The present invention relates to a photocatalyst toothbrush using an AOP (advanced oxidation process) which is configured such that a light source unit 113 such as UV lamps is attached to a photocatalyst reaction unit 114 coated with a photocatalyst such as TiO₂. Superoxide anion and OH radical are generated by a photocatalyst action, and the generated superoxide anion and OH radical are collected and are transferred together with external air to an oral cavity by using an air pump 115. In this way, organic substances, such as food, viruses, bacteria, plaque, tartar, etc., existing in the oral cavity are decomposed and removed so as to provide a clean oral-cavity state. Since the exemplary embodiment of the present invention is innovative in the generation and transfer configuration of anion and OH radical and has a simple configuration, the manufacturing is easy.
Fig. 5
PHOTOCATALYST TOOTHBRUSH USING ADVANCED OXIDATION PROCESS

BACKGROUND OF INVENTION

[0001] The present invention relates to a photocatalyst toothbrush using an advanced oxidation process (hereinafter referred to as an AOP), and more particularly, to a photocatalyst toothbrush which removes an organic substance in an oral cavity by adding a photocatalyst effect using a UV lamp and a photocatalyst and particularly has a sterilizing function, a whitening function, a plaque removing function, and a bad breath removing function. Further, the present invention also relates to a photocatalyst toothbrush capable of preventing external viruses and bacteria, which can be generated on bristles, through an interlocking operation with a toothbrush holder, so as to always maintain a clean state.

[0002] Various eating habits appeared with recent changes of lifestyles influence oral health and cause problems such as gum diseases and bad breath which cause problems in interpersonal relationships, resulting in rising of interest in oral health. These problems result from incorrect tooth-brushing habits. If neglecting this, plaque and tartar irritate thinned blood vessels in gums, causing inflammations. Most people don’t know the seriousness of plaque and tartar and often do not take measures to prevent such problem. In addition, nasty viruses may cause systematic diseases such as cardiovascular diseases, heart diseases, pneumonia while moving to other tissues and organs of the body through the inflammations.

[0003] Attempts to remove plaque and tartar for preventing tooth-decay and periodontal diseases have been made as long as human history. As oral care methods, use of toothbrushes and toothpastes is the most general, and various other aids such as interdental brushes and mouth rinses are used.

[0004] In general, toothbrushes are classified into general toothbrushes and electric toothbrushes. A general toothbrush is composed of toothbrush bristles and a toothbrush handle, and a user brushes the teeth while moving up, down, left, and right by himself so as to remove plaque, tartar, and food remaining in the mouth. However, if plaque and tartar are not efficiently removed due to incorrect tooth-brushing habits, etc., the plaque and tartar may cause tooth-decay and periodontal diseases.

[0005] Electric toothbrushes have been developed for patients and the handicapped, and users are continuously increasing because of excellent plaque and tartar removal effects by the electric toothbrushes. However, since electric toothbrushes adapt a rotation manner, there is a disadvantage in which long-term use of electric toothbrushes may cause dental attrition. Further, if electric toothbrushes are incorrectly used, which can continuously irritate dental roots, a problem that dental nerves are exposed may occur.

[0006] Meanwhile, electric toothbrushes have been transformed from an initial rotating type in which toothbrush bristles rotate in one direction into a counter-rotating type in which a number of toothbrush bristles reciprocatingly rotate, on the basis of physically rotation movement. Currently, an oscillating type in which toothbrush bristles rotate left and right and a combined type in which pulsating movement is added to the oscillation type are most widely used. Through these changes, development of toothbrushes having additional functions other than plaque and tartar removal functions while brushing the teeth is continuously being conducted.

[0007] In U.S. Pat. No. 2,215,031, there is disclosed a toothbrush including bristles driven to rotate, and in U.S. Pat. No. 4,156,620, there is disclosed a technique of converting the drive force of a rotation motor into linear reciprocating movement in order to rotate bristles clockwise and counterclockwise. Further, in U.S. Pat. No. 3,577,579, there is a toothbrush in which a toothbrush head moves with respect to a brush holder in order for all the bristles mounted on a toothbrush head to move back and forth with respect to the axis direction of the brush holder. These and other patents propose toothbrushes allowing relatively simple tooth brushing.

[0008] Other patents proposing multi-functional toothbrushes will be described as follows. In U.S. Pat. No. 1,796,641, there is disclosed a spotting brush for dry cleaning in which one pair of parallel heads are mounted to rotate. Further, in U.S. patent Ser. No. 10/260,583, there is disclosed an electric toothbrush that includes two separate, movable toothbrush bristle sections or tuft blocks and includes a linear oscillating section and a rotating electric section having toothbrushes for cleaning, polishing, and whitening on both sides of the toothbrush bristle sections or the tuft blocks.

[0009] In U.S. patent application Ser. No. 11/624,780, there is disclosed a toothbrush having a plurality of tuft blocks (tooth cleaning elements), thereby providing advantages such as cleaning, polishing, tooth whitening, and massaging. Further, in U.S. patent application Ser. No. 11/672,979, there is disclosed an electric toothbrush in which a tissue cleanser is added on a surface of a head opposite to a surface, where a tooth cleansing element is disposed, in a toothbrush according to the related art to clean a tongue, thereby adding a bad breath removing function.

[0010] Recently, development of ultrasonic wave toothbrushes using sound waves in electric toothbrush forms based on rotation movement as described above has progressed. Ultrasonic wave toothbrushes are an advanced type of electric toothbrushes, improves plaque and tartar removal efficiency while reducing irritation pointed out as the biggest problem of the electric toothbrushes, and has a large share of market in US, Japan, Europe, etc., as compared to electric toothbrushes. However, even though the ultrasonic wave toothbrushes reduce irritation as compared to the electric toothbrushes, there is still the inconvenience of use due to unique vibration of ultrasonic waves as a problem to be solved.

[0011] In U.S. Pat. No. 3,828,770, there is disclosed a tooth cleaning method generating an ultrasonic wave and sound wave operation during use by using a continuous ultrasonic mechanical vibration. Further, in U.S. Pat. No. 4,333,197, there is disclosed an ultrasonic toothbrush having a thin, long handle member with a hollow housing form in which a low-voltage coil and a cooperating ferrite core driven at an ultrasonic frequency are disposed. Further, in U.S. Pat. Nos. 4,991,249 and 5,150,492, there are disclosed ultrasonic toothbrushes having exchangeable toothbrush members attachably and detachably attached to ultrasonic electric members.

[0012] In U.S. Pat. No. 5,546,624, there is disclosed an ultrasonic toothbrush converting electronic energy into sound-wave energy, and in U.S. Pat. No. 5,150,492, there is disclosed an ultrasonic toothbrush having an exchangeable ultrasonic implement capable of being attachably and detachably mounted to an ultrasonic power unit included in a toothbrush handle. Further, in U.S. Patent Application No. 60/517,638, there is disclosed an ultrasonic toothbrush which
includes an ultrasonic converter and an acoustic waveguide as components, transmits a sound wave, and induces microbubbles, thereby facilitating removal of plaque and tartar from teeth.

[0013] And, currently, development of toothbrushes that use ultraviolet rays and photocatalysts for eliminating viruses and bacteria including Streptococcus mutans bacteria in an oral cavity and have similar effects as those of a photocatalyst toothbrush proposed in the present invention have progressed. However, among current techniques, a method of directly irradiating an ultraviolet ray may seriously damage skin in an oral cavity, and an indirect irradiation method through toothbrush bristles coated with a photocatalyst has a technical limit in which its effect is poor and has never had a huge impact on sterilizing power.

[0014] In U.S. Patent Application No. 60/449,188, there is disclosed an oral phototherapy apparatus including one or more radiation emitters for irradiating phototherapeutic radiation onto a part of an oral cavity, and in U.S. patent application Ser. No. 12/252,876, there is disclosed a toothbrush in which a light emitting diode having a wavelength of 420 nm to 480 nm is mounted on a toothbrush head. Further, in U.S. Pat. No. 6,094,767, there is disclosed a toothbrush which has a cleaning effect by having an ultraviolet ray as a light source and using toothbrush bristles including a photocatalyst.

[0015] Meanwhile, since a condition under which external viruses and bacteria easily breed on toothbrush bristles is formed in keeping toothbrushes, many people separately buy and use toothbrush sterilizers to prevent contamination under the above condition.

[0016] In U.S. Pat. No. 4,806,770, there is a technique for sterilizing toothbrushes by using a UV lamp of 200 nm to 300 nm. That is, this technique is configured to sterilize bristles of toothbrushes by disposing the UV lamp inside a housing coated with aluminum. Further, in U.S. Pat. No. 5,126,572, there is a toothbrush sterilizer which has a timer and sterilizes toothbrushes by using an ultraviolet ray and a battery.

[0017] Furthermore, in U.S. Pat. No. 3,820,251, there is disclosed a toothbrush sterilizer of a form drying toothbrushes by using an ultraviolet ray as a heat source, not as a light source, and in U.S. Pat. No. 7,213,603, there is disclosed a toothbrush sterilizer of a type in which a UV lamp is attached inside a cylindrical body, a timer is provided, and toothbrushes are hung with bristles downward.

[0018] The term "photocatalyst" is very widely used; however, the exact definition thereof is used to designate a catalyst accelerating a photochemical reaction. The photocatalyst represented by titanium dioxide (TiO2) is a semiconductor substance and converts light energy into chemical energy by electric transfer of excited conduction band electrons and valence band holes, generated by receiving light, at an interface. The electrons excited by light energy and holes have very strong reducing power and oxidizing power and combine with oxygen or moisture in the vicinity of the photocatalyst to form superoxide anion, OH radical, etc. The superoxide anion or OH radical has much stronger oxidizing power than chlorine, hypochlorous acid, peroxide, ozone, etc. is widely used for disinfection or sterilization and thus has excellent effects in decomposition of organic contaminants, deodorization, inhibiting microbe growth, etc.

[0019] In particular, the core of the oxidizing power of the photocatalyst effects is that, since the OH radical is generated, many photocatalyst oxidation reactions start by reacting with the OH radical rather than directly reacting with the holes. The oxidizing power of the OH radical is very strong and it is known that a chemical substance having stronger oxidizing power than the OH radical is only F radical. Since the OH radical reacts with a contaminant to form H2O, the OH radical can be the most eco-friendly oxidizing agent.

[0020] The OH radical may be generated by various physical-chemical methods other than the photocatalyst reaction, and an effective OH-radical generating method can be applied as a useful technique. An AOP uses UV lamps having wavelengths of 254 nm and 184 nm and generates a large amount of OH radicals in a photolysis process through combination with oxygen in the air, and the degree of activity is increased through a photocatalyst reaction, resulting in excellent oxidizing power.

SUMMARY OF THE INVENTION

[0021] The present invention has been made in an effort to provide a photocatalyst toothbrush having advantages capable of being used in the same way as general toothbrushes, preventing tooth wear, unlike electric toothbrushes, being simply used without a vibration phenomenon during use, unlike ultrasonic toothbrushes, and having a sterilizing effect, a plaque removal effect, a whitening effect, and a bad-breath removal effect by using a photocatalyst such as ZnO, CdS, WO3, SnO2, ZrO2, Cu2O, CdSe, and TiO2, and the sun’s light, black light, a fluorescent lamp, a LED lamp, a UV lamp, etc., serving as a light source, and adding a photocatalyst effect and an AOP to innovatively compensate partial and inefficient sterilizing power of existing photocatalyst toothbrushes.

[0022] Further, the present invention has been made in an effort to provide a photocatalyst toothbrush having advantages capable of always maintaining a clean state by hanging the toothbrush in a toothbrush holder, capable of just holding the head part of the photocatalyst toothbrush, with the head part of the photocatalyst toothbrush downward and sterilizing toothbrush bristles and the inside of the toothbrush holder by operating the photocatalyst toothbrush during a predetermined time period.

[0023] An exemplary embodiment of the present invention provides a photocatalyst toothbrush using an AOP (advanced oxidation process) including a head part having a brush used to brush a user's teeth, the head part including an air transfer unit for discharging airflow received by the head part to the outside of the toothbrush. The toothbrush also includes a toothbrush body connected to the head part. The toothbrush body is capable of providing airflow to the head part and has an internal cavity defined by an external structure which a user can hold for brushing teeth. The toothbrush body includes an air inflow opening formed on one side of the toothbrush body to be connected to the internal cavity, as well as a battery provided in the internal cavity for supplying power. A light source unit is also included for receiving power from the battery, and for generating a first light ray having a first wavelength within a sterilization wavelength range and a second light ray of a second wavelength within an ozone generating wavelength range. The toothbrush body also houses a photocatalyst reaction unit at least partially surrounding the light source unit and having a surface coated with a photocatalyst, where the photocatalyst reaction unit generates superoxide anion and OH radicals when said first and second light rays contact the photocatalyst. The toothbrush body also includes an air transfer member for transfer-
ring to the head part of the toothbrush the superoxide anion and OH radicals generated in the photocatalyst reaction unit together with external airflow from the external inflow air opening.

[0024] In the photocatalyst toothbrush, the air transfer member may be an air pump or may include a motor and an impeller.

[0025] Further, the head part may be attachable to and detachable from the upper end part of the toothbrush body.

[0026] The air transfer unit may include an air flow path formed along the inside of the air transfer unit, and a plurality of air discharge openings connected to the outside at an end of the air flow path. Meanwhile, the air inflow opening may be formed in a lower end part of the toothbrush body.

[0027] Further, an air flow line through which air flows from a lower end part to an upper end part the toothbrush body may be formed inside the toothbrush body, and the air flow line may be connected to the air flow path.

[0028] The photocatalyst coated on the photocatalyst reaction unit may be any one of ZnO, CdS, WO3, SrTiO3, ZrO2, CuO, CdS, or TiO2, and the light source unit may be any one of the sun’s light, black light, a fluorescent lamp, an LED lamp, or a UV lamp.

[0029] Further, the wavelength range for the sterilization function may be an ultraviolet wavelength range, and more particularly 254 nm. Furthermore, the wavelength range for generating the ozone may be 184 nm.

[0030] According to the exemplary embodiments of the present invention, a large amount of superoxide anion and OH radical are generated, and the generated superoxide anion and OH radical are transferred into an oral cavity and functions to decompose and remove organic substances, such as food, viruses, bacteria, tartar, etc., existing in the oral cavity. Meanwhile, since these processes are performed while brushing the teeth, it is possible to solve the problems of existing general toothbrushes and electric toothbrushes such as poor plaque and tartar removal effect and provision of causes of periodontal diseases according to tooth waste, and ensure a clean and healthy oral-cavity state.

[0031] Further, according to the exemplary embodiments of the present invention, the photocatalyst toothbrush is mounted in a toothbrush holder, capable of just holding the head part of the photocatalyst toothbrush, with the head part of the photocatalyst toothbrush downward, and then the photocatalyst toothbrush is operated during a predetermined time period, whereby the generated superoxide anion and OH radical prevent contamination by external viruses or bacteria capable of acting on the inside of the toothbrush holder and the toothbrush bristles, which makes it possible the functions of a toothbrush sterilizer always maintaining cleanliness. Therefore, the exemplary embodiment of the present invention has an advantage in which effort and cost for additionally buying a toothbrush sterilizer do not occur.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] FIG. 1 is a schematic view illustrating a configuration of a photocatalyst toothbrush using an AOP (advanced oxidation process) according to an exemplary embodiment of the present invention;

[0033] FIG. 2 is a cross-sectional view taken by cutting the photocatalyst toothbrush shown in FIG. 1 in a longitudinal direction;

[0034] FIG. 3 is a schematic view illustrating modified form of the photocatalyst toothbrush according to an exemplary embodiment of the present invention;

[0035] FIG. 4 is a schematic view illustrating a toothbrush holder for holding the photocatalyst toothbrush shown in FIG. 1; and

[0036] FIG. 5 is a photograph illustrating results of experiments on organic substance removal capability using a dye with respect to an experimental group according to an experimental example of the present invention and a control group.

[0037] It should be understood that the drawings are not necessarily to scale and that the embodiments are sometimes illustrated by graphic symbols, phantom lines, diagrammatic representations and fragmentary views. In certain instances, details which are not necessary for an understanding of the present invention or which render other details difficult to perceive may have been omitted. It should be understood, of course, that the invention is not necessarily limited to the particular embodiments illustrated herein.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0038] Hereinafter, a photocatalyst toothbrush using an AOP (advanced oxidation process) according to an exemplary embodiment of the present invention will be described in detail with reference to the accompanying drawings.

[0039] As shown in FIGS. 1 and 2, a photocatalyst toothbrush 100 using an AOP (advanced oxidation process) according to an exemplary embodiment of the present invention includes a toothbrush body 110 having an external structure which a user can hold for brushing the teeth and an inside containing space, and a head part 120 exchangeably joined with an upper part of the toothbrush body 110 and having a brush used to brush the teeth.

[0040] The toothbrush body 110 may have any form as long as a user can conveniently hold it, and is configured to have the containing space inside. Inside the toothbrush body 110, a battery 111, a circuit unit 112, a light source unit 113, a photocatalyst reaction unit 114, and an air pump 115 are sequentially disposed from the lower end part of the toothbrush body 110. Outside the toothbrush body 110, an operation switch 116 is provided.

[0041] Here, the battery 111 functions to supply power, and the circuit unit 112, in which a microcomputer and an inverter for converting a power supply are designed, functions to control the light source unit 113 and the air pump 115. The light source unit 113 functions to receive power supply of the battery 111, generate a ray of a wavelength range for sterilization and a ray of a wavelength range for generating ozone, and irradiate the rays onto the photocatalyst reaction unit 114. The photocatalyst reaction unit 114 functions to generate superoxide anion and OH radical by the ray of the wavelength range for sterilization and the ray of the wavelength range for generating ozone irradiated from the light source unit 113. That is, the photocatalyst reaction unit 114 is disposed to locate around the light source unit 113, has a surface coated with a photocatalyst, and generates the superoxide anion and the OH radical by the ray of the wavelength range for sterilization and the ray of the wavelength range for generating ozone. Here, the wavelength range for sterilization may be an ultraviolet wavelength range, and in particular, 254 nm. Further, the wavelength range for generating ozone may be 184 nm.
The air pump 115 functions to transfer the superoxide anion and the OH radical generated by the photocatalyst reaction unit 114 together with external inflow air to the head part 120. The operation switch 116 electrically connects the battery 111, the circuit unit 112, the light source unit 113, and the air pump 115. If the user presses the operation switch 116 used 117, interrupts the electrical connections between the battery 111, the circuit unit 112, the light source unit 113, and the air pump 115, if the user presses the operation switch 116 once more, may be a well-known touch-type operation switch.

Meanwhile, the lower end part of the toothbrush body 110 is configured to have an air inflow opening 117 connected to the inside containing space. Further, inside the toothbrush body 110, an air flow line through which air flows from the lower end part to the upper end part is formed even though the above-mentioned components are arranged inside the toothbrush body 110. Therefore, the superoxide anion and the OH radical generated by the photocatalyst reaction unit 114 can smoothly move to the head part 120 through the inside of the toothbrush body 110 together with the external inflow air flowing into the toothbrush body 110 along the air inflow opening 117.

The head part 120 is joined with the upper end part of the toothbrush body 110 to be exchangeable, and includes a brush 121 used to brush teeth, and an air transfer unit 122 which is configured as one body with the brush 121 and is exchangeably joined with the upper end part of the toothbrush body 110 to transfer the superoxide anion and the OH radical, transferred by the air pump 115, together with external inflow air to the vicinity of the brush 121, and discharges the superoxide anion and the OH radical together with the external inflow air.

Here, the brush 121 is configured in a form similar to or same as a brush constituting a general toothbrush. Further, an air flow path 122a through which air or the like can smoothly flow is formed inside the air transfer unit 122, and a plurality of air discharge openings 122b connecting to the outside are formed at the end of the air flow path 122a. In this case, the plurality of air discharge openings 122b are formed in the vicinity of the brush 121 and are configured to discharge the superoxide anion and the OH radical together with the external inflow air to an oral cavity while a user brushes the teeth.

The operation method of the photocatalyst brush using the AOP (advanced oxidation process) according to the exemplary embodiment of the present invention configured as described above will be described below.

First, the operation switch 116 located outside the toothbrush body 110 is pushed. Then, a signal is transmitted to the circuit unit 112 to supply power from the battery 111 to the light source unit 113 and the air pump 115, respectively. Then, the light source unit 113 irradiates the ray of the wavelength range (for example, a wavelength of 254 nm) for sterilization and the ray of the wavelength range (for example, a wavelength of 184 nm) onto the photocatalyst reaction unit 114, whereby the superoxide anion and the OH radical are generated inside the photocatalyst reaction unit 114 by a photocatalyst action. The generated superoxide anion and OH radical move to the head part 120 together with the external inflow air flowing inside through the air inflow opening 117 by the operation of the air pump 115. That is, the generated superoxide anion and OH radical together with the external inflow air passes through the air flow line of the inside of the toothbrush body 110 and the air flow path 122a of the air transfer unit 122 of the head part 120 and are transferred into the oral cavity of the user through the plurality of air discharge openings 122b.

While brushing the teeth, the superoxide anion and the OH radical transferred to the oral cavity as described above evenly spread into the oral cavity so as to be transferred to places which it is difficult to reach, and decomposes and removes organic substances, thereby decomposing viruses and bacteria causing tooth decay. Therefore, not only a tooth decay prevention effect but also a clean oral cavity state through plaque removal, whitening effect, bad breath removal are provided.

Meanwhile, in a photocatalyst brush using the AOP (advanced oxidation process) according to an exemplary embodiment of the present invention, instead of the air pump 115 of FIGS. 1 and 2, an air transfer member including a motor 118 and an impeller 119 as shown in FIG. 3 may be provided on at least one side of the front end and the rear end of the photocatalyst reaction unit 114, thereby capable of more smoothly discharging the superoxide anion and OH radical generated by the photocatalyst reaction unit 114 to the air discharge openings 122b.

After use of the photocatalyst toothbrush 100 is completed, the photocatalyst toothbrush 100 is washed. Then, the photocatalyst toothbrush 100 is mounted in a toothbrush holder 130 capable of holding the head part 120 of the photocatalyst toothbrush 100 as shown in FIG. 4 with the head part 120 downward, and is operated during a predetermined time period, whereby the superoxide anion and the OH radical generated through the above-mentioned operation relation prevent contamination by external viruses and bacteria capable of acting the inside of the toothbrush holder 130 and the toothbrush bristles, so as to always maintain clearness.

First Experimental Example

The photocatalyst toothbrush provided according to the exemplary embodiment of the present invention has the configuration described with reference to FIGS. 1 and 2. First, UV lamps having wavelengths of 254 nm and 184 nm was attached inside an aluminum pipe coated with a photocatalyst, TiO2, serving as the photocatalyst reaction unit, thereby making a preparation so that a photocatalyst action and the AOP can be performed. Further, an air pump was provided in the upper part of the aluminum pipe provided as the photocatalyst reaction unit to facilitate discharge of the superoxide anion and the OH radical generated inside the photocatalyst reaction unit. Two disposable 1.5V AAA batteries were connected in series as a power supply, and a PCB having a micro computer and an inverter attached thereto was provided in the lower part of the aluminum pipe in order to facilitate the operations of the UV lamps and air pump. In order to prevent the air inflow and the flow of the generated superoxide anion and OH radical from being externally influenced, the above-mentioned components were mounted inside a sealed structure having a toothbrush form.

In order to check the sterilizing power of the photocatalyst toothbrush manufactured in the above-mentioned method, an experiment using an E. coli group was conducted. The E. coli used for the experiment was purified out from Korean Cultural Center of Microorganisms and used, and Trypticase Soy Broth or Trypticase Soy Agar brought from BD Biosciences was used as a culture medium and a preservation medium. 0.1 ml aliquots of the prepared bacterial cul-
ture medium were put in 1.5 ml microtubes so as to prepare an experimental group and a control group, and then the photocatalyst toothbrush was fixed to be 0.5 cm high from the bacterial culture medium. Then, the photocatalyst toothbrush was operated during 3 minutes and the number of *E. coli* was measured before and after the process, thereby checking the sterilizing power. The experiment was conducted in the same manner three times and an average value was calculated.

[0053] Table 1 shows experimental results of the sterilization experimental using *E. coli* according to the first experimental example. It can be found out from the experimental results that sterilizing power was 50% to 60% in 3 minutes and 70% to 80% in 5 minutes.

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Second Experimental Example

[0054] In order to check the organic-substance removal capability of a photocatalyst toothbrush manufactured in the same method as the first experimental example, a decolorization experiment using a dye was conducted. A blue series product manufactured by CIBA was used as the dye used for the experiment and was diluted with pure water 10000 times so as to prepare the diluted solution.

[0055] The head part of the photocatalyst toothbrush was put in the prepared diluted solution to facilitate transfer of the superoxide anion and the OH radical generated in the photocatalyst into the diluted solution.

[0056] The experiment was conducted by distinguishing the experimental group and a control group having the same conditions as the experimental group manufactured in the above-mentioned method except that the inside of the photocatalyst reaction unit is not coated with TiO2. The experiment was conducted to until when all the diluted dye solution was decolorized and the organic-substance removal capability was checked through the time to until all the diluted dye solution was decolorized.

[0057] FIG. 5 is a photograph showing the experimental results of the organic-substance removal capability using the dye according to the second experimental example. (a) of FIG. 5 shows the results of the experiment using the experimental group, and it can be found out from the (a) of FIG. 5 that after one hour elapsed, all the diluted dye solution was decolorized. (b) of FIG. 5 shows the results of the experiment using the control group, and it can be found out from the (b) of FIG. 5 that after two hours elapsed, all the diluted dye solution was decolorized. It can be found out from the experimental results that the photocatalyst toothbrush according to the exemplary embodiment of the present invention adapting all of the photocatalyst action and the AOP exhibits excellent organic-substance removal capability as compared to a case in which at least one of the photocatalyst action and the AOP is not adapted.

[0058] Although the technical features of the photocatalyst toothbrush using the AOP (advanced oxidation process) according to the exemplary embodiment of the present invention has been described with reference to the accompanying drawings, they are used in a generic and descriptive sense only and not for purposes of limitation.

[0059] It will be apparent to those skilled in the art that modifications and variations can be made in the present invention without departing from the spirit or scope of the invention.

[0060] Thus, there has been shown and described several embodiments of a photocatalyst toothbrush which fulfills all of the objects and advantages sought therefor. As is evident from the foregoing description, certain aspects of the present invention are not limited by the particular details of the examples illustrated herein, and it is therefore contemplated that other modifications and applications, or equivalents thereof, will occur to those skilled in the art. Many changes, modifications, variations and other uses and applications of the present invention will, however, become apparent to those skilled in the art after considering the specification and the accompanying drawings. All such changes, modifications, variations and other uses and applications which do not depart from the spirit and scope of the invention are deemed to be covered by the invention which is limited only by the claims which follow.

What is claimed is:

1. A photocatalyst toothbrush using an AOP (advanced oxidation process) including:
   a head part having a brush used to brush a tooth, said head part including an air transfer unit for discharging airflow received by the head part to the outside of the toothbrush; and
   a toothbrush body connected to said head part and capable of providing said airflow to said head part, said toothbrush body having an internal cavity and an external structure which a user can hold for brushing a tooth, said toothbrush body including:
   an air inflow opening formed on one side of the toothbrush body to be connected to the internal cavity, a battery provided in the internal cavity for supplying power,
   a light source unit for receiving power from the battery, and for generating a first light ray having a first wavelength within a sterilization wavelength range and a second light ray of a second wavelength within an ozone generating wavelength range,
   a photocatalyst reaction unit at least partially surrounding the light source unit and having a surface coated with a photocatalyst, said photocatalyst reaction unit generating superoxide anion and OH radicals when said first and second light rays contact said photocatalyst, and
   an air transfer member for transferring to the head part of the toothbrush the superoxide anion and OH radicals generated in the photocatalyst reaction unit together with external airflow from the external inflow air opening.

2. The photocatalyst toothbrush using an AOP (advanced oxidation process) according to claim 1, wherein the air transfer member is an air pump.

3. The photocatalyst toothbrush using an AOP (advanced oxidation process) according to claim 1, wherein the air transfer member includes a motor and an impeller.

4. The photocatalyst toothbrush using an AOP (advanced oxidation process) according to claim 1, wherein the head part is attachable to and detachable from the upper end part of the toothbrush body.
5. The photocatalyst toothbrush using an AOP (advanced oxidation process) according to claim 4, wherein the air transfer unit includes an airflow path formed along the inside of the air transfer unit, and a plurality of air discharge openings connected to the outside at an end of the air flow path.

6. The photocatalyst toothbrush using an AOP (advanced oxidation process) according to claim 5, wherein the air inflow opening is formed in a lower end part of the toothbrush body.

7. The photocatalyst toothbrush using an AOP (advanced oxidation process) according to claim 6, wherein an air flow line through which air flows from a lower end part to an upper end part of the toothbrush body is formed inside the toothbrush body, and the air flow line is connected to the air flow path.

8. The photocatalyst toothbrush using an AOP (advanced oxidation process) according to claim 1, wherein the photocatalyst coated on the photocatalyst reaction unit is any one of ZnO, CdS, WO₃, SnO₂, ZrO₂, Cu₂O, CdSe, or TiO₂.

9. The photocatalyst toothbrush using an AOP (advanced oxidation process) according to claim 1, wherein the light source unit is any one of the sun’s light, black light, a fluorescent lamp, an LED lamp, or a UV lamp.

10. The photocatalyst toothbrush using an AOP (advanced oxidation process) according to claim 1, wherein the sterilization wavelength range is an ultraviolet wavelength range.

11. The photocatalyst toothbrush using an AOP (advanced oxidation process) according to claim 10, wherein the ultraviolet wavelength range is 254 nm.

12. The photocatalyst toothbrush using an AOP (advanced oxidation process) according to claim 11, wherein the ozone generation wavelength range is 184 nm.

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