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Green Synthesis of Cuonanoparticles by Olive Leaf Extract and use in Preparation Solar Cell

[1]Hamdia Hateem Al-Shammary, [2]Kadhim A. Aadim, [3]Radea H. Al-Shammari,
[4]Waleed Madhloom Khalaf, [1]Moaed Saleh Mohammed,
[1]Marwa Shaker Mahmood and [1]Nafeesa Jabbar Kadhim
[1]Department of Chemistry, College of Science for Women, University of Baghdad, Baghdad, Iraq
[2]Department of Physical, College of Science, University of Baghdad, Baghdad, Iraq
[3]Department of Physical, College Education, Mustansiriya University, Baghdad, Iraq
[4]Police College, Ministry of Interior, Baghdad, Iraq

Abstract: Research on green production methods for metal oxide Nanoparticles (NPs) is growing with the objective to overcome the potential hazards of these chemicals for a safer environment. In this study, facile, eco friendly synthesis of Copper Oxide (CuO) nanoparticles was successfully achieved using olive leaf extract. Nanoparticles were further characterized by Scanning Electron Microscopy (SEM), Energy Dispersive X-ray (EDX), Fourier Transforms Infrared Spectroscopy (FTIR), Atomic Force Microscope (AFM). Plant-mediated CuO nanoparticles were found to be oval shaped and well dispersed in suspension. Copper oxide nanoparticles are used in many applications, therefore, these green synthesized CuO NPs are application in prepare solar cell give.

Key words: Nanoparticles, copper oxide, SEM, FTIR, EDX

INTRODUCTION

Cupric Oxide (CuO) is one of the very attractive semiconducting materials a p-type semiconductor with a narrow band gap of 1.2 eV (Chen *et al*., 2013). Owing to its many superior characteristics, for example, good thermal stability, electrical conductivity and optical properties, CuO has found widespread applications in different fields like photocatalysis (Devi and Singh, 2014; Bhattacharjee and Ahmaruzzaman, 2016; Akhavan *et al*., 2011), superconductivity (Eibl, 1993), solar energy harvesting (Rakhshani, 1986), energy storage (lithium ion batteries) (Wang *et al*., 2009) and antimicrobial devices (Ren *et al*., 2009). Moreover, the efficiency of CuO materials has been improved by nano structuring their particle size for this purpose different methods have been adopted and/or developed which helped in getting CuO materials in diverse morphologies (Safa *et al*., 2016). Some of these classical methods are sol-gel, coprecipitation, electrochemical, solvothermal/ hydrothermal, sonochemical, solid state synthesis and microwave irradiation (Borkow and Gabbay, 2009). However, harmful chemicals are either used during manipulations or produced as byproducts in nearly all these methods. Consequently, synthesis of CuO by one of these methods poses serious threats to the environment. To avoid the dangers posed by the use of harmful chemicals and/or produced as by products, green synthesis of NPs is gaining tremendous attention (Sharma *et al*., 2015). Besides, it is simple, no expensive and environment friendly. CuO NPs have been prepared using different plants which influence the morphology of the resulting nanomaterial (Fan *et al*., 2003; Xu *et al*., 2002). In fact the plant extracts act as reducing and capping agents to direct the structure of the resulting NPs (Sharma *et al*., 2015). Following the principles of green chemistry, here we report upon the construction of CuO NPs by using extracts of different vegetables (Cauliflowers, Potatoes and Peas peels) wastes and exploration of their microstructure, morphology and optical properties.

Green chemistry focuses on the production of desired products without generation of hazardous intermediate byproducts in chemical reaction processes. Integrating green chemistry principles into nanotechnology has led to the identification of environmentally friendly reagents that are multifunctional in that they can serve as a reducing agent as well as a capping agent (Iravani, 2011; Han *et al*., 2013). Synthesis of Nanoparticles (NPs) can be performed using a number of routinely used chemical and physical methods (Ershov *et al*., 1991). Plants and their related materials for production of nanomaterials are not only ecofriendly alternatives but they are also cost effective. Synthesis of Copper Oxide (CuO) nanoparticles has been performed using extracts of soybeans (Dhas *et al*., 1998), gum karaya (Feldmann and

Corresponding Author: Hamdia Hateem Al-Shammary, Department of Chemistry, College of Science for Women, University of Baghdad, Baghdad, Iraq

Jungk, 2001), bark extract (Stopic *et al*., 2005), leaf extract (Xiong *et al*., 2011; Guajardo-Pacheco *et al*., 2010), fruit (Padil and Cernik, 2013; Yallappa *et al*., 2013), tea and coffee powder (Angajala *et al*., 2014), peel extract (Naika *et al*., 2015) and flower extract (Sankar *et al*., 2014). Development in large-scale production for both metallic and nonmetallic nanoparticles has introduced risk to the environment and human health (Viswadevarayalu *et al*., 2016; Sutradhar *et al*., 2014). Improper disposal of nanomaterial waste by labs as well as industry is an alarming threat to the ecosystem as well as aquatic life. With this perspective, researchers are focusing on the green synthesis of nanomaterials. The aim is to protect the environment and human health from toxic impacts of nanomaterials and their derived complex compounds and at the same time safely utilize nanomaterials. Environmental and biological risks for copper nanoparticles have been investigated by many researchers. Synthesized nanoparticles by leaf extract of Pterospermum acerifolium which is an angiosperm belonging to the family Malavacea distributed in Southeast Asia (Karimi and Mohsenzadeh, 2015). The aim is to protect the environment and human health from toxic impacts of nanomaterials and their derived complex compounds and at the same time safely utilize nanomaterials. Environmental and biological risks for copper nanoparticles have been investigated by many researchers. However, the toxicity of nanosized and bulk CuO metal oxide nanoparticles to bacteria (Rispoli *et al*., 2010). In recent years, they are receiving lot of attention for their versatile properties andpotential use as gas sensors, solar cells, lithium ion batteries and heterogeneous catalysts (Rakhshani, 1986).

MATERIALS AND METHODS

Experimental (preparation of olive leaf extract): To prepare the leaf extract of olive leaf extract (25 g) were thoroughly washed, dried and finely chopped. The finely, chopped material was allowed to boil for 5 min at 80°C with 100 mL of de-ionized water in a 250-mL Erlenmeyer flask and then cooled down to room temperature. The resulting solution is passed through a filter paper to remove any solid particles and then again filtered through a Whatman filter paper of pore size 0.2 μm. The filtrate is stored at 4°C as a stock for the synthesis of CuO NPs.

As fifty milliliters of 10 mm aqueous solution of copper nitrate (99.99% purity, Aldrich) was added to 5 mL finely chopped in a 100 mL Erlenmeyer flask with constant stirring on a magnetic stirrer at 100-120°C. Colour change of the reaction mixture was observed from deep blue to colourless and then to brick red and dark red on vigorous stirring for 24 h. Then the resultant solution is centrifuged at 10,000 rpm for 10 min at room temperature (using Beckman centrifuge with a Beckman JA-17 rotor) and the mixture is collected after discarding the supernatant. The collected CuO NPs are allowed to dry in a watch glass. The formed black

Where a solar cell was prepared from target of the deposition of nano CuO, it was mix (Ag_2O and CuO) in the rate of (1.2/1.8) on series, shaped liked disc with a diameter of 1 cm. Using the deposition method (PLD), (Ag_2O and CuO) film on substrate Ps, the influence of laser energy was (600-1000 mJ). The substrate and target inside vacuum at a pressure of 10^{-3} mbar. The substrate was placed at 3 cm from the (Ag_2O and CuO) target, the (Ag_2O and CuO) target it is bombarded by 400 pulses by 10-30 sec to obtain a one layer of film. During the deposition was fired using a Nd:YAG laser operating under specific energy. The Nd:YAG laser with a fundamental harmonic frequency (λ = 1064 nm, 10 nsec, 6 Hz) is focused on a (Ag_2O and CuO) target with a quartz lens. The laser beam is focused on the target by an angle of incidence of 45°. The study their influenceof laser energy on the of solar cell of (Ag_2O and CuO) and properties of the deposited film.

Characterization of synthesized CuONPs: The morphological, structural and chemical composition of CuO NPs were analyzed by employing SEM-EDS INSPECT S50) and XRD (PAN analytical: XPERT-PRO) equipment. Through FTIR (Shimadzu FTIR Prestige 21). AFM (SPM Scanning Probe Microscope) and and UV–Vis (Shimadzu UV–Vis 2450) spectroscopy spectral analysis.

RESULTS AND DISCUSSION

UV–Vis and FTIR: Figure 1-4 shows UV spectra of CuO NPs using olive leaf extract. The colloidal suspension after reduction showed two strong resonances, one is in between 265-285 nm and another weak but broad resonance centered at about 670 nm indicating the formation of CuO NPs. The peak at 260 nm is due to inter-band transition of core electrons of copper metal, while that of peak around 670 nm and corresponds band edge transition of Cupric Oxide (CuO). FTIR spectra were recorded in solid phase using the KBr pellet technique in the range of 4000-400 cm^{-1}. FTIR analysis Fig. 5 of green synthesized CuO nanoparticles revealed a strong band at 1100 cm^{-1} whereas peaks at 529 cm^{-1} can be attributed to vibrations of CuO, confirming the formation of highly pure CuO nanoparticles (Ren *et al*., 2009). The bands around 3450, 1600 and 2350 cm^{-1} show the presence of -OH, C–C and C = O stretching of hydroxyl groups, alkenes and presence of alkanes, respectively.

2-2-atomic force microscope: The AFM analysis provides the measurements of average grain size (Fig. 3).

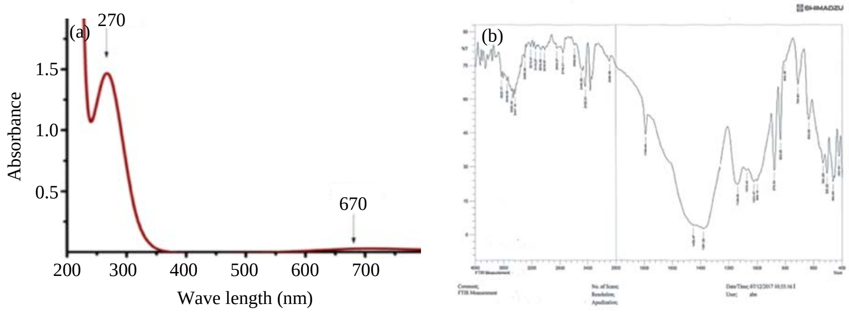

Fig. 1(a, b): UV spectra and FTIR spectraof CuONPs

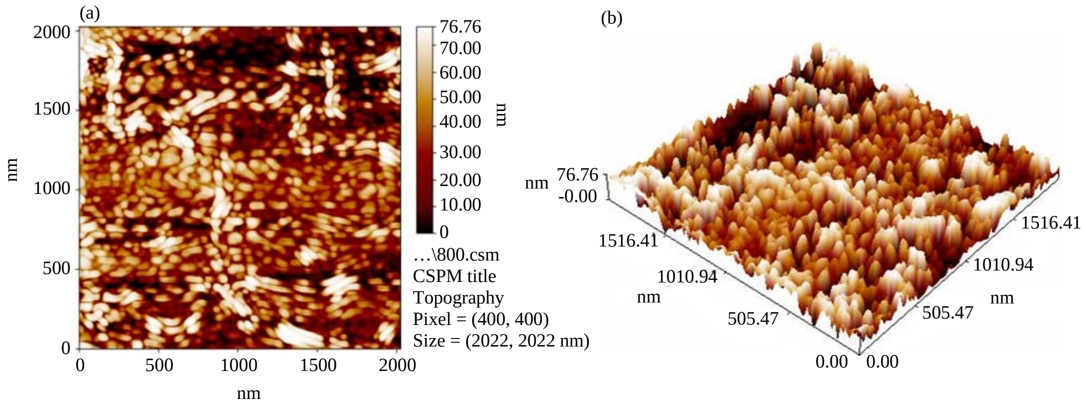

Fig. 2(a, b): AFM image of CuO

Avg. Diameter:72.53 nm **<=10% Diameter:0 nm**
<=50% Diameter:65.00 nm **<=90% Diameter:90.00 nm**

Diameter (nm)<	Volume(%)	Cumulation(%)	Diameter (nm)<	Volume(%)	Cumulation(%)	Diameter (nm)<	Volume(%)	Cumulation(%)
60.00	14.03	14.03	85.00	8.60	84.62	110.00	0.45	98.64
65.00	16.74	30.77	90.00	3.62	88.24	120.00	0.90	99.55
70.00	22.62	53.39	95.00	6.33	94.57	130.00	0.45	100.00
75.00	12.67	66.06	100.00	3.17	97.74			
80.00	9.95	76.02	105.00	0.45	98.19			

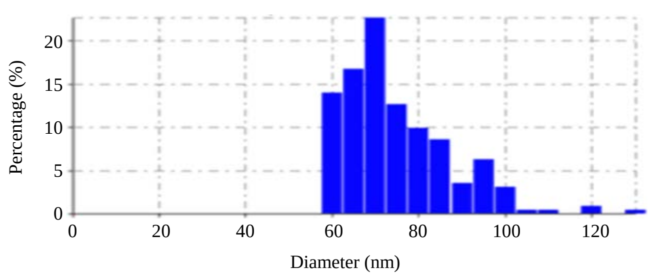

Fig. 3: The measurements of average grain size of CuO

Figure 2 shows typical surface AFM image (a: in tow and b: in three dimensional) and the granularity cumulating distribution for CuO. The average diameter is 72 nm for CuO.

X-ray diffraction and scanning electron micrograph: The XRD technique was used to determine and confirm thecrystal structure of the nanoparticles. XRD analysis showed aseries of diffraction peaks at 2θ of 32.41, 35.61, 38.81, 48.91, 53.31, 58.21, 61.61 and 66.31. The XRD spectrum clearly suggested the crystallinenature of the CuO NPs synthesized from leaf extract ofOlive Leaf Extract. The peak positions exhibited the monoclinic structure of CuO which was confirmed by the International Centre for Diffraction Data (ICDD) card no. 801916 Fig. 4.

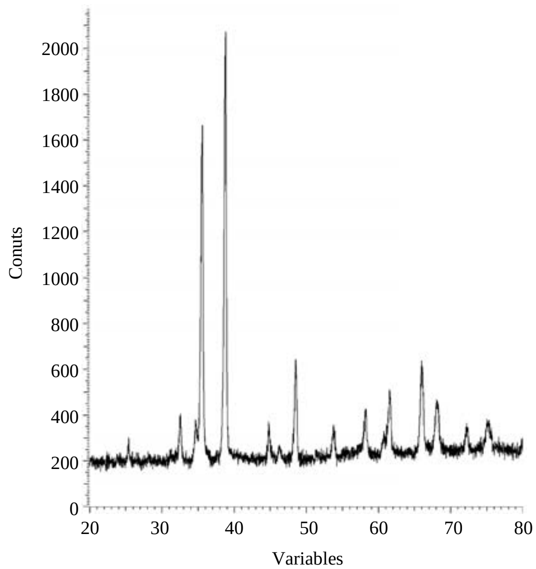

Fig. 4: XRD patterns of pure CuO

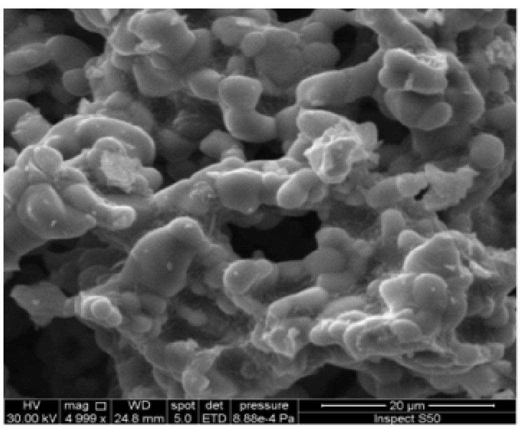

Fig. 5: Scanning electron micrograph

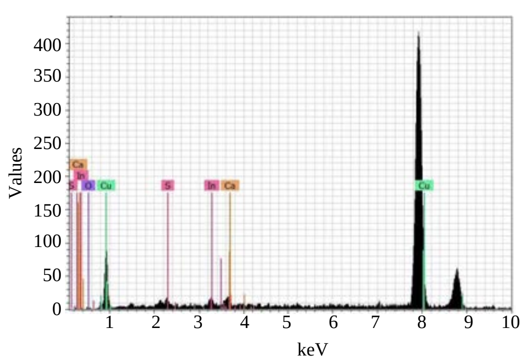

Fig. 6: EDX analysis

SEM image (Fig. 5) of CuO nanoparticles showed the presence of some large particles which can be attributed to aggregation or overlapping of smaller particles with sizesaround 100 nm, the morphology of CuO is appear nanorod. The EDS analysis revealed the chemical composition of the nanoparticles having atomic percent of 54% for Cu and 45% for O (Fig. 6 and Table 1).

Table 1: V-I characteristics of solar cell

Influence of laser energy (mJ)	Jsc (mA/cm^2)	Voc (V)	F.F	% η
1000	5	0.53	0.648	1.71
900	4.8	0.54	0.617	1.60
800	4.9	0.48	0.538	1.26
700	4.82	0.51	0.488	1.20
600	4.7	0.49	0.500	1.15

CONCLUSION

In summary, the green synthesis of CuO NPs was carried outby using Olive Leaf Extractsingly without the involvement ofany other chemical reagent. XRD, SEM and AFM analysis conformed that the CuO NPs show to an average grain size of 70 nm. These green synthesized CuO NPs are application in prepare solar cell give.

REFERENCES

Akhavan, O., R. Azimirad, S. Safa and E. Hasani, 2011. CuO/Cu(OH)2 hierarchical nanostructures as bactericidal photocatalysts. J. Mater. Chem., 21: 9634-9640.

Angajala, G., P. Pavan and R. Subashini, 2014. One-step biofabrication of copper nanoparticles from Aegle marmelos correa aqueous leaf extract and evaluation of its anti-inflammatory and mosquito larvicidal efficacy. RSC. Adv., 4: 51459-51470.

Bhattacharjee, A. and M. Ahmaruzzaman, 2016. CuO nanostructures: Facile synthesis and applications for enhanced photodegradation of organic compounds and reduction of p-nitrophenol from aqueous phase. RSC. Adv., 6: 41348-41363.

Borkow, G. and J. Gabbay, 2009. Copper, an ancient remedy returning to fight microbial, fungal and viral infections. Curr. Chem. Biol., 3: 272-278.

Chen, H., G. Zhao and Y. Liu, 2013. Low-temperature solution synthesis of CuO nanorods with thin diameter. Mater. Lett., 93: 60-63.

Devi, H.S. and T.D. Singh, 2014. Synthesis of copper oxide nanoparticles by a novel method and its application in the degradation of methyl orange. Adv. Electron. Electr. Eng., 4: 83-88.

Dhas, N.A., C.P. Raj and A. Gedanken, 1998. Synthesis, characterization and properties of metallic copper nanoparticles. Chem. Mater., 10: 1446-1452.

Eibl, O., 1993. Application of a new method for absorption correction in high-accuracy, quantitative EDX microanalysis in the TEM: Analysis of oxygen in CuO-based high-Tc superconductors. Ultramicroscopy, 50: 189-201.

Ershov, B.G., E. Janata, M. Michaelis and A. Henglein, 1991. Reduction of aqueous copper (2+) by carbon dioxide (1-): First steps and the formation of colloidal copper. J. Phys. Chem., 95: 8996-8999.

Fan, H., L. Yang, W. Hua, X. Wu and Z. Wu *et al*., 2003. Controlled synthesis of monodispersed CuO nanocrystals. Nanotechnol., 15: 37-42.

Feldmann, C. and H.O. Jungk, 2001. Polyol-mediated preparation of nanoscale oxide particles. Angew. Chem. Intl. Ed., 40: 359-362.

Guajardo-Pacheco, M.J., J.E. Morales-Sanchez, J. Gonzalez-Hernandez and F. Ruiz, 2010. Synthesis of copper nanoparticles using soybeans as a chelant agent. Mater. Lett., 64: 1361-1364.

Han, C., M. Pelaez, Nadagouda, M.N. Obare and S.O. Falaras *et al*., 2013. The Green Synthesis and Environmental Applications of Nanomaterials. In: Sustainable Preparation of Metal Nanoparticles: Methods and Applications, Luque, R. and R.S. Varma (Eds.). The Royal Society of Chemistry, London, UK., ISBN:978-1-84973-428-8, pp: 106-143.

Iravani, S., 2011. Green synthesis of metal nanoparticles using plants. Green Chem., 13: 2638-2650.

Karimi, J. and S. Mohsenzadeh, 2015. Rapid, green and eco-friendly biosynthesis of copper nanoparticles using flower extract of Aloe vera. Synth. React. Inorg. Metal Org. Nano Metal Chem., 45: 895-898.

Naika, H.R., K. Lingaraju, K. Manjunath, D. Kumar and G. Nagaraju *et al*., 2015. Green synthesis of CuO nanoparticles using Gloriosa superb L. extract and their antibacterial activity. J. Taibah Univ. Sci., 9: 7-12.

Padil, V.V.T. and M. Cernik, 2013. Green synthesis of copper oxide nanoparticles using gum karaya as a biotemplate and their antibacterial application. Int. J. Nanomed., 8: 889-898.

Rakhshani, A.E., 1986. Preparation, characteristics and photovoltaic properties of cuprous oxide-a review. Solid State Electron., 29: 7-17.

Ren, G., D. Hu, E.W.C. Cheng, M.A. Vargas-Reus and P. Reip *et al*., 2009. Characterisation of copper oxide nanoparticles for antimicrobial applications. Intl. J. Antimicrob. Agents, 33: 587-590.

Rispoli, F., A. Angelov, D. Badia, A. Kumar and S. Seal *et al*., 2010. Understanding the toxicity of aggregated zero valent copper nanoparticles against *Escherichia coli*. J. Hazard. Mater., 180: 212-216.

Safa, S., R. Azimirad, S.S. Moghaddam and M. Rabbani, 2016. Investigating on photocatalytic performance of CuO micro and nanostructures prepared by different precursors. Desalin. Water Treat., 57: 6723-6731.

Sankar, R., P. Manikandan, V. Malarvizhi, T. Fathima, K.S. Shivashangari and V. Ravikumar, 2014. Green synthesis of colloidal copper oxide nanoparticles using *Carica papaya* and its application in photocatalytic dye degradation. Spectrochim. Acta Part A: Mol. Biomol. Spectrosc., 121: 746-750.

Sharma, J.K., M.S. Akhtar, S. Ameen, P. Srivastava and G. Singh, 2015. Green synthesis of CuO nanoparticles with leaf extract of Calotropis gigantea and its dye-sensitized solar cells applications. J. Alloys Compd., 632: 321-325.

Stopic, S., P. Dvorak and B. Friedrich, 2005. Synthesis of spherical nanosized copper powder by ultrasonic spray pyrolysis. World Metall. ERZMETALL., 58: 195-201.

Sutradhar, P., M. Saha and D. Maiti, 2014. Microwave synthesis of copper oxide nanoparticles using tea leaf and coffee powder extracts and its antibacterial activity. J. Nanostructure Chem., 4: 1-6.

Viswadevarayalu, A., P.V. Ramana, G.S. Kumar, L.R. Sylvia and J. Sumalatha *et al*., 2016. Fine ultrasmall copper nanoparticle (UCuNPs) synthesis by using *Terminalia bellirica* fruit extract and its antimicrobial activity. J. Cluster Sci., 27: 155-168.

Wang, H., Q. Pan, J. Zhao and W. Chen, 2009. Fabrication of CuO/C films with sisal-like hierarchical microstructures and its application in lithium ion batteries. J. Alloys Compd., 476: 408-413.

Wasfi, M., 2011. Solar energy and photovoltaic systems. J. Sel. Areas Renewable Sustainable Energy, 1: 1-8.

Xiong, J., Y. Wang, Q. Xue and X. Wu, 2011. Synthesis of highly stable dispersions of nanosized copper particles using L-ascorbic acid. Green Chem., 13: 900-904.

Xu, C., Y. Liu, G. Xu and G. Wang, 2002. Preparation and characterization of CuO nanorods by thermal decomposition of CuC2O4 precursor. Mater. Res. Bull., 37: 2365-2372.

Yallappa, S., J. Manjanna, M.A. Sindhe, N.D. Satyanarayan, S.N. Pramod and K. Nagaraja, 2013. Microwave assisted rapid synthesis and biological evaluation of stable copper nanoparticles using *T. arjuna* bark extract. Spectrochimica Acta Part A: Mol. Biomolecular Spectroscopy, 110: 108-115.