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Inductively Coupled Plasma Spectroscopy as Instrumental Tool for Detection of Nanoparticles

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Abstract

Nanotechnology playing important role for the synthesis of chemical compounds by emphasizes on their applications in different fields due to their physical and chemical properties. ICP-OES is the most advanced technique with modifications in their instrumental working leads to effective analysis of chemicals compounds, nanoparticles characterization, trace elements in water and other geographical applications. Failure to achieve the calibration leads to ineffective characterization through ICP-OES that especially functioned in high recoveries of Au NPs when using such a special macerating enzyme that appeared to release the NPs from plant tissue without changing the size distribution of the NPs. ICP-OES is used for capturing the toxins and heavy metals in environment as the biological pollutants. Its efficiency to remove the nearby metals and other portents deliberately increased due to advances in the fields of the biomedical engineering in conjugation with the environment sciences. ICP-OES is widely used in mining processes, mining purity control, rocks analysis, etc.

Keywords: ICP (Inductively coupled plasma), Nanoparticles, heavy metals detection.

INTRODUCTION

Nanotechnology in chemistry playing important role for the synthesis of chemical compounds by emphasizes on their applications in different fields due to their physical and chemical properties. They are more compatible to the cells of living system as these are biodegradable and no harmful effects on human body [1, 2]. Nanoparticles are utilized for delivery of chemical materials, dug delivery and other biomedical applications through interactions of various chemical molecules with the surface of targeted compounds. Size-dependent properties are observed such as quantum confinement in semiconductor particles, surface plasmon resonance in some metal particles and superparamagnetism in magnetic materials [3].

ICP-OES is the advanced technique with modifications in their instrumental working leads to effective analysis of chemicals compounds, nanoparticles characterization, trace elements in water and other geographical applications [4]. Biodegradable polymers with good biocompatibility, such as poly (lactic-co-glycolic acid) (PLGA), polylactic acid (PLA), and polycaprolactone (PCL), have been widely used in developing particulate drug delivery systems. ICP is used for detection of toxic metals, trace elements in ground water and used to control the biological pollution [5].

Table-1: Shows the different types of techniques and their chemical applications

Technique Type	Instrumental Role	Applications	References
ICP-OES	Analytical Technique,	Used for analysis of water, trace metals, pollution control.	[9]
HPLC	Analytical Technique, for medical based analysis	Detection of heavy metals in medical and pharmaceutical industries.	[16]
Atomic absorption spectroscopy	Analytical Technique	chemical pollutants in water detection, pharmacology analysis	[19]
NMR	Bio/analytical Technique	Medical, health and agricultural analysis	[27]
Gas chromatography	analytical Technique	Used for analysis of gaseous samples	[25]

ICP for chemical characterization of Nanoparticles

Most of the nanoparticles can be optimized through the ICP-OES that required extensive calibrating of the instrument with standard curve [6]. Failure to achieve the calibration leads to ineffective characterization through ICP-OES that especially functioned in high recoveries of Au NPs when using such a special macerating enzyme that appeared to release the NPs from plant tissue without changing the size distribution of the NPs [7]. This application of ICP-OES in nanoparticles characterization helpful to discovery the novel chemical compounds and drugs that helpful at the industrial level. Nanoparticle that have been characterized through ICP-OES may used for chemical discovery of elements on rocks and geographical purposes [8].

There are many types of nanoparticles that are chemically used to treat the number of diseases. One of such type of nanoparticles is the copper based nanowires that allow the fine regulation of materials into the cells of human body by treating the human fungal diseases [9]. Copper Nano pesticides cause little or no negative physiological effects at the recommended doses, and that in fact, plants may gain biomass when protected with these materials [10]. These copper based nanoparticles have side effects as more temperature leads to melting the fibrous material composition of the nanoparticles leads to effects on human body. Thus, temperature is an imitate factor in controlling the copper based nanoparticles [11].

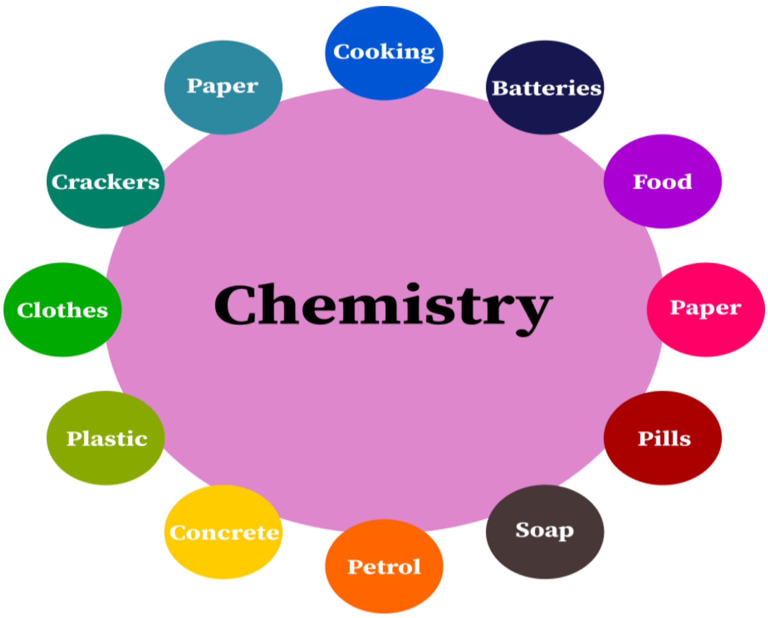

Fig-1: Shows the role of chemistry for different synthesis of industrial products

Chemicals are causing highly reaction to the nanoparticles if synthesized in integrative approach. There are lots of methods for the synthesis of nanoparticles using biological approach with chemophysiological engendering that leads to effective synthesis of biocompatible nanoparticles [12]. Nanoparticles that synthesized through advanced engineering approach can be used as biological target to treat the diseases caused by inherited factors. This can only be achieved through benign synthesis procedures of a biological nature using biotechnological tools that are considered safe and ecologically sound for nanomaterial fabrication as an alternative to conventional physical and chemical methods. It laid the foundation of biologically syntheses nanoparticles as green synthesis method that have very low cost and most effective for synthesized chemical extracts [13, 14].

Principle working of ICP

ICP mainly follows the principles of spectroscopy in which plasma strike to the particular sample in order to excite the atoms from their energy level. Each element in the sample absorbs the different type of radiations [15]. The first step in the principle of if ICP-OES is the generation of the plasma by supplying the argon gas that is tightly combine to the torch. When electric current supply is provided to the system of ICP-OES, it resulted the bluish light that indicated the generation of plasma. This plasma has high electron density and temperature 10000K and this energy is used in the excitation-emission of the sample. Samples for the ICP-OES analysis can be prepared before generation of plasma as it save the electrical energy and argon gas cost. Samples are prepared in the solution form that readily through the narrow tube in the center of the torch tube [16, 17].

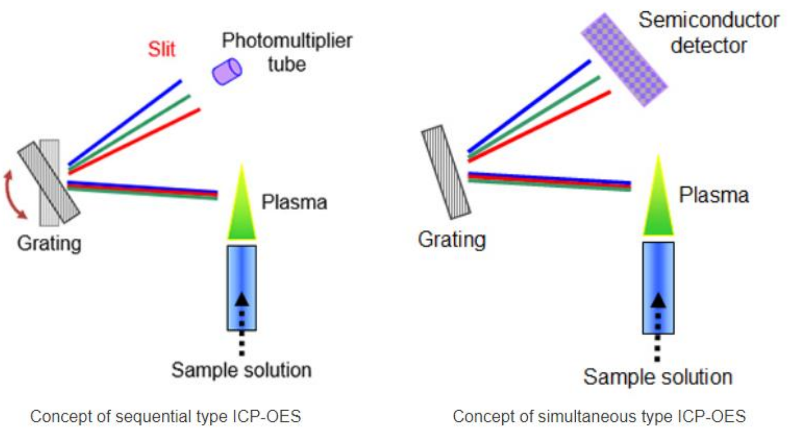

Fig-2: Shows the principles working of different types of ICPs

There are different steps in the preparation of samples for ICP instrumentation that needed to calibrate carefully before running the samples as contaminated samples leads to defect in order leads to loss of instrumental damage. The sample holding tubes should be delivered in 12 – 15 ml tubes [18]. Samples can be passing though fine drops of acidic solution such as 1-5% HNO_3in order to keep metals in solution. HCl cannot be used for the preparation of the samples in ICP as it cause damage the metals in the particular samples leads failure to achieve the accuracy of results [19]. Organic samples are utilized in ICP for samples preparation as these are suitable for increasing power. Before samples running, calibrating of the ICP very instrument as standard. The calibration curve determines the relationship between the intensity of light emitted at a specific wavelength and the concentration of the element in the solution [20].

ICP-OES is instrumented of nebulizers that usually made up of fine particles of glass allow the flash light produced by torch in order to keep analysis in right direction [22]. Sometimes, it is made up of quart materials that allow the accuracy of the results thus providing better positive results than glass because glass materials are not reliable due to melting of fibrous materials of glass [23]. This melting leads to decreases the efficiency of the torch of the ICP-OES. The size of nebulizers is in the range of 0.01–0.1 mL/min that also comprised of quartz construction is more resistant to chemical attack. Quartz material die to crystals structural involved to the efficiency of the torch of the ICP-OES [24].

Applications of ICP in Chemistry

Industrial pollution has become a major problem in these days due to releasing the waste and toxic chemicals by different industries that causing the serious diseases in different nearby areas. Pollution has become a biological health issue and mandatory steps needed to remove the toxic metals and wastes as pollutants [25]. Environment wastes and biological toxins reused form different hospitals causing infectious diseases. ICP-OES is used for capturing the toxins and heavy metals in environment as the biological pollutants. Its efficiency to remove the nearby metals and other portents deliberately increased due to advances in the fields of the biomedical engineering in conjugation with the environment sciences. Thus, it helpful in eradication of pollution risks in the environment [26].

ICP-OES is mostly used for the analysis of trace metals analysis and heavy metals found in water as it contains lots of hazardous materials and needed to separate out the toxic metals from the particular samples. Presence of toxic metals in water leads to cellular toxicity thus causing the serious problems associated with the digestive and immune systems [27]. ICP-OES is mainly designed to separate the metals on the basis of the molecular size, density and other physical properties. Sometimes, it is contaminated with more concentrations of the toxic metals leads to falsification of results. Thus, calibration of the instrument is necessary before running the samples [25-27].

ICP-OES is used for detection of As, Se, Sb and Hg and analyze hydride forming elements and other elements, resulting in improved throughput and ease-of-use for different purposes. Their efficiency to detect the particular sample determining the calibration of the instrument. Standard solutions are prepared before running the soils samples and other liquids based chemicals. This application of ICP-OES for detection helpful for cleaning the environmental thus reduces the pollution [28-32]. There many other potential applications of ICP-OES in the fields of the geography, ecological sciences, mining and earth sciences by detection of particular metals form the particular sources thus promising source to find the precious metals from the earth sources [33, 34].

CONCLUSION

ICP-OES can handle geological, mining and rare earth elements. ICP-OES is widely used in mining processes, mining purity control, rocks analysis, etc. It also helpful to check the purity of precious metals and other elemental composition in the form of carbon, oxygen, hydrogen, nitrogen and other elements in lesser concentrations. Advances in the instrumental of ICO leads to significant changes for detection of other biological and chemical samples as well as emerging in medical fields.

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