

Effect of plasma jet on the water and hydrogen peroxide that used for assisted teeth bleaching

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Abstract

In this work the interaction of plasma jet with water and hydrogen peroxide liquids used for assisted teeth bleaching by plasma jet had been study. A homemade plasma jet system was used. The plasma jet supply by 15 W electrical power generated by high voltage power supply of 9.6 kV peak to peak and frequency of 33 kHz .this power supply generate high electric field on electrodes that would be enough to ionize the argon gas. Some important agents were study such as the effect of the Ar gas flow rates on the length of the plasma jet, the influence of plasma jet on some properties of water and two hydrogen peroxide concentrations 25 % and 30 % like pH, conductivity and liquid temperature for different exposure time. The liquids temperature was measured by digital infrared thermometer, the gas flow rate were measured by gas flow meter, the pH, and the conductivity was measured by pH conductivity ultra-meter. The results illustrated that the conductivity and liquid temperature increase with increasing of exposure time. It can be conclude that the liquid properties were changed less than the boundaries that could affect adversely to the cells that located in the plasma jet.

Key words

Atmospheric pressure plasma jet, dielectric barrier discharge, teeth bleaching.

Article info.

Received: Dec. 2016

Accepted: Dec. 2016

Published: Sep. 2017

تأثير بلازما النفط على الماء وبيروكسيد الهيدروجين المستعمله للمساعده في تبييض الاسنان

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الخلاصة

درس في هذا العمل تفاعل بلازما النفط مع الماء وبيروكسيد الهيدروجين التي استعملت كمساعد في عملية تبييض الاسنان. استخدمت منظومة بلازما نفث محلية الصنع قدرتها 15 واط، وفولتية 9.6 كيلو فولت، ترددها 33 كيلو هيرتز. مجهز قدرة المنظومه يولد مجال كهربائي كافي لتأين غاز الاركون المستخدم لتوليد البلازما. درست بعض العوامل المهمة مثل تأثير تدفق الغاز على طول البلازما، وتأثير البلازما على بعض خصائص الماء، وبيروكسيد الهيدروجين بتراكيز مختلفة (25%، 30%)، مثل الحامضية، التوصيلية، درجة الحرارة السوائل لازمنة تعرض مختلفة. وقد اتضح من النتائج ان درجة حرارة السوائل وتوصيليتها تزداد مع ازدياد الزمن بينما يظهر سلوك درجة الحامضيه معاكس لهما. ويمكن ان نستنتج من هذا ان تأثير البلازما على السوائل تكون بالحدود التي لا يمكن ان تؤثر بها سلباً على الخلايا الواقعة تحت تأثير البلازما.

Introduction

Plasma is defined as a gas in which part of the particles are present in ionized form plasma is a collection of stripped particles. Once the electrons are stripped from atoms and molecules, those particles change state and

become plasma. Plasmas are naturally energetic because stripping electrons uses constant energy. If the energy dissipates, the electrons reattach and the plasma particles become a gas once again. Unlike ordinary matter, plasmas can exist in a wide range of

temperatures without changing state [1]. The main active agents in plasma jet are the chemical reactive species, ions, electrons, UV radiation, electromagnetic fields, and visible light. The produced in the cold plasma jet is depend on a number of variable, for example, the type of used gas, the input energy, and the plasma frequency. These agents generated by the plasma will affect the properties of the used water and peroxide to assist the teeth bleaching. In general there are two types of plasma: thermal and non-thermal or cold atmospheric plasma. Thermal plasma has electrons and heavy particles (neutral and ions) at the same temperature. Cold Atmospheric Plasma (CAP) is said to be non-thermal because it has electron at a hotter temperature than the heavy particles that are at room temperature. CAP is a specific type of plasma that is less than 40°C at the point of application [2]. Tooth bleaching is one of the most commonly applied of discolored pulp less teeth were described in variety of agents such as chloride, sodium hypochlorite, and hydrogen peroxide have been used, either alone or in combination with heat, laser radiation, or UV light [3-5]. In recent years low-temperature cold plasmas at atmospheric pressure in air (or in other gases and gas mixtures) have been shown to provide distinct advantages for tooth bleaching [6], particularly when used in conjunction with hydrogen peroxide or water [7-10]. Outside of a container, plasma were resembles the gas particles don't have a definite shape. But unlike gas, magnetic and electric fields can control plasma and shape it into useful, malleable structures [1]. Various type of plasma were produce such as Dielectric Barrier Discharge (DBD), Atmospheric Pressure Plasma Jet (APPJ), plasma needle, and plasma pencil. Gases that can be used to

produce CAP are helium, argon, nitrogen, heliox (a mix of helium and oxygen) [11]. After the plasma treatment, several important properties of water such as pH, conductivity and temperature are often changed due to the chemical reactions between the plasma and the liquids. Plasma interact with the liquid will produce reactive oxygen species (ROS) and reactive nitrogen species (RNS) These types will affect the liquids properties and thus the way they interact with living tissue. So the evolution of these properties with plasma treatment time needed to assess [12].

Experimental work

In this work the plasma jet system is similar to that was used in our previous work [13]. This plasma jet supply of 15 W electrical power generated by high voltage power supply of 9.6 kV peak to peak and frequency of 33 kHz. It is valuable to understand the controlling factors of the plasma jet length because it will bring benefits to the practical use of the plasma jet. In this work, the effect of gas flow rate (1, 2.5, 5.5 and 7.5ℓ/min) on the plasma jet length were determined. The jet length was determined by using a camera and a ruler. The effect of the plasma jet on some properties such as PH, conductivity and temperature for 20ml water and 20ml hydrogen peroxide for two concentration 25% and 30% were measured. The pH and the conductivity were measured by ultra-meter and the liquids temperature were measured by digital infrared thermometer. The measurements of properties were taken at different exposure time (5, 10, 15, 20 and 25min). Fig.1 shows the liquid treatment by plasma jet. (note: in this work use Ar gas).



Fig.1: Plasma jet liquids treatment.

Results and discussion

Gas flow rate effect on plasma jet length

Controlling of the jet length in this work had been performed through examining the influence of the gas flow rate. Fig. 2 shows the effect of

argon gas flow rate on plasma jet length. One can observed from this figure of gas flow rate yields increasing of plasma jet length for all values of gas flow rate below 2.5ℓ/min. While the gas flow rate increase above 2.5ℓ/min, the plasma jet length will decrease. This behavior may be attributed to the shortening of contact time of the feed to the electrode surface owing to its high gas fluid velocity. The gas flow rate of (5 ℓ/min) gave the longest plasma jet length (2.8cm) and sufficient to sustain the plasma jet. Fig.3 shows the relation between the plasma jet length as a function of argon gas flow rate.

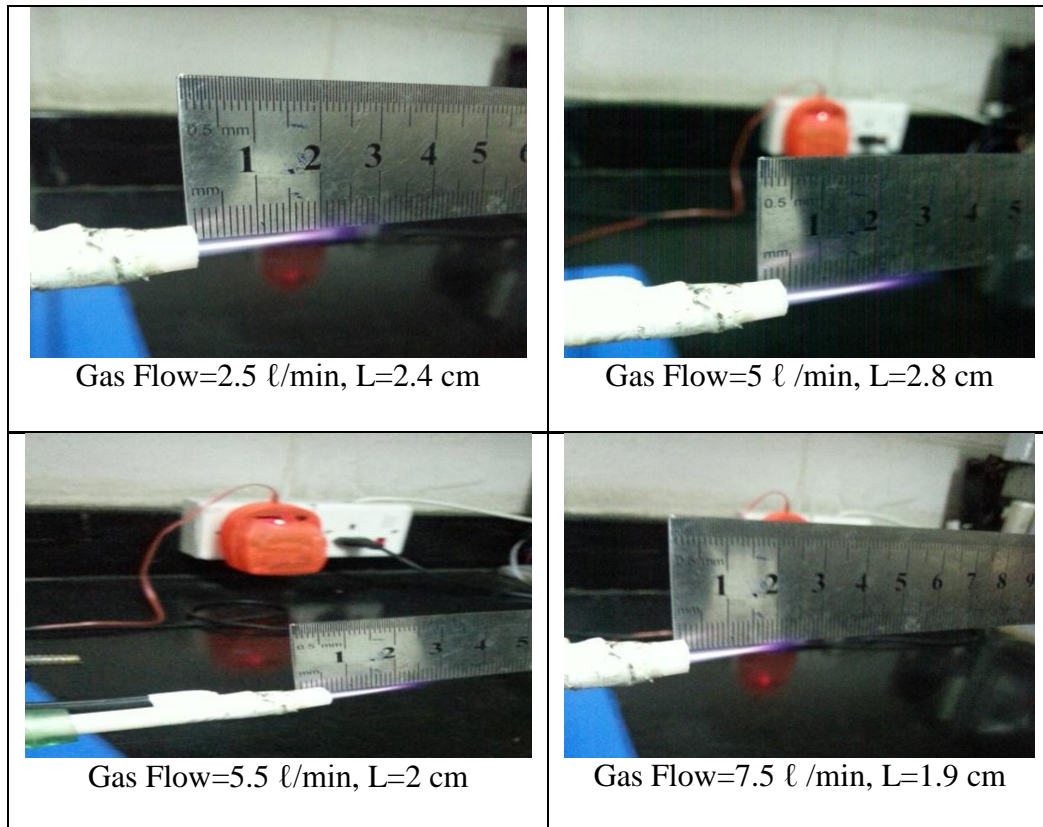


Fig.2: The effect of argon flow rate on plasma jet length.

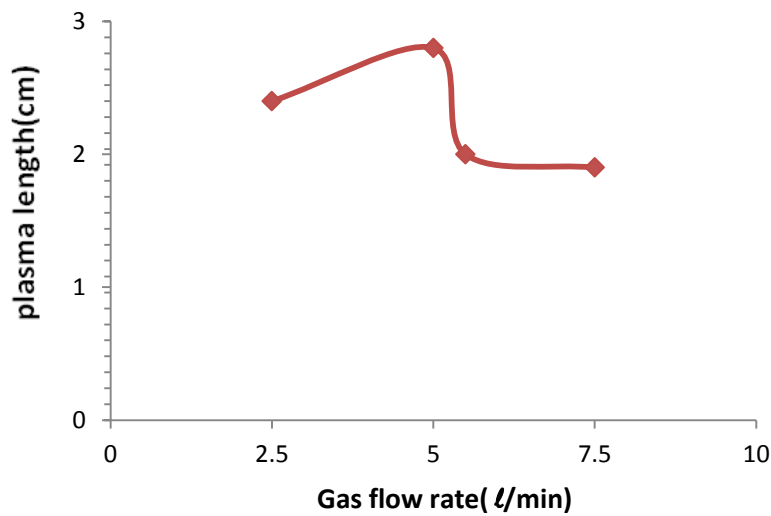


Fig.3: Plasma jet length as a function of gas flow rate.

Effects of plasma jet on some properties of water and hydrogen peroxide

After the plasma treatment, several important properties such as pH, conductivity and temperature of water and hydrogen peroxide are often affected due to the chemical reactions between liquid and plasma. Fig.4 (a, b and c) estimated the pH, conductivity and temperature of water as function of exposure time, respectively. One can observe from this Fig., the water conductivity and the temperature increase with increasing of plasma exposure time. While the pH of water shown opposite behavior with the exposure time. The increasing of water

conductivity may be caused by electrolysis. Rising of water temperature when exposed to plasma caused by a multi factors, including the water absorption to the ultraviolet and infrared radiation associated with plasma as well as the electrons and ions interaction with water molecules. On the other hand the decreasing of pH with increasing of exposure time was due to the reaction between active species and water. Fig.5 (a, b and c) show the influence of plasma jet on some properties of hydrogen peroxide (25% and 30% concentration). These results have a good agreement with the others [14].

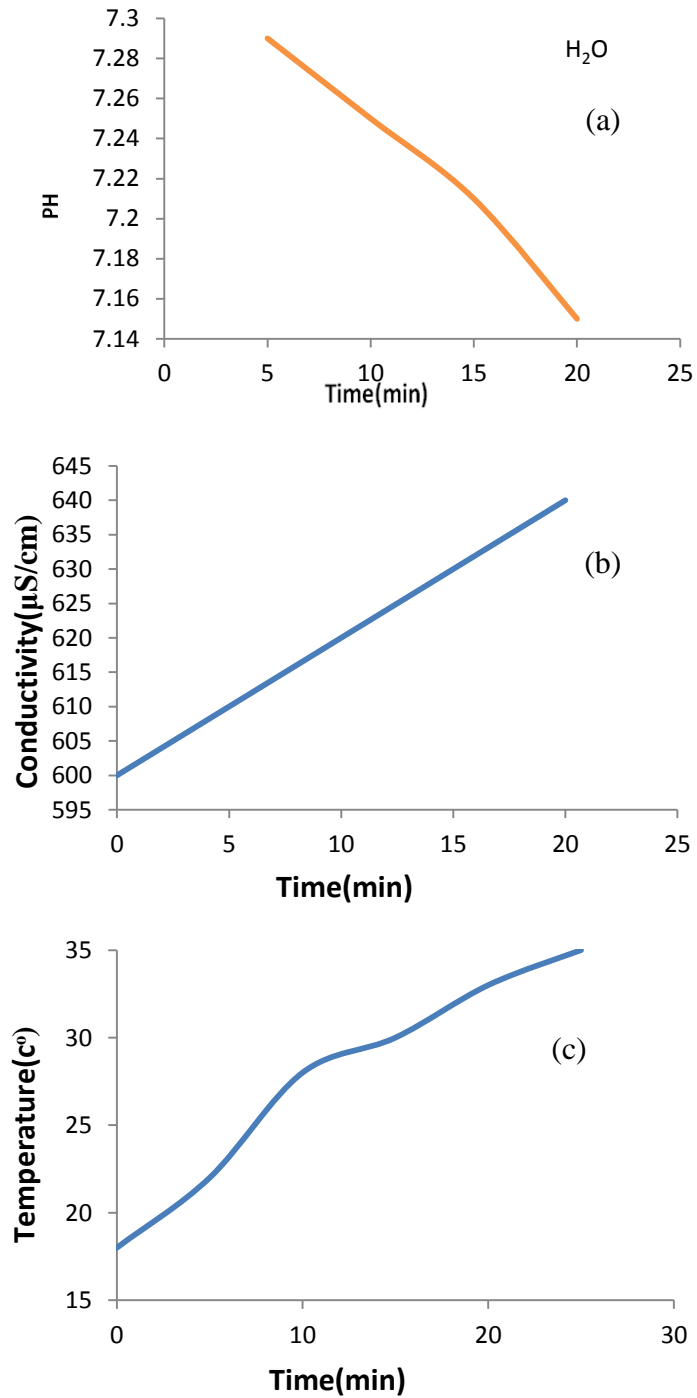
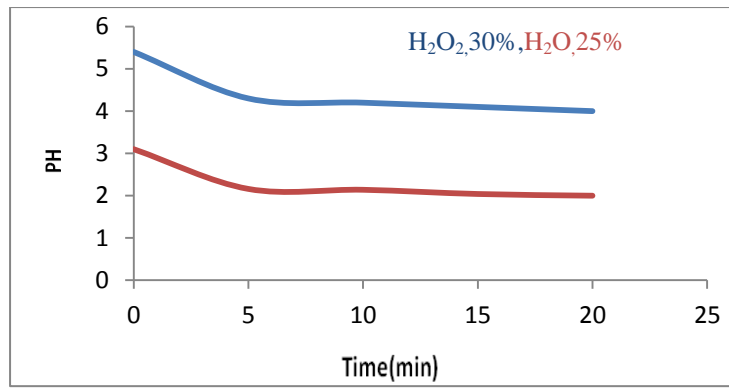
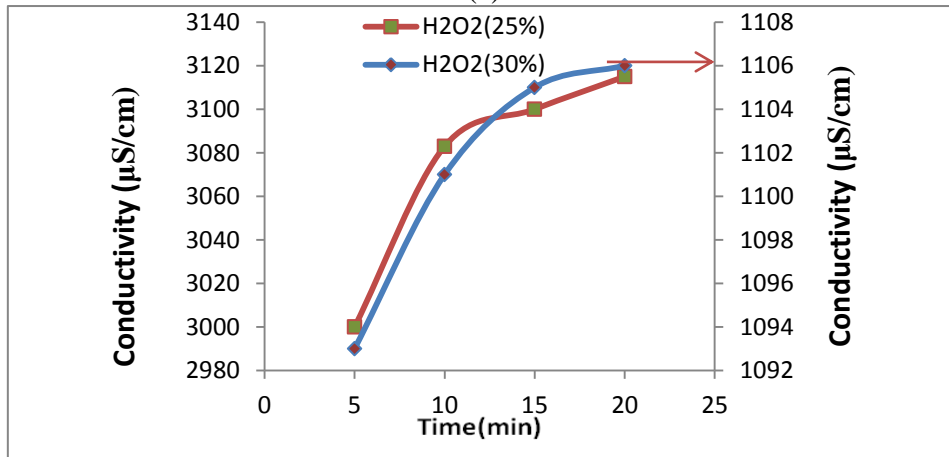


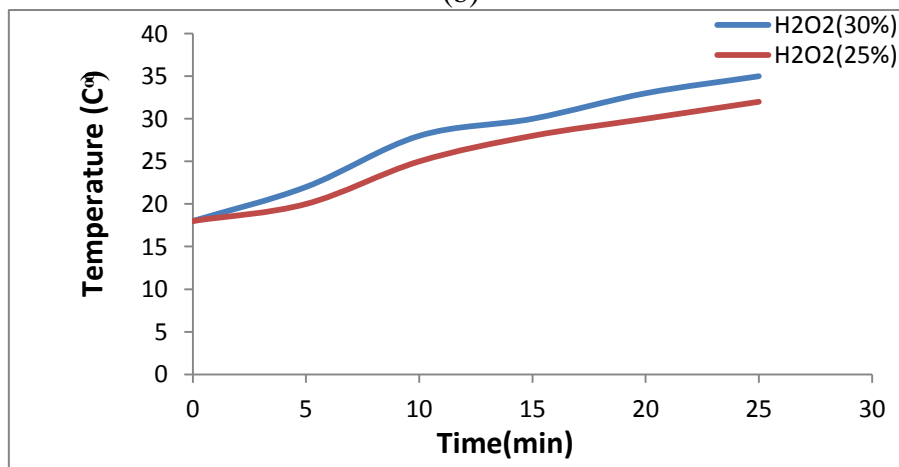
Fig.4: (a) Water PH variation with the time (b) water conductivity variation with the time (c) water temperature variation with the time.



(a)



(b)



(c)

Fig.5: (a) pH variation of with the exposer time (b) conductivity variation for hydrogen peroxide (25%, 30%) concentration, with the exposure time (c) temperature variation with the exposure time for hydrogen peroxide (25%, 30%) concentration.

Conclusions

From this work it can be conclude that the pH for the liquids increased when exposed to the plasma jet, as well as temperature, electrical conductivity and that this increasing is less than the boundaries that could

affect adversely to the cells that located in plasma jet.

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