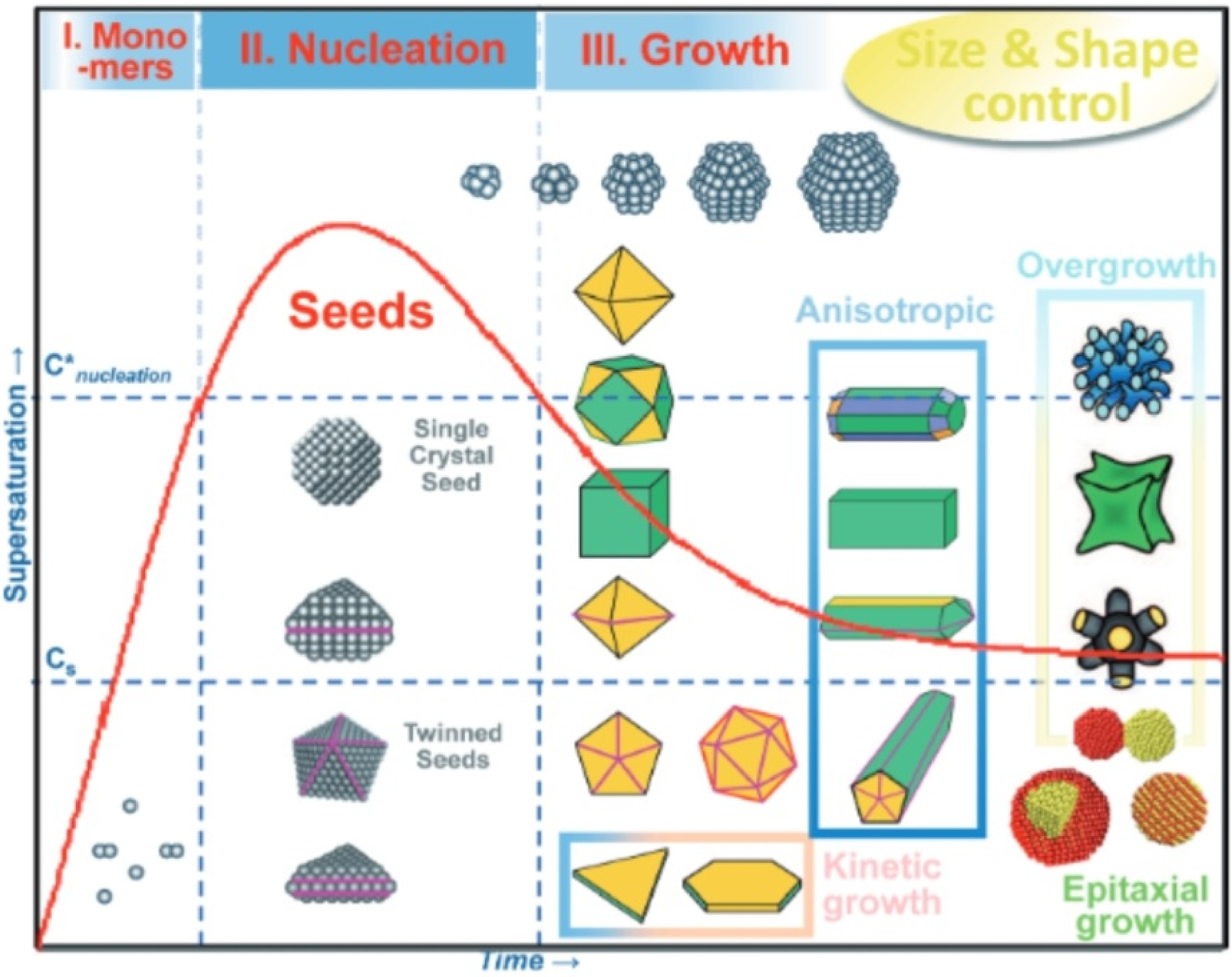


Figure 2.

Figure (2) schematic representation of general synthesis strategies for controlling the shape and size of nanoparticles [5]

Nanomaterial shapes

Nanomaterials vary greatly in shape, with different compositions, properties and size in terms of diameter and length, each has unique uses, these materials can be classified based on their different shapes [6].

1 – Nanoballs:

These are nanomaterials in the form of multi- layered hollow sphere with no gaps on their surface reaching a diameter of 500 nanometers or more, Among the most important are carbon nanospheres made of C60, which belong to the fullerene class.

Academia Open
Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889

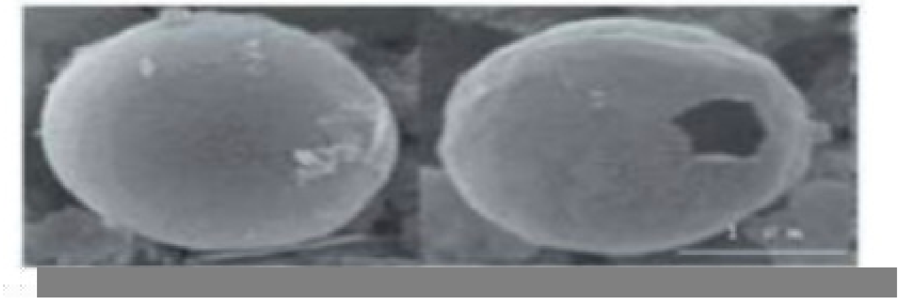


Figure 3.

Figure (3) image illustrating of a secondary sphere

2 - Q uantum Dots:

These are three- dimensional semiconductor nanostructures with dimensions ranging from 2 to 10 nanometers, when the diameter of a quantum dot is 10 nanometers, 3 million quantum dots can be lined up side by side with a lengthen equivalent of the width to the mankind digit.

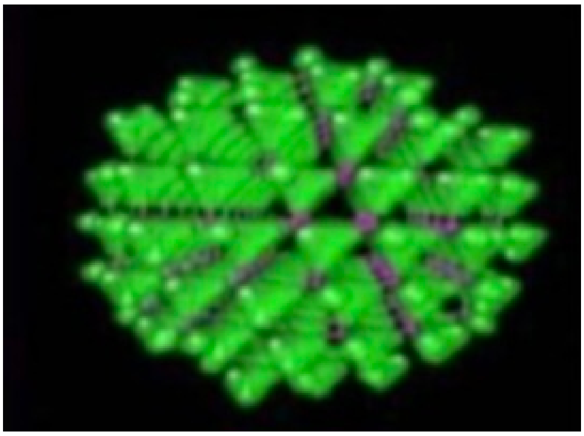
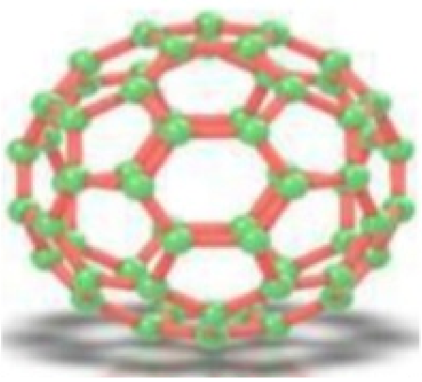


Figure 4.

Figure (4) image illustrating quantum dots

3 – Fullerene:

They are nanoparticles made up of triple – bonded carbon atoms that give the shape of spheres with structure similar to graphite, but instead of a pure hexagonal shape they contain pentagonal and possibly heptagonal shapes of carbon atoms which leads to the layers bending into spheres or cylinders, the most famous fullerene is the C60 molecule in which 60 carbon atoms are arranged on the verticals of a truncated icosahedron and it is characterized as a magnetized and non-friable molecule.



ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open
Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889

Figure 5.

Figure (5) image representing fluorine

4 – Nanowire:

These are wire with a diameter of less than 1 nanometer and varying lengths, they are classified as one – dimensional materials surpassing conventional wires due to the electrons with in them quantum confined to mono side, giving them a power level different from that found in tangible materials, this type of material does not occur naturally but is prepared in laboratories, they have different shapes including helical wire or pentagonal symmetrical wires.

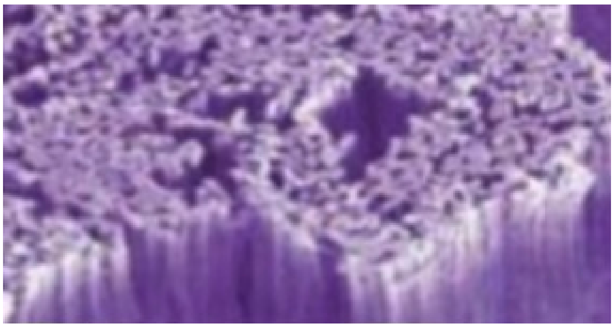


Figure 6.

Figure (6) image of nanowire

Materials and Methods

Chemicals

Nickel nitrate .6H2O Pure 99.9% (Molar Mass is 290.79 g/mol) it has a solid emerald green appearance, were obtained it at sigma Aldrich, Roselle blossoms, Whatman filter sheet, absolute ethanol was purchased it at Merck (KGaA, Germany) with distilled water is utilize in the job.

Production of aqueous extract

Nanomaterials can be formed via blossoms and leaves of flora where parts of flora are quite washed and the assist of faucet water with antisepsis through double – distilled water add to through drying at room temperature. the arid pattern goes to the procedure of weighting with grinding. Thereafter flora extract is blended and water as per aspired focus with ebullition and continual moving. The produced solution is then ultrafiltered and Whatman filter sheet, with the part in which there is an apparent solution was available for pattern [7].

Green synthesis of Nickel Oxide nanomaterials

Nickel oxide nanoparticles prepared using adding (0.1) g from Nickel nitrate to)50 ml(from plant extract (Roselle extract) which preappointed synthesis from leaves at room and stirred in the mix for 30 min, then mixture is then left in the dark for one day after which the extract is evaporated resulting in the back precipitated the product was then collected after being washed with water and alcohol and place in a ceramic bowl with heated in furnace to 400 for 4 hour then the particles grinded in a mortarium with pounder [8].

Result and Discussion

X – ray Diffraction pattern (XRD)

The X-ray diffraction technic was utilized to diagnosis with enhance the crystalline composition of synthesis nanomaterials. X-ray Diffraction sample of NiO NPs is appear in (Fig.7) the datum of best three beams. The beams position of the patterns shown the monoclinic ultrastructure with singular phase of Nickel Oxide nanomaterials with central cubic structure. Not contaminants were detected. It can be concluded that the diffraction of NPs include very sharps beams and a hyperfine normal with upper crystalline the enhances purity with exact shaping of metallic-oxide nanoparticles [9,10,11,12,13].

Academia Open
Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889

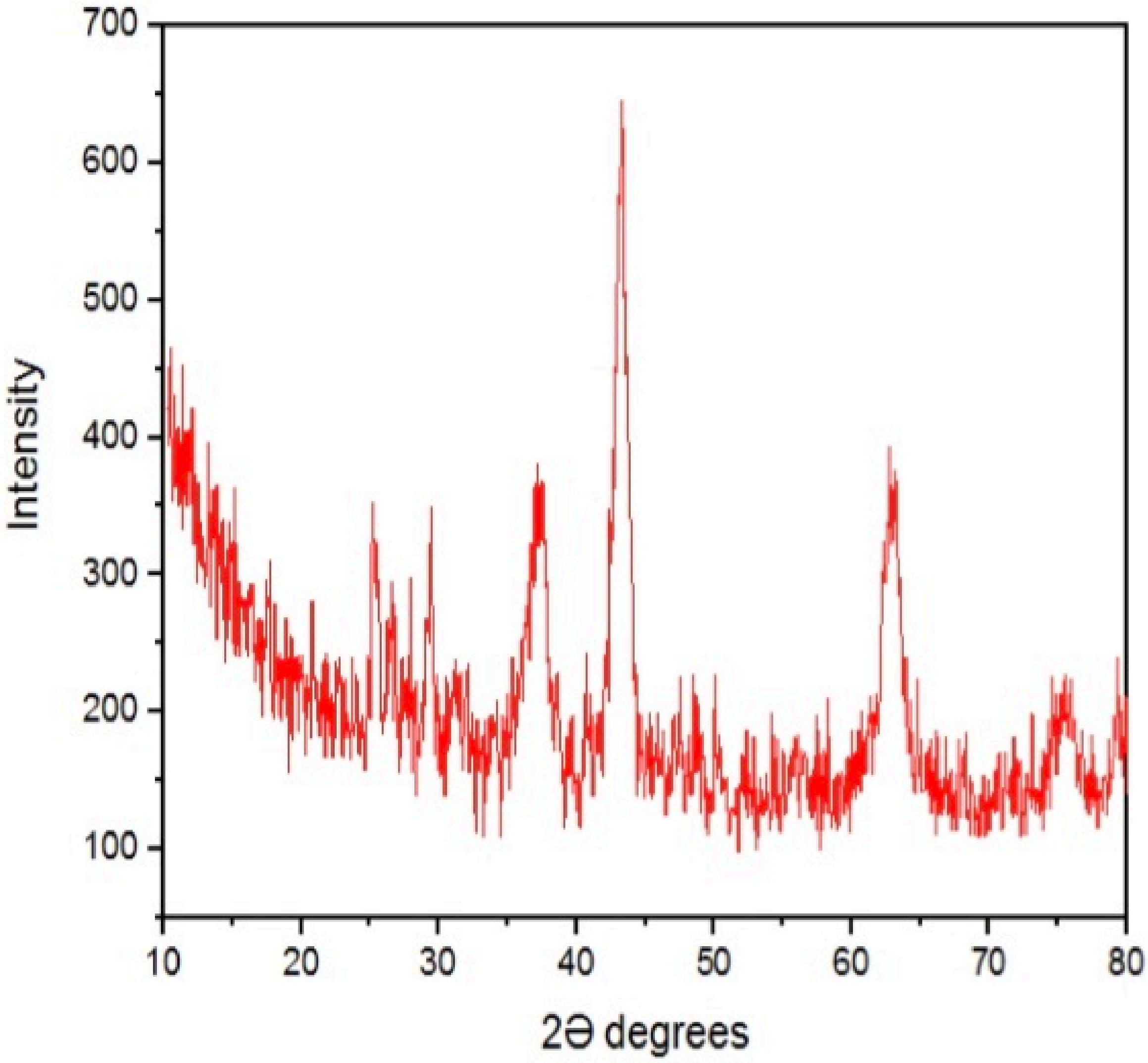


Figure 7.

Figure (7) XRD sample of formed (NiO nanoparticle)

FieldEmission - Scanning Electron Microscopy (FE-SEM)

FE-SEM technic was utilized to research the morphological nature of NiO nanoparticles. (Fig.8) exhibit the FE-SEM photo of the prepared nickel- Oxide NPs that have spherical agglomerated forms with variation particles size and greatly crystalline moreover extremely agglomerated with shows as cluster of nanomaterials. some of them have a single – dispersion rod shape. The clusters of nanomaterials may be because of exposure of the nanoparticles to big size of the heat through calcination stage or owing to the highly surface stress of the nanomaterials with highly surface energy [14,15,16,17].

Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889

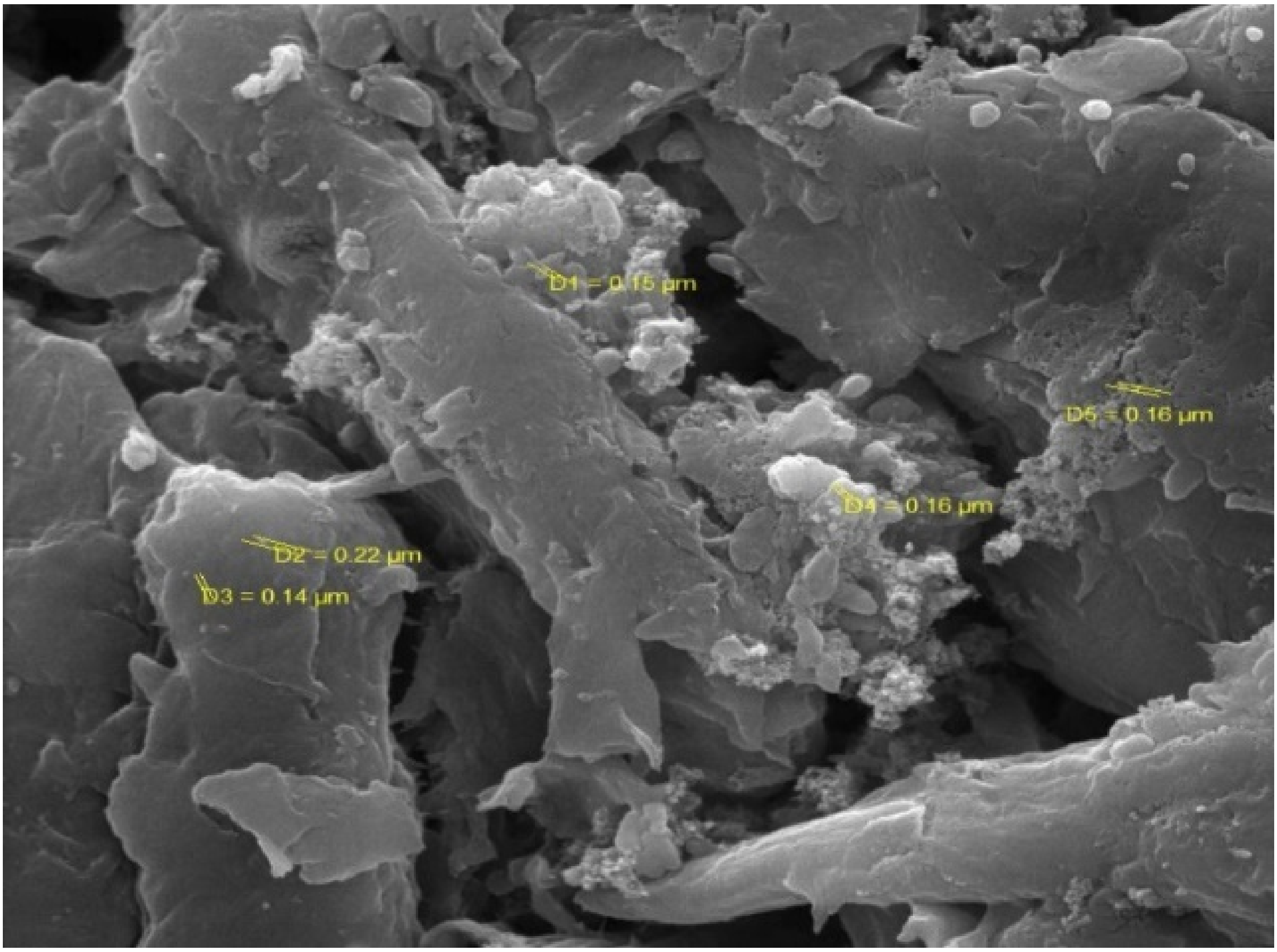


Figure 8.

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open
Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889

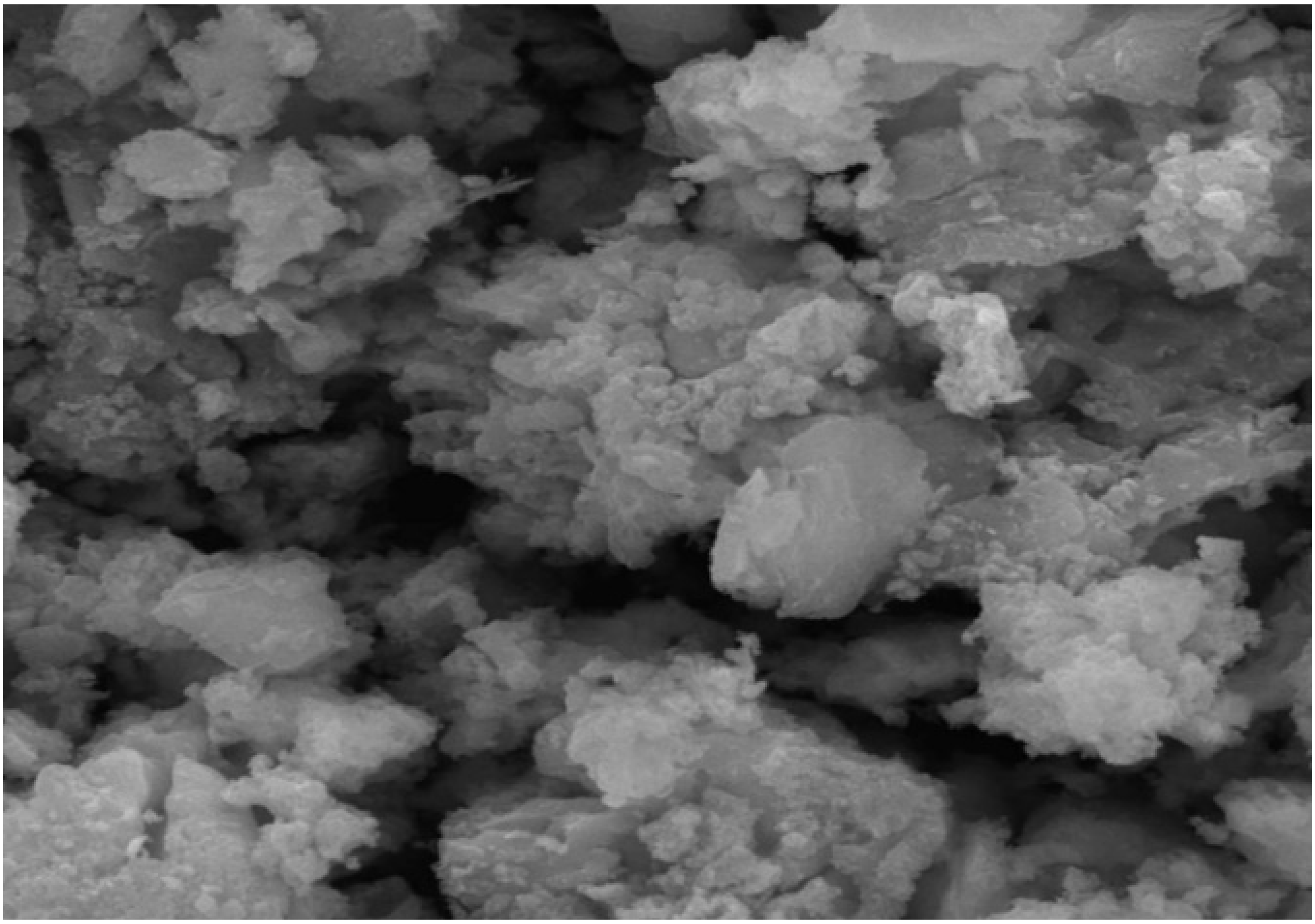


Figure 9.

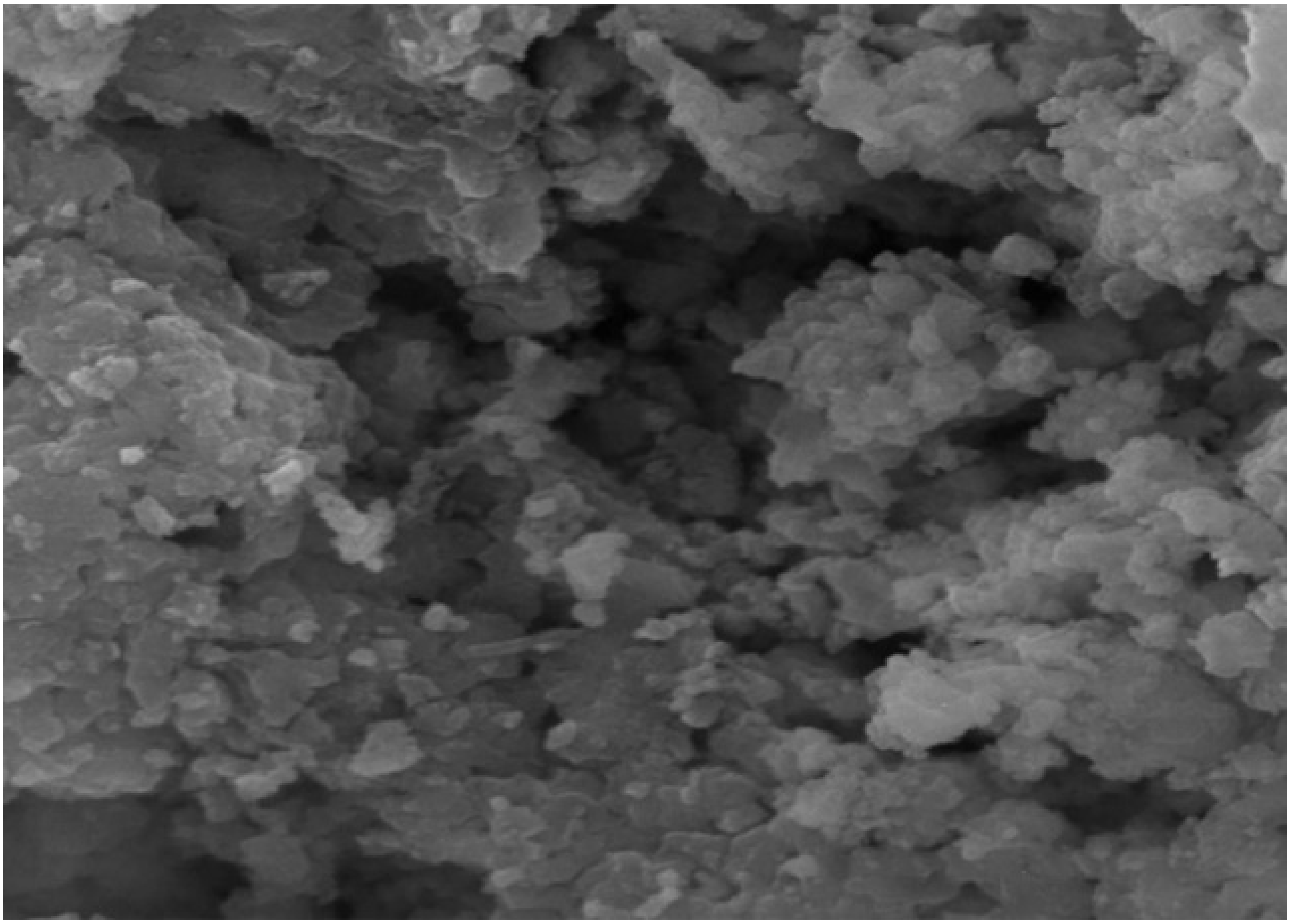


Figure 10.

Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889

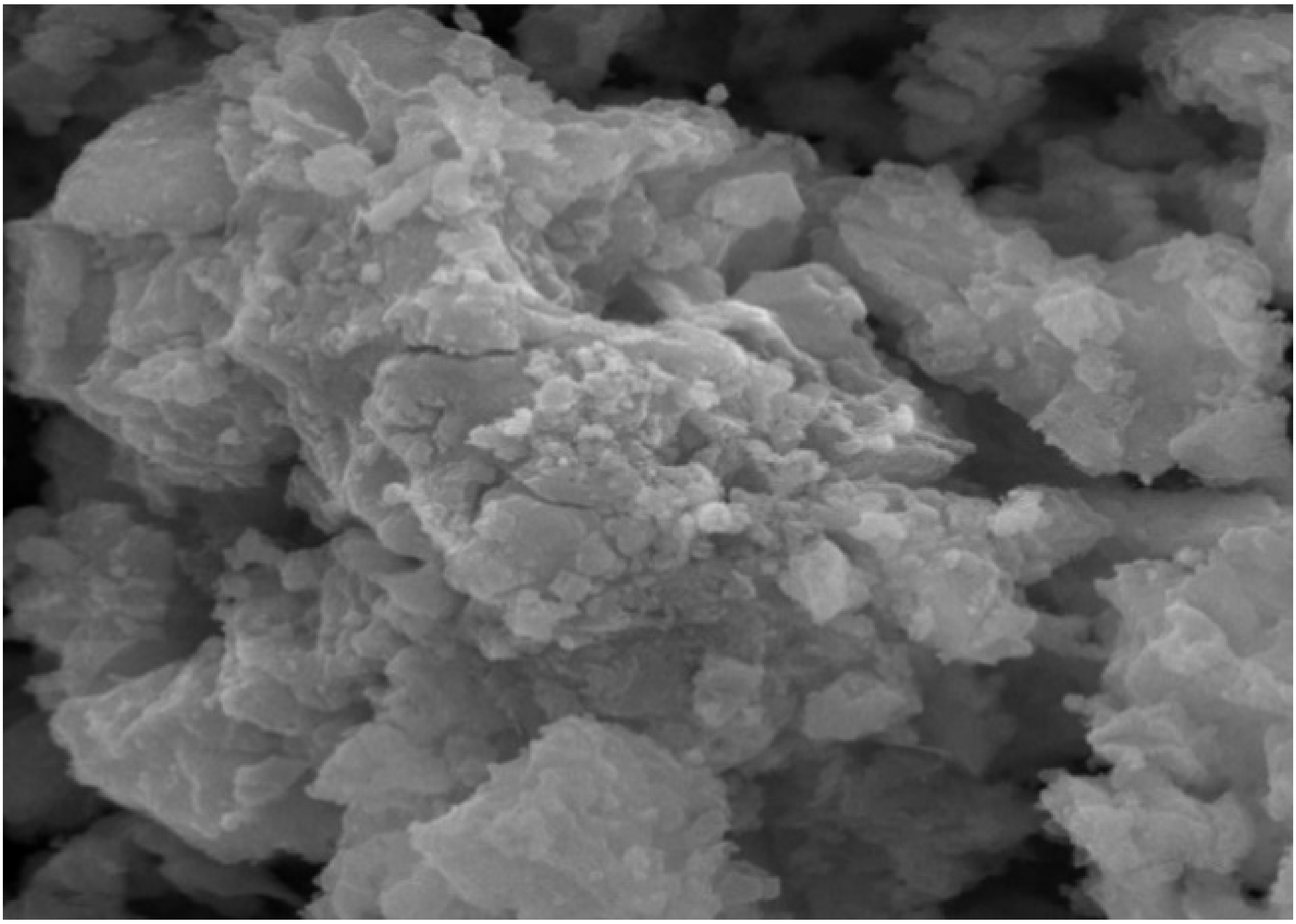


Figure 11.

Figure (8) FE-SEM photo of formed (NiO nanoparticle)

References

1. Lakhcakhch and R. Rmeissa, "A study of the antibacterial and antioxidant activity of nikel nanoparticles prepared according to green chemistry techniques," Doctoral dissertation, Kasdi Merbah University, Ouargla, Algeria, 2020.
2. L. H. Jatra and S. Al-Zoubi, "Degree of inclusion of chemistry and earth science textbooks for the secondary level for nanotechnology applications and green chemistry," Mutah Journal for Humanities and Social Sciences, vol. 40, no. 3, pp. 45-68, 2025.
3. M. A. Nasseri, F. Ahrari, and B. Zakerinasab, "Green biosynthesis of NiO nanoparticles using aqueous extract of Tamarix serotina and their characterization and application," Applied Organometallic Chemistry, vol. 30, no. 12, pp. 978-984, 2016.
4. K. Ghraissi and K. Grab, "Biosynthesis of copper oxide nanoparticles using aqueous extract of Artemisia herba-alba and investigation of its antibacterial activity," Doctoral dissertation, Kasdi Merbah University, Ouargla, Algeria, 2021.
5. K. An and G. A. Somorjai, "Size and shape control of metal nanoparticles for reaction selectivity in catalysis," ChemCatChem, vol. 4, no. 10, pp. 1512-1524, 2012.
6. Aoun and M. Mouna, "Preparation and characterization of the physicochemical properties of NPS nanoparticles by the deposition method," Doctoral thesis, Kasdi Merbah University, Ouargla, Algeria, 2019.
7. S. Jadoun, R. Arif, N. K. Jangid, and R. K. Meena, "Green synthesis of nanoparticles using plant extracts: A review," Environmental Chemistry Letters, vol. 19, no. 1, pp. 355-374, 2021.
8. P. Ramesh and A. Rajendran, "Green synthesis of nickel oxide nanoparticles for photodegradation analysis," Materials Today: Proceedings, vol. 68, pp. 367-372, 2022.
9. N. A. Jawad and K. H. Hassan, "Structure characterization of NiO nanoparticles prepared by green chemistry synthesis using Arundo donax leaves extract," Journal of Physics: Conference Series, vol. 1818, no. 1, p. 012007, 2021.
10. Kiran, S. Hussain, I. Ahmad, M. Imran, M. Saqib, B. Parveen, and M. Iqbal, "Green synthesis of NiO and

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Vol. 12 No. 1 (2027): June
DOI: 10.21070/acopen.12.2027.15889

NiO@graphene oxide nanomaterials using Elettaria cardamomum leaves: Structural and electrochemical study," Heliyon, vol. 10, no. 20, p. e38920, 2024.

11. Mariam, "Bio-synthesis of NiO and Ni nanoparticles and their characterization," M.S. thesis, Department of Physics, Alagappa University, Karaikudi, India, 2014.
12. K. Lingaraju, H. R. Naika, H. Nagabhushana, K. Jayanna, S. Devaraja, and G. Nagaraju, "Biosynthesis of nickel oxide nanoparticles from Euphorbia heterophylla (L.) and their biological application," Arabian Journal of Chemistry, vol. 13, no. 3, pp. 4712-4719, 2020.
13. Z. Sabouri, A. Rangrazi, M. S. Amiri, M. Khatami, and M. Darroudi, "Green synthesis of nickel oxide nanoparticles using Salvia hispanica L. (chia) seeds extract and studies of their photocatalytic activity and cytotoxicity effects," Bioprocess and Biosystems Engineering, vol. 44, no. 11, pp. 2407-2415, 2021.
14. M. Rashid, S. D. Salman, A. K. Mohammed, and Y. S. Mahdi, "Green synthesis of nickel oxide nanoparticles for adsorption of dyes," Sains Malaysiana, vol. 51, no. 2, pp. 533-546, 2022.
15. Iqbal, B. A. Abbasi, T. Mahmood, S. Hameed, A. Munir, and S. Kanwal, "Green synthesis and characterizations of nickel oxide nanoparticles using leaf extract of Rhamnus virgata and their potential biological applications," Applied Organometallic Chemistry, vol. 33, no. 8, p. e4950, 2019.
16. El Ghmari, H. Farah, and A. Ech-Chahad, "Biosynthesis, characterization of nickel (II) oxide nanoparticles NiO and their high-efficient photocatalytic application," International Journal of Nanoscience and Nanotechnology, vol. 19, no. 3, pp. 135-147, 2023.
17. T. Theivasanthi and M. Alagar, "Chemical capping synthesis of nickel oxide nanoparticles and their characterization studies," arXiv preprint arXiv:1212.4595, 2012.

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo