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A Review of Important Prerogatives Using of Atmospheric-Pressure Plasma Jet to Sterilize Hospitals and Quarantine Room to Reduce the Spread of Diseases in Iraq

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Atmospheric –pressure plasma jet system;
Pathogenic bacteria;
Nanostructured materials.

Abstract

Today, the world lives in the worst conditions because of the outbreak of bacteria and an increase in the number of people infected with the different diseases due to contact of minerals, wood, papers, hospitals, and laboratories. The physical devices used can support the current crisis and can be used as tools for sterilization and reducing the spread of the diseases. The methods that have been used to prepare nanostructured materials to play an important role in the biological and medical fields, because very tiny particles can inter the membranes of microorganisms. Atmospheric–pressure plasma jet system has sufficient power to sterilize and kill the bacteria, also is an important tool to employ in the medical field.

Introduction

The atmospheric-pressure plasma jet technique is described, wherever the plasma generated at the electrolyte media (gas and solution interface) as the electrode (cathode) for the preparation of different nanostructure materials or using directly to exposure on surfaces contaminated with virus/bacteria. Much attention has been attentive on discovering the effects of several parameters like the kind of system electrolyte [1,2]. The plasma jet system has huge importance from the organization of plasma because of its features of small physical size, generation [3-4], the stability of atmospheric-pressure [5], and non-equilibrium thermodynamics [6-7]. This property makes atmospheric-pressure plasma jet a good choice for many applications, such as medical treatment, surface modification, and nano-fabrication [8]. The characterization of plasma gives the unlimited potential to study the field of biomedical. plasma jet or needle is skillful of diseases (bacteria and virus) decontamination and removal cell without affecting necrosis to treat cells [9]. Furthermore, it has a modest design. A high-voltage electrode (cathode) usually make from a needle syringe and a metal pin. The discharge gas flows over the pin at a different flow rate and uses the controller to regulate the gas flow rate [10]. the conditions for biomedical applications are that the needle should be near room temperature and conveys a low current. To date, applications such as cancer treatment sterilization, bleaching (dentistry), and healing of wound treatment have been demonstrated [11]. The plasma system is used in many applications such as industrial, biomedical, and environmental effectiveness, it is essential to know the parameters of plasma-like electron temperature and density of electron. To measure these parameters at low-pressure plasma, Langmuir probe measurement is used [12].

The hospital-acquired infections or called Nosocomial infections (NI), are developed through hospital care is not existing at entry fees but appearing after discharge [13].

The genus of Pseudomonas is the best common (gram-negative) bacteria involved in hospital-infections causing opportunistic infection in humans, particularly among immunodeficiency patients [14]; [15]. The explanations to determine most infections nosocomial when the PAeruginosa rarely attacks healthy tissues, it may infect virtually whole tissues in the body. [16]; [17]. This microorganism produces some of the enzymes which are associated with the

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pathogenesis of P. Aeruginosa infections. Despite developments in antibiotic treatment, P. Aeruginosa is fundamentally resistant to a number of that antibiotic [18]. Cold plasma can help as an alternative to other conventional decontamination methods such as heat, chemical, and irradiation sterilization methods, especially for sterilize heat-sensitive tools. It promotes an effective killing of the microbes and reduces the degree of destruction of the materials. The photons of UV and reactive species such as atoms and radicals play a major role in the cold plasma decontamination. Cold plasma can inactivate microorganisms and cell wall rupture and destroy biomolecules, such as DNA and proteins [19]. Therefore, plasma proved an effective "bactericidal" agent a "decontamination" technology to address the contamination of surgical instruments [20].

Preparation of Nanoparticles (Copper Oxide)

The nanoparticles of Copper oxide CuO have been synthesized by atmospheric-pressure plasma jet. The experimental system of the schematic diagram is shown in Figure 1. [21]. The copper oxide was prepared with and without adding CuCl2 into the electrolyte medium, as shown in Figure 2 [21]. Many crystal planes have been observed in Figure 2a. It was referred into polycrystalline, and containing four peaks belong to copper oxide nanostructures was observed via (ICDD, USA (1979) JCPDS 1979), C 29-1133. Also, the addition of CuCl2 powder on the compositions and distilled water led to an increase in the appearance of peaks.

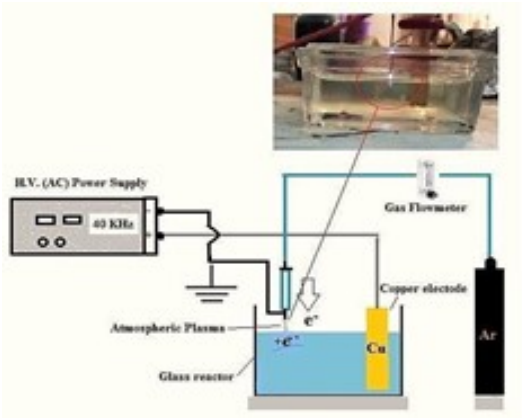

Figure 1 The atmospheric-pressure plasma jet system uses to synthesis of cooper oxide nanoparticles.

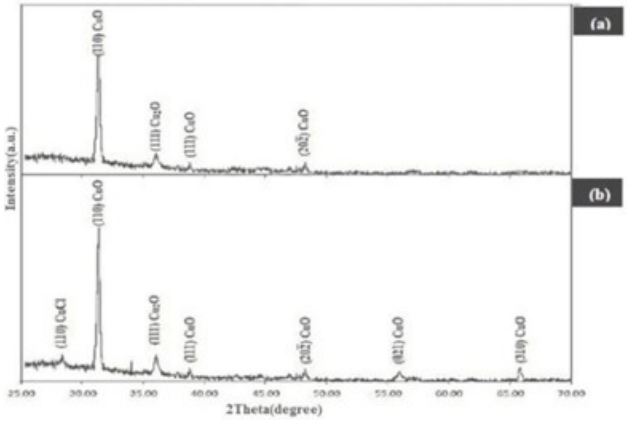

Figure 2 The x-ray diffraction patterns of the copper oxide nanoparticles were synthesized via atmospheric-pressure plasma jet system at different arrangements: (a) without CuCl2 (b) with CuCl2

It was shown that the copper oxide nanostructure prepared because of the existence of Cu with Cl2 and contributing to structure into the electrolyte system, see Figure 2b. This difference may have observed from change the color powder, see Figure 3 [21].

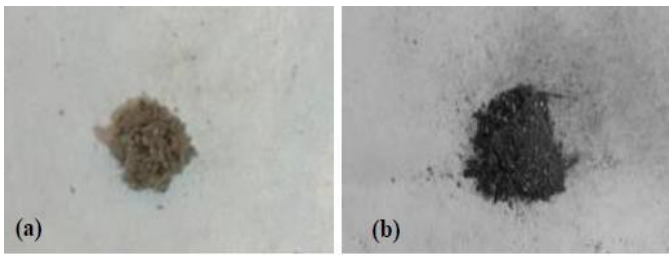

Figure 3 The photographs of powders synthesized via atmospheric-pressure plasma jet (a)without CuCl2 and (b) with CuCl2.

Copper oxide nanoparticles have extensive applications like adsorption of organic pollutants and solar cells. The outcome can be considered high and the work can be a good attempt to prepare copper oxide via this technique as a new preparation method to use it in important applications such as in biomedical.

Fabrication of Nanostructured Silver Nanoparticles

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Silver nanoparticles have fascinated much attention because of their greater antibacterial property, it has a high fraction of surface atom [22]. All methods were informed to create Ag nanoparticles with required particle size, including physical, chemical, and biological approaches [23,24]. Silver nanoparticles were prepared by atmospheric plasma jet [25].

Figures 4a and 4b, show the TEM image of the Ag nanostructures prepared at 80 wt.% AgNO3 and 20 wt.% sucrose with preparation time 25min. As shown, approximately uniform shaped like (palm fronds) were grown and the minimum particle size was 20nm. While these shapes have been disappeared when the concentration becomes 60 wt.% AgNO3 and 40 wt.% sucrose at the same preparation time (25min), and then, it can be seen the Ag nanoparticles with minimum particle size was 10nm as shown in Figure (4c).

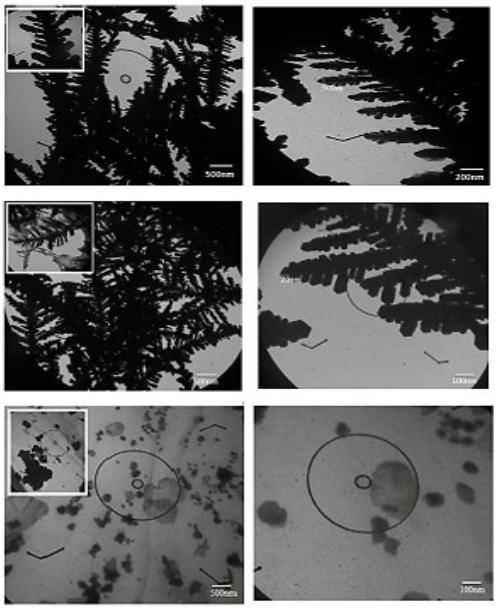

Figure 4 TEM images of Ag nanoparticles prepared at (a) at 80 wt% AgNO3 and 20 wt% sucrose with preparation time 10 min, (b) at 80 wt% AgNO3 and 20 wt% sucrose with preparation time 25 min, and(c) at 60 wt% AgNO3 and 40 wt% sucrose with preparation t

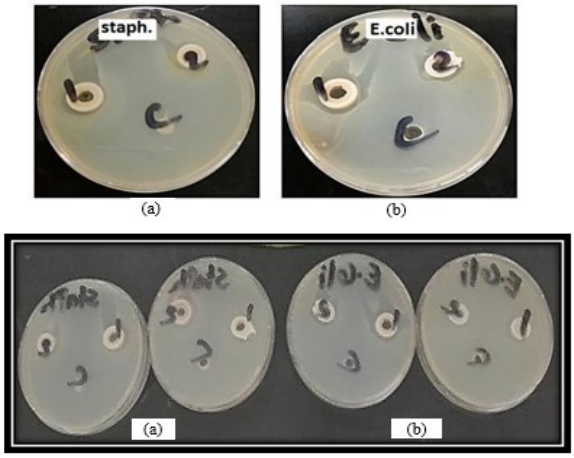

Figure 5 The disks show antimicrobial activity of Ag nanoparticles (a)Staphylococcus and (b) Escherichia coli

The two results were confirmed the sucrose prevented the aggregation, besides, the new features are dependent on the fractional composition of the prepared sample and preparation time. These results were helped to employ the Ag nanoparticles for killing and sterilizing bacteria and viruses. Figure 5 exhibits the antibacterial activity of silver nanoparticles. Its clear inhibition zone after twenty-four-hour incubation of the plate at 37 °C in temperature. The strains susceptible to silver nanoparticles show a superior inhibition zone, for two types of bacteria The inhibition zone for wholly samples with the mentioned micro-organisms was shortened in Table 1 [25].

Table 1 Inhibition zone of bacteria with Ag nanoparticles in mm

Sample No.	Staphylococcus	Escherichia coli
1	15 mm	16mm
2	17mm	15mm
3	19mm	14mm
4	16mm	17mm

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Bacterial description of the bacteria (Pseudomonas Aeruginosa) has been carried out via microscopic, cultural, and biochemical tests [26]. Also, verification of the Bacterial identification tests was examined by using of API 20E kit [27]. The colony of P. Aeruginosa was cultured overnight 18 hours via inoculating a single insulated colony of bacteria in the nutrient broth, at 37 oC. Cells of bacteria were Precipitates by centrifuge at 8000g for 10 min; the supernatant was removed and the bacterial cell pellet was rinsed twice with sterile phosphate-buffered saline (PBS) and re-suspended in 10 ml of PBS [28]. Figures 6 and 7 indicate the outcomes from culturing the exposure P. Aeruginosa on a nutrient agar plate. Furthermost of the inactivation curves followed a biphasic pattern. Especially, a decline in populations usually looked after plasma exposure from early exposure time, shadowed via a decrease at the rate of inactivation after high exposure time.

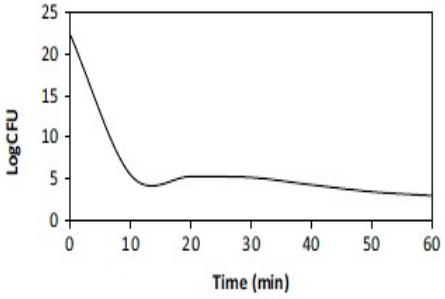

Figure 6 The decline curve of all isolates of bacteria (P. aeruginosa) signifying log CFU/ml as a function of exposure time of plasma

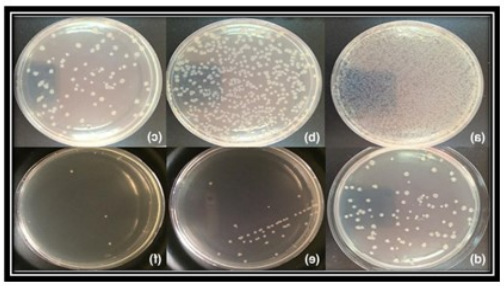

Figure 7 The inactivation of P. aeruginosa culture after plasma exposure at different time (a) 10, (b) 20(c) 30 (d) 40 (e) 50 and (f) 60 min [28]

Genomic deoxyribonucleic acid has been taken out from P. Aeruginosa bacteria via Kit (Intron Biotechnology, Korea). A specific primer was used for gene amplification. Figures (8 and 9) indicated the amplified 16S rRNA fragment using a molecular size around 956 bp in length.

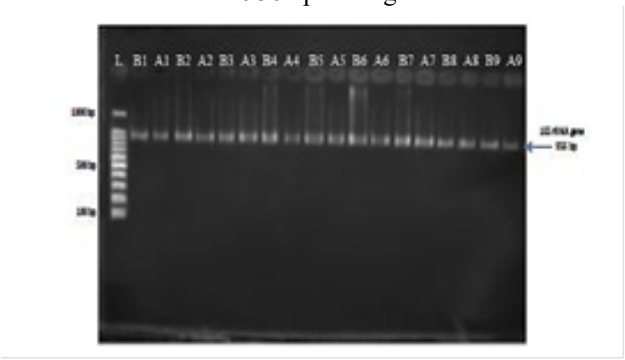

Figure 8 Electrophoresis Technique of P. aeruginosa, lane (L), DNA ladder, lanes (B1–B9): bacterial samples before plasma exposure, lanes (from A1 to A9): bacterial samples after Plasma exposure, [28].

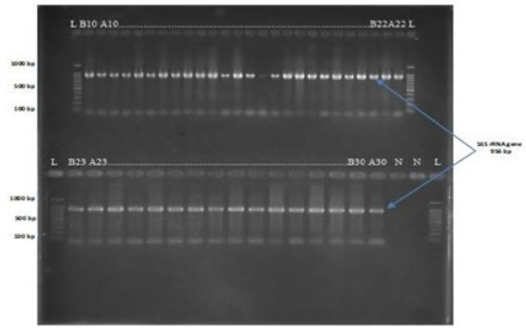

Figure 9 . Electrophoresis Technique of P. aeruginosa lane (L), (1500–100 bp DNA ladder), lanes (B10–B30): bacterial samples before plasma exposure, lanes (A10– A30): bacterial samples after plasma exposure lane (N): the negative control, [28].

Conclusions

Several recent developments prepared in the atmospheric-pressure plasma jet system has been discussed in this paper. These include the adjustment of this technique in many several applications. Together, these developments have transformed the capabilities of the plasma jet and helped to form it as the process of special for the production of imperative tools for decontaminating and sterilize the different places. The outcomes of some recent important studies in this review. Also been included the preparation of nanoparticles and it can be considered a good attempt to use in killing bacteria. Overall, hence, this paper provides a review of the current status of the atmospheric–pressure plasma jet process and considers future areas of exploitation for this technique.

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