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[Mohindru* *et al.*, 6(7): July, 2017]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

GREEN SYNTHESIS OF COPPER NANOPARTICLES USING TEA LEAF EXTRACT

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DOI: 10.5281/zenodo.827502

ABSTRACT

The present study reports green synthesis of copper nanoparticles using plant extract (tea leaf extract) with water as the medium for reduction and identifies their main physical properties. The stabilization of Copper nanoparticles was studied with capping agents such as starch and gelatine. The reaction mixture was heated using a kitchen microwave for about 5 minutes. The pH of the solution was adjusted to alkaline using 5% solution of NaOH. Formation of Copper Nanoparticles was indicated by change in colour from blue to yellowish black which is supported by the UV absorption at 570nm. The characterization of Nanoparticles was done by TEM and XRD. In addition to the X-ray diffraction investigations and infrared spectroscopies confirmed the single phase of the copper nanoparticles. Other physical properties such as magnetic susceptibility and optical properties were also determined

KEYWORDS: Green synthesis, plant extract, TEM, Antibacterial

I. INTRODUCTION

Synthesis of metal Nanoparticles have been an area of interest in recent past as Nanoparticles show unusual structural, electrical, optical and magnetic properties. The unique properties of Nanoparticles can be tailored during the growth of Nanoparticles. So it is the need of the hour to develop certain green methods of synthesis which have lesser detrimental effects on environment**. [1-5]** It is a well known fact that green chemistry has been employed successfully in the preparation of highly functionalized products particularly in organic synthesis; efforts are being carried out to synthesize nanoparticles via greener routes. The development of high-precision, low-waste and greener methods of nanoparticle manufacturing will be crucial to their commercialization. In addition to providing enhanced research and development strategies, green chemistry can also play a prominent role in guiding the development of nanotechnology to provide the maximum benefit of these products for society and the environment. The high surface area to mass ratios of nanoparticles can greatly enhance the adsorption capacities of sorbent materials. Nanotechnology is a deliberate manipulation of matter at size scales of less than 100 nm (Figure 1) in at least one dimension meaning at the level of atoms and molecules as compared with other disciplines such as chemistry, engineering, and materials science. **[6-10]**

Metallic nanoparticles of specific sizes and morphologies can be readily synthesized using chemical and physical methods. However, these methods employ toxic chemicals as reducing agents, organic solvents and non biodegradable stabilizing agents which are therefore potentially dangerous to the environment and biological systems. The use of plant extracts for Nanoparticles synthesis is advantageous over microorganisms due to elaborate process of maintaining cell cultures. Gold and silver Nanoparticles have been synthesized using various plant extracts including hibiscus (*Hibiscus rosa sinensis*) leaf extract, Neem (*Azadirachta indica*) leaf broth, black tea leaf extracts, Indian gooseberry (*Emblica officinalis*) fruit extract, sun dried camphor (*Cinnamomum camphora*) leaves, and Aloe vera plant extract. The synthesis of metal nanoparticles using plant extracts has developed a rapid, cost-effective biosynthetic protocol for bulk synthesis of stable metallic nanoparticles. In the present work we have developed green synthesis of copper Nanoparticles via a single-step, room-temperature reduction of metal ions using tea leaf extract. Some reagents can function both as reducing and capping agents. Phenolic compounds present in plant extracts are water-soluble, nontoxic and biodegradable, affording a green synthesis process. [**11-18]**

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II. MATERIALS AND METHODS

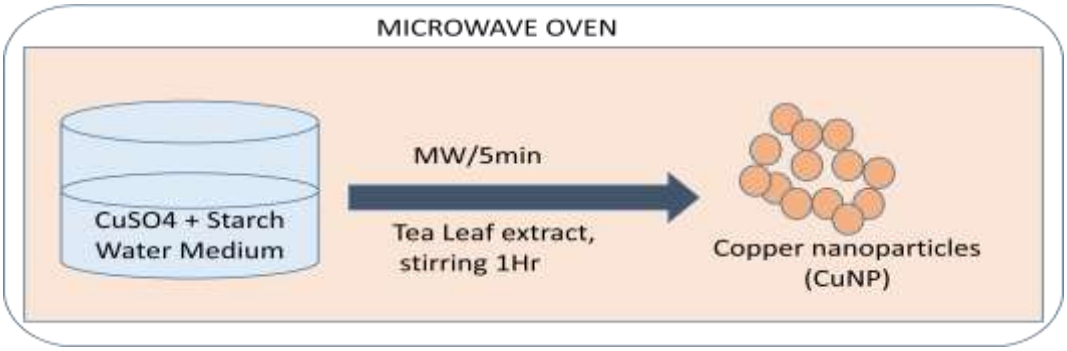
Materials:

All the chemicals used were of analytical grade (Merk), these have been used as such without any further purification. A stock solution of copper sulphate having concentration 0.1M was prepared and other solutions were made by dilution.

Preparations of copper Nanoparticles

Copper Nanoparticles were synthesized in a microwave assisted process using tea leaf extracts as reductant in water. The stabilization of copper Nanoparticles was studied with a wide variety of reagents such as starch, PEG and Gelatin. The pH was adjusted to alkaline using 5% NaOH solution. Formation of Copper Nanoparticles was indicated by change in color of the solution from blue to yellowish black which is supported by the UV absorption at 540-570nm. The synthesized particles were washed several times with water and finally with alcohol. The effect of various parameters such as contact time, pH, concentration and heating method was also optimized**.**

Figure: 1



Green synthesis of copper nanoparticles using tea leaf extract

III. RESULTS AND DISCUSSION

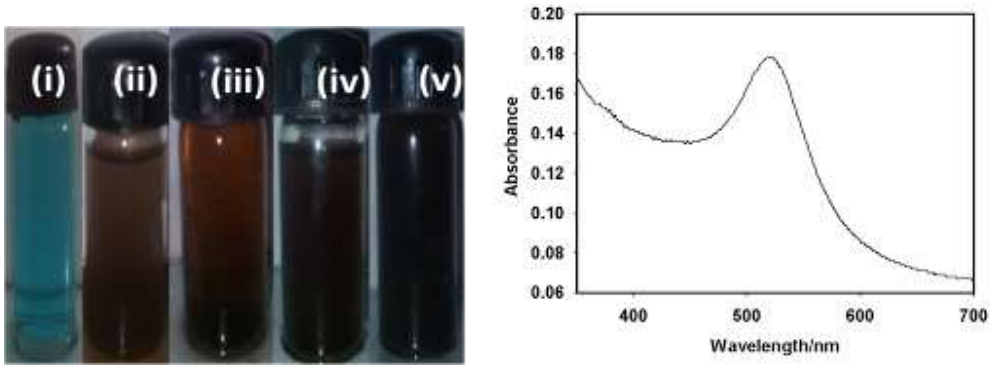
Formation of Copper Nanoparticles

Addition of tea leaf extract to a solution of copper ion having starch produces nanoparticles when optimum pH is attained. A comparison of traditional heating process with microwave assisted process revealed that it is more efficient and less time consuming.

Effect of tea extracts volume (ml) for the Nanoparticle Synthesis

Solutions at different concentrations of copper (II) ions were used synthesizing copper nanoparticles. Tea leaf extract was added (2.0; 4.0 and 6.0ml) in the copper ion solution (0.01, 0.02, 0.05& 0.08M).The nanoparticles prepared by reducing Cu(II) with2.0; 4.0 and 6.0ml of tea leaf extract were yellowish brown or yellowish black colored giving characteristic absorption in the region around 540-570nm**.**

Figure: **2**



Synthesized nanoparticles and their UV Spectrum

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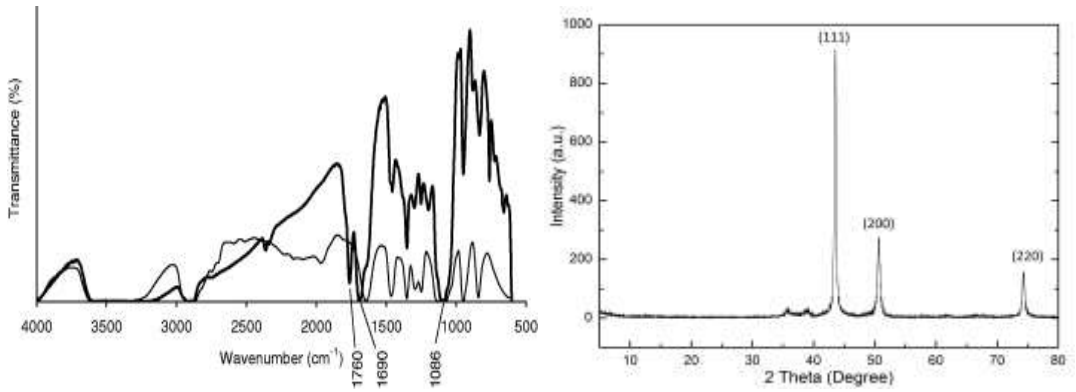
Structural Studies

The formation of Copper Nanoparticles was confirmed by UV spectrum showing characteristic absorption in the region 540-570 nm. Synthesized particles were separated by ultracentrifugation (5000rpm) and the dried powder was analyzed by FTIR(Perkin Elmer FTIR spectrophotometer using KBr pallets). XRD studies were carried out by XRD spectrometer operating at a voltage of 40KV and current of 20mA with Cu Kα radiation. [**19-20]** FTIR and XRD studies showed the purity and characteristic bands in the regions.

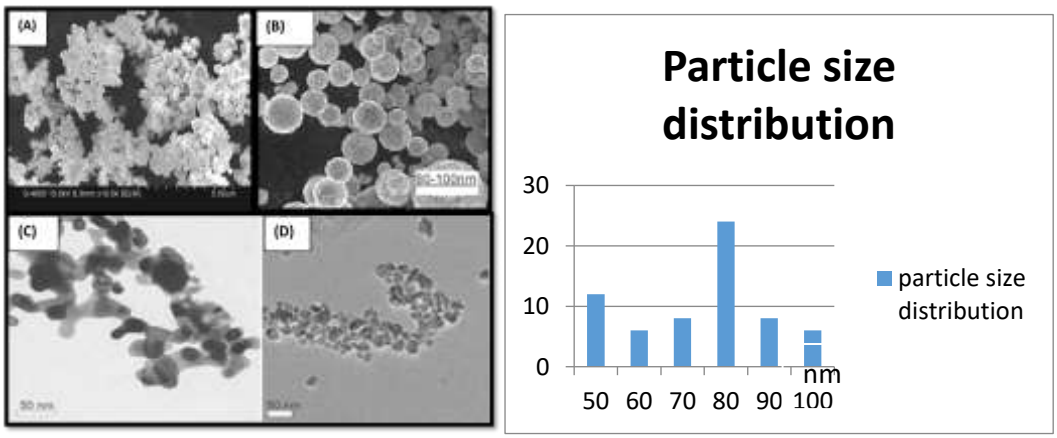
Figure: **3**



FTIR & XRD Spectrum of synthesized copper nanoparticles

Final analysis pertaining to the determination of size of Nanoparticles is the TEM analysis and it was found that the particle size of copper Nanoparticles falls in the range 70-90nm.

Figure: **4**



TEM Images of synthesized copper nanoparticles

Optical studies

The optical absorption measurements of stabilized copper nanoparticles were carried out in the wavelength range from 520 to 650 nm at room temperature. The nanoparticles synthesized using different concentration of copper ion showed a difference in absorbance in the visible region, indicating their applicability as an absorbing material. The absorption of incident radiation depends on the factors such as size and shape of the nanoparticles. With the decrease in size of nanoparticles the absorption properties of particles show hypsochromic shift in the UV spectrum **[21-22]**. These variations in optical band gap energies may be due to quantum confinements of the copper nanoparticles. The average band gap of the stabilized copper nanoparticles was obtained from plots between hv vs. $(\alpha hv)^2$ and hv vs. The Band gap of 1.98-2.02 eV is reported.

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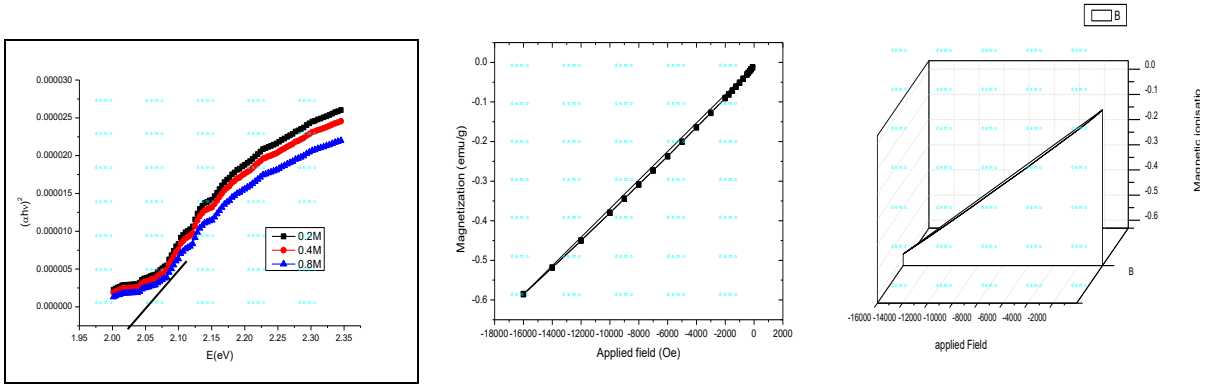
Magnetic studies

Magnetic properties of copper nanoparticles were studied using vibrating sample magnetometer (VSN, Micro sense, model 90). It was found that copper nanoparticles showed characteristic paramagnetic behavior which is shown in various plots**.**

Figure: **5**



Optical and Magnetic plots of synthesized copper nanoparticles

IV. CONCLUSION

Copper Nanoparticles in the size range 50-100nm were synthesized successfully by using green strategy .Optical band Gap as obtained from the UV analysis increases as the size of the Copper Nanoparticles increases which in turn depends upon the concentration of copper ions taken in the solution. Magnetic properties of the Synthesized Nanoparticles showed a Paramagnetic behavior. The Experiments suggest that the synthesized particles can be used in future for water purification, Air Quality monitoring, removal of toxic ions from water samples and other adsorbent properties.

V. ACKNOWLEDGEMENTS

The authors are thankful to IKG Punjab Technical University, Kapurthala and Guru Nanak Dev University, Amritsar for their support in analyzing the data and University Grants Commission for funding a Minor research project vide letter no:**F. No. 8-3(43) / 2011 (MRP/NRCB).**

VI. REFERENCES

[1] Koch.C.C, "Nanostructured Materials, Processing, Properties and Applications," Noyes Publications: Norwich, New York. 2002
[2] Jennifer A. Dahl, Bettye L. S. Maddux, and James E. Hutchison, "Toward Greener Nanosynthesis," Chem. Rev., Vol.107, pp2228-2269, 2007
[3] Ahmad, A.; Mukherjee, P.; Mandal, D.; Senapati, S.; Khan, M. I.; Kumar,R.; Sastry, M, J. Am. Chem. Soc., Vol. 124,pp 12108–1210, .2002
[4] Bharde, A. A.; Parikh, R. Y.; Baidakova, M.; Jouen, S.; Hannoyer, B.; Enoki, T.; Prasad, B. L. V.; Shouche, Y. S.; Ogale, S.; Sastry, M, . Langmuir, Vol.24, pp5787–5794, 2008
[5] Nadagouda, M. N.; Castle, A. B.; Murdock, R. C.; Hussain, S. M.; Varma, R. S. Green Chem., Vol.12, pp114–122, 2010
[6] Philip, D. Physica E, Low Dimens. Syst. Nanostruct., Vol. 42, 1417–1424, 2010
[7] Hoag, G. E.; Collins, J. B.; Holcomb, J. L.; Hoag, J. R.; Nadagouda, M. N.; Varma, R. S., J. Mater. Chem., Vol. 19, pp8671–8677, 2009
[8] Herrera-Becerra, R.; Zorrilla, C.; Ascencio, J. A., J. Phys. Chem. C, Vol.111,pp 16147-53, 2007
[9] Huang, J.; Li, Q.; Sun, D.; Lu, Y.; Su, Y.; Yang, X.; Wang, H.; Wang, Y.; Shao, W.; He, N.; Hong, J.; Chen, C., Nanotechnology, Vol.18, pp 105104–105115, 2007
[10] Weare, W. W.; Reed, S. M.; Warner, M. G.; Hutchison, J. E., J. Am.Chem. Soc., Vol.122, 12890, 2000

ISSN: 2277-9655
Impact Factor: 4.116
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[11] Gardea-Torresdey J. L.; Parsons, J. G.; Gomez, E.; Peralta-Videa, J.; Troiani, H. E.; Santiago, P.; Yacaman, M., J. Nano Lett., Vol.2,pp397, 2002
[12] Synthesis of ultrafine copper particles by complex-reduction-extraction method YANG Jian-guang, et al, Trans. Nonferrous Met. Soc. China, Vol.17,pp1181-1185, 2007
[13] Panigrahi S., Kundu S., Ghosh S.K., Nath S. and Pal T., "General method of synthesis for metal Nanoparticle" Journal of Nanoparticle Research, Vol.6, pp 411–414, 2004
[14] Yin Z., Ma D.* and Bao X., "Emulsion-assisted synthesis of monodisperse binary metal Nanoparticles," Chem. Comm., Vol. 46,pp 1344–1346, 2010
[15] Xuegeng Yanga, Shenhao Chen[a,b*], Shiyong Zhao[a], Degang Li[a] and Houyima, "Synthesis of copper nanorods using electrochemical methods," J. Serb. Chem. Soc. Vol. 68(11), pp843–847, 2003
[16] Pillai, Z. S., Kamat, P. V., J. Phys. Chem. B, American Chemical Society , Vol.108,pp 945-947, 2004,
[17] Eric C. Njagi, Hui Huang, Lisa Stafford, Homer Genuino, Hugo M. Galindo, John B. Collins, George E. Hoag, and Steven L. Squib, "Biosynthesis of Iron and Silver Nanoparticles at Room Temperature Using Aqueous Sorghum Bran Extracts" Langmuir, Vol.27(1), pp 264–271, 2011,
[18] Eric C. Njagi, Hui Huang, Lisa Stafford, Homer Genuino, Hugo M. Galindo, John B. Collins, George E. Hoag, and Steven L. Squib, Langmuir, Vol.27(1), pp 264–271, 2011
[19] A.U. Ubale and M.R. Belkhedkar., J. Mater. Sci. Technol., Vol.31(1),pp1-9, 2015,
[20] Mohindroo J. J. and Garg U.K., Optical Properties of copper nanoparticles, AIP ConferenceProceeding,1728,020534; http://dx.doi.org/10.1063/1.4946585 , 2016,
[21] Mohindru J. J. and Garg U.K., Silver Nanoparticles: Green Synthesis & Optical Properties, Int. J. Sci. Res. & Development, Vol.4(11), pp450-453,2017

CITE AN ARTICLE

Mohindru, Jeevan Jyoti , and Umesh Kumar Garg. "GREEN SYNTHESIS OF COPPER NANOPARTICLES USING TEA LEAF EXTRACT." *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY* 6.7 (2017): 307-11. Web. 15 July 2017.