Nidhi Patel Journal of Engineering Research and Application *www.ijera.com*
ISSN : 2248-9622 Vol. 9,Issue 4 (Series -1) April 2019, pp 58-61

RESEARCH ARTICLE OPEN ACCESS

Review on synthesis of copper nanoparticles from recovered copper using advance technologies

Nidhi Patel*, Mehali Mehta**
**(Department of civil engineering, GTU, Gujarat, India)*
***(Department of civil engineering, GTU, Gujarat, India)*
Corresponding Author: Nidhi Patel

ABSTRACT:
This paper reviews the problem related to e-waste, improper disposal techniques and related environmental issues. Life span of electronic devices are getting short day by day due to technological advancement ultimately increase the volume of e-waste. It also increases the health hazards and environmental pollution in many ways such as soil, water and air pollution. So recovery of metals using different technology gives alternative of disposal. Various physical and chemical methods, metallurgy and biological methods have been used since years to reduce the pollution related to e-waste. To use recovered copper for synthesis of copper nanoparticles can be prove economical option. Copper nanoparticles can be synthesized using physical and chemical methods. Cu NP is used as catalyst, disinfectant and in electronic sector. It has high conductivity and high surface to volume ratio. So, different method for recovery of copper and synthesis of copper nanoparticles from recovered copper using method has been reviewed with application of copper nanoparticles.
Key words: E-waste, Copper nanoparticles, Copper recovery, Metallurgical process, Printed circuit boards

---

DATE OF SUBMISSION: 01-04-2019 DATE OF ACCEPTANCE: 15-04-2019

I. INTRODUCTION:

Advancement in technologies and lifestyle increases the need of electronics and electrical equipment with versatility [1]. Due to extreme marketing, electronic gadgets have earned its popularity but after inappropriate discard of it by unaware users makes e-waste an emerging problem [2, 3]. Life span of these gadgets are decreasing day by day due to faster replacement and ultimately increasing the mass of waste [4]. Availability of superior version in electronic equipment having more advance technology replaces the older gadgets and then an older version gadget reaches up to their end-of-life [3]. As per the European commission (2012/19/EU), electronic waste is primarily categorized in 10 groups as per their product type. It has been divided in 58 sub-categories with approximately 900 different types of products [5]. The primary category of e-waste starts from major household gadgets, minor household gadgets, user gadgets, automatic dispenser, medical devices, electrical and electronic apparatus, IT and telecommunication gadgets, Toys, leisure and sports gadgets , illumination gadgets to monitoring and control instruments [1].

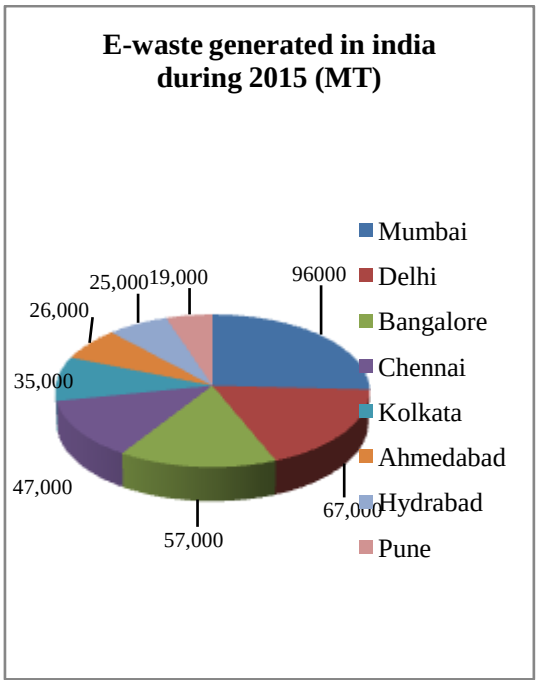

Figure 1: Generation of e-waste year 2015

Waste is mainly classified in two categories 1. Hazardous and 2.Non-hazardous material [6]. E-Waste is composed of Plastics, ferrous and non ferrous material, wood, glass and ceramics, rubber, printed circuit board and other items [2]. In non ferrous material, different type of metals like Aluminum, Copper and precious metals

such as gold, silver, palladium and platinum [6]. Overall, PCB contains plastics (30%), metals (40%) and ceramics (30%) [7]. There are 60 metals from elementary table which are used to make printed circuit board, LCD, cathode ray tube and displays [5]. Due lead, arsenic, mercury, cadmium are present in e-waste, it ultimately convert in to hazardous waste which directly or indirectly affects the health of public and quality of environment [2, 1].

Technique for disposal of e-waste is playing a vital role in environmental pollution. Land filling of e-waste pollutes the ground water quality and releases dioxin and other gaseous substance which ultimately pollute the atmosphere as it contains hazardous and toxic compounds [5, 7]. Second technique involves incineration, which gives byproduct such as bottom and fly ash enriched with heavy metals. Both techniques are wasting the source of heavy, precious, rare earth metals and other elements which can be recovered using different physical and chemical methods and it also reduces the burden of processing the metals from its ore [8]. Current methodologies which are used to recover the metals from e-waste are pyrometallurgy, hydrometallurgy, and biometallurgy, physical, chemical and thermal treatment [9].

Smart phones are nowadays mandatory tool for every age group's routine. Different application of smart phones makes it fastest growing and powerful device. To give it more advancement, sizes of smart phone are getting compacted day by day. Also people are using it as a fashion icon to show their character and for that they are buying smart phones frequently with updated version. This is the major reason for increasing volume of e-waste and disposal of it. Most important part of mobile for recovery of metals is printed circuit board and it contributes 20-30% of total mobile weight [10]. Two types of PCB are generally used in computers and smart phones, FR-2 and FR-4. The size of smart phones is compact then PC so FR-4 type of PCB are used it in which is composed of multilayer epoxy resin and copper layer coated on fiber glass. Resins are ultimately organic plastic polymers which is both land filled or incinerated and creating environmental problems [11]. In characterization of printed circuit board, it was found that copper has highest concentration among the entire element present. PC has 20wt% of copper present in it while in mobile PCB 34.5wt% is copper. So recovery of copper especially from smart phone due to its increasing volume make worth [12].

After recovery of copper using different recovery system, synthesis of copper nanoparticles from that introduce new way to use recovered copper. Nanotechnology is emerging and most promising technology which is able to understand the matter at nano scale. Their demands are increasing due to its high surface area and small size. Also the property of copper nanoparticles made them more popular among all the other metal nanoparticles such as high conductivity, excellent solderability and high melting point [13]. They have application such as disinfectant, catalyst and antimicrobial agent [13, 14].

II. RECOVERY OF COPPER FROM E-WASTE

2.1 Mechanical/physical treatment

Physical treatment is usually given to liberate metals during process such as crushing, shredding and separator. To reduce burden of chemical and metallurgical processes, physical treatment has been used. The first step of physical treatment includes manual dismantling in which hammer and chisel are used to remove top mounted materials [11]. After that different type of crushers has been used such as rotary crushers, hammer crushers and shredders. Pulverization is also a good option to reduce the size of particles. Generally, copper is found between resin layers. 6mm size should be appropriate for complete copper libration. For separation of particles, gravity or magnetic separation and corona electrostatic or eddies current are used. When size of particles reduced, leaching efficiency increase with it [9].

2.2 Thermal treatment

In thermal treatment, pyrolysis and smelting process are used to recover metals. Smelting is having high energy consumption while in pyrolysis in presence of inert gas, oil and metal reach residue produced up to 900˚C. Also toxic compounds are formed during the process [5].

2.3 Metallurgical treatment

In this technique either metals are melted in pyrometallurgical or dissolved in leaching solution (hydrometallurgical process). Cu smelter, plasma arc surface and incineration are efficiently recovering Cu along with silver and gold [11]. Waste having high concentration directly fed into the converting process.

In hydrometallurgy process, leaching is the most important step for recovery of metals. Selective leaching using hydrochloric acid, sulfuric acid, nitric acid and hydrogen peroxide has been used for effective result. After leaching of copper, solution are treated with crystallization or electro refining process for purification [9]. Cementation process is also used to purify copper in which ions get reduced to zero valences.

Hydrometallurgical process is more preferable due to easily controlled, predictable and exact results. but on other side, it generates more amount of sludge and liquid waste [11].

Another process is biometallurgy, where bioleaching and biosorption are two main areas. Bioleaching from metal sulfide has been well proven to recover copper from e-waste using A. ferrooxidans. Different types of microbial species are interacting with metals. It has less environmental impact with low energy consumption and low investment cost in comparison with conventional process [9].

III. SYNTHESIS AND APPLICATION OF COPPER NANOPARTICLES

3.1 Synthesis of copper nanoparticles

Oxidation of copper makes it more difficult in preparation of copper nanoparticles. Also it drags more attention when compared to other noble metals. When it comes in contact with air, it gets oxidized and agglomerates. So, it usually produced in inert atmosphere to stop reacting with air [13].

Chemical and physical method can be used to produce copper nanoparticles. Physical method is not giving quality product as compared to chemical method. Each parameter can be controlled in chemical process [14].

Electrochemical synthesis method is chemical method for synthesis of copper nanoparticles. Electricity is used as driving force to prepare Cu NP. Size of produced copper nanoparticles is 40-60 nm. It is a simple, cost effective and eco-friendly method. Parameters which can affect the morphology of copper nanoparticles are current density, temperature and concentration of copper.

A chemical reduction method is method in which precipitation of copper nanoparticles is performed using salt and oxides. This method has control on morphology and size of copper nanoparticles with simple and low cost operation. Size of nanoparticles produced from this method is in the range of 15±2 nm. pH, temperature and concentration of copper are the parameter which can affect the morphology of Cu NP [15].

In sonochemical method, ultrasonic waves are applied to molecules. Bath temperature, deposition potential, ultrasonic power and pH are the parameters which can control the size and shape of Cu NP. In the range of 300MHz to 300GHz, microwaves are used in form of electromagnetic energy in microwave method. Interaction happens between reaction mixture and microwaves using coupling mechanism. Average size of synthesized nanoparticles using microwave method should be 18nm [13].

In sol-gel process, colloidal particle or chemical solution is used to produce copper nanoparticles. Chlorides of metals are usually used as precursor to synthesize the Cu NP. They undergo hydrolysis and make colloidal system followed by drying. The copper nanoparticles produced from this method used as a catalyst having range of 17-20nm [16].

Various physical methods are used to synthesize copper nanoparticles. Pulse wire discharge, solvothermal decomposition, mechanical / ball milling methods, mechnochemical synthesis and pulse laser ablation/deposition are the methods which involved in physical process.

Biosynthesis of copper nanoparticles is type of method which overcomes the drawback of both physical and chemical method such as hazardous chemical and cost. It can be considered in chemical method. Different types of microorganism and plants have been used to produce nanoparticles [13].

3.2 Application of copper nanoparticles

Synthesize copper nanoparticles can be used as a disinfectant which is first and most important application of copper nanoparticles. It has an antimicrobial activity against bacteria which finds application in food and medical area [14]. Bio diesel with nanocopper particles as additive gives high performance [13]. It has a catalytic property so can be used as a catalyst due to its high surface to volume ratio. Also it finds application in electronic and drug inducts [14].

4. Conclusion

E-waste is the biggest source of metals. Instead of simply land filling or incinerating, recycle of metals and other material is good option. Also recovery reduces the burden on primary ores which is unevenly distributed all over the world. Copper was found in highest amount from printed circuit board. It was observed that physical and thermal treatment increase the efficiency for next technique. Due to some environmental challenges, pyrometallurgy method does not prefer for recovery. While in case of hydrometallurgy cooper recovery, has been carried out using different acids and alkaline solutions. But in comparison with both conventional techniques of recovery, biohydrometallurgy has been most promising and eco friendly technology to recover metals with help of bacteria. Synthesis of copper nanoparticles using recovered copper might be a batter option instead of using pure precursor. Application of copper nana particles made them worth choosing over any other material from recovered copper.

In synthesis of copper nanoparticles, physical method demands a expensive equipment and high temperature. While chemical method has simple operation with low cost. Also it produces eco-friendly materials with no need of vacuum.

Electrochemical and chemical reduction method has been giving best result with controlled in size and shape.

REFERENCE:

[1]. Garlapati, V. K. (2016). E-waste in India and developed countries: Management, recycling, business and biotechnological initiatives. Renewable and Sustainable Energy Reviews, 54, 874-881.

[2]. Needhidasan, S., Samuel, M., & Chidambaram, R. (2014). Electronic waste–an emerging threat to the environment of urban India. Journal of Environmental Health Science and Engineering, 12(1), 36.

[3]. Pathak, P., & Srivastava, R. R. (2017). Assessment of legislation and practices for the sustainable management of waste electrical and electronic equipment in India. Renewable and Sustainable Energy Reviews, 78, 220-232.

[4]. Borthakur, A., & Govind, M. (2017). Emerging trends in consumers' E-waste disposal behaviour and awareness: A worldwide overview with special focus on India. Resources, Conservation and Recycling, 117, 102-113.

[5]. Işıldar, A., Rene, E. R., van Hullebusch, E. D., & Lens, P. N. (2018). Electronic waste as a secondary source of critical metals: Management and recovery technologies. Resources, Conservation and Recycling, 135, 296-312.

[6]. Patel Y.,Sengupta B.(2016). E-Waste Indian Perspective And Recovery of Valuable Metals From E-Waste-A Review. International Refereed Journal of Engineering and Science.70-80

[7]. Khaliq, A., Rhamdhani, M. A., Brooks, G., & Masood, S. (2014). Metal extraction processes for electronic waste and existing industrial routes: a review and Australian perspective. Resources, 3(1), 152-179.

[8]. Wu, Z., Yuan, W., Li, J., Wang, X., Liu, L., & Wang, J. (2017). A critical review on the recycling of copper and precious metals from waste printed circuit boards using hydrometallurgy. Frontiers of Environmental Science & Engineering, 11(5), 8.

[9]. Cui, J., & Zhang, L. (2008). Metallurgical recovery of metals from electronic waste: a review. Journal of hazardous materials, 158(2-3), 228-256.

[10]. Maragkos, K. G., Hahladakis, J. N., &Gidarakos, E. (2013). Qualitative and quantitative determination of heavy metals in waste cellular phones. Waste management, 33(9), 1882-1889.

[11]. Kaya, M. (2016). Recovery of metals and nonmetals from electronic waste by physical and chemical recycling processes. Waste Management, 57, 64-90.

[12]. Yamane, L. H., de Moraes, V. T., Espinosa, D. C. R., &Tenório, J. A. S. (2011). Recycling of WEEE: characterization of spent printed circuit boards from mobile phones and computers. Waste Management, 31(12), 2553-2558.

[13]. Tamilvanan, A., Balamurugan, K., Ponappa, K., & Kumar, B. M. (2014). Copper nanoparticles: Synthetic strategies, properties and multifunctional application. International Journal of Nanoscience, 13(02), 1430001.

[14]. Din, M. I., &Rehan, R. (2017). Synthesis, characterization, and applications of copper nanoparticles. Analytical Letters, 50(1), 50-62.

[15]. Chandra, S., Kumar, A., &Tomar, P. K. (2014). Synthesis and characterization of copper nanoparticles by reducing agent. Journal of Saudi Chemical Society, 18(2), 149-153.

[16]. Yousef, S., Tatariants, M., Makarevičius, V., Lukošiūtė, S. I., Bendikiene, R., &Denafas, G. (2018). A strategy for synthesis of copper nanoparticles from recovered metal of waste printed circuit boards. Journal of Cleaner Production, 185, 653-664.

Nidhi Patel" Review on synthesis of copper nanoparticles from recovered copper using advance technologies" International Journal of Engineering Research and Applications (IJERA), Vol. 09, No.04, 2019, pp. 58-61