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(54) **ULTRAVIOLET STERILIZATION DEVICE**

ULTRAVIOLETTSTERILISIERUNGSVORRICHTUNG

DISPOSITIF DE STÉRILISATION PAR ULTRAVIOLETS

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Description

TECHNICAL FIELD

[0001] The present invention relates to the technical field of light sterilization, in particular to an ultraviolet sterilization device.

BACKGROUND ART

[0002] Because ultraviolet rays can effectively inactivate bacteria and viruses, it has become a common sterilization method. In recent years, ultraviolet Light Emitting Diodes (LEDs) based on AlGaN materials have developed rapidly. Compared with traditional mercury lamps, ultraviolet LED lamps have many advantages, such as small size, no mercury, fast response speed, low-voltage light source and so on, so that ultraviolet LED lamps are widely used in the fields of surface sterilization, liquid sterilization, air sterilization and so on.

[0003] US2013/236353A1 discloses a device for disinfecting of gases and/or liquids, includes a tube of UV-transparent glass having a hollow interior space and a tube wall with a tube inside wall and a tube outside wall, as well as at least one UV-light source. The UV-transparent glass tube has an indentation extending into the interior space on at least one location and in the at least one indentation at least one UV-light source is arranged. The geometry causes the UV-light sources to be closer to the medium to be disinfected, so that a large portion of the UV-light reaches the interior space on a direct path through the glass, thus allowing fbr a low-loss transfer of the UV-light.

[0004] WO2020/163733A1 discloses an UV light disinfecting system where UV light is distributed along the walls of a highly reflective tube. In some embodiments, the UV light disinfecting system is flexible. In at least one embodiment, the UV light disinfecting system includes at least one UV-LED positioned external to a highly reflective tube. In exemplary embodiments, the reflective tube includes a plurality of openings that are arranged so as to position each opening adjacent to a corresponding UV-LED such that UV light generated by the corresponding UV-LED is able to pass through the opening and into the reflective tube. The UV light is scattered along the length of the reflective tube to prevent or eliminate the presence of biofilms as well s to disinfect, sterilize, and purify and pathogens within the tube. Methods to mitigate the growth of biofilms in a water conduit is also provided.

[0005] US2016/052802A1 discloses a water purification apparatus. In the water purification apparatus, a light source irradiates the water, passing through the flow passage, with ultraviolet light. The light source has a light emitting diode that emits the ultraviolet light whose wavelength is contained in a bandwidth of 220 nm or above to less than 300 nm, and the optical output in this wavelength bandwidth is in a range of 1 W to 50 W. The flow passage passes the water at a flow rate of 5 mL/second to 250 mL/second. The flow passage is formed by a wall surface having a tubular shape. A window through which the ultraviolet light is passed is provided in at least part of the wall surface.

[0006] US 2020/189936 A1 discloses a fluid sterilizing device which includes barrel portion having a channel where fluid to be sterilized flows; inlet formed on one end portion side of the barrel portion; outlet formed on the other end portion side of the barrel portion; a light source that emits ultraviolet light toward the fluid; and a rectifier mounted inside the channel and having a cylindrical through hole.

[0007] One of the existing devices for ultraviolet sterilization of liquid is provided with a liquid storage tank, and the liquid in the liquid storage tank is sterilized by long-term ultraviolet irradiation. The sterilization device can achieve the sterilization rate of 99.9%, and the sterilization device is cheap and relatively mature in technology. However, under the long-term ultraviolet irradiation, the above ultraviolet sterilization device will cause yellowing of the plastic of the tank body of the liquid storage tank and even result in powdering in severe cases. Therefore, in the prior art, a flow-through sterilization device is proposed. When the liquid flows through the sterilization cavity, it can achieve 99.9% of sterilization at a flow rate of several liters/minute.

[0008] However, in order to achieve the sterilization ability, the above flow-through sterilization devices generally use ultraviolet LED light sources with higher ultraviolet power. At the same time, the flow-through sterilization device needs to be designed with a more complex heat dissipation structure and a liquid flow structure, which is large in volume and high in cost, and brings difficulties to large-scale popularization.

SUMMARY

[0009] The embodiment of the present invention provides an ultraviolet sterilization device according to claim 1. The ultraviolet sterilization device of the invention is simple in structure, low in cost, and suitable for popularization and use in scenes such as household water dispensers, faucets, pet water dispensers, humidifiers, smart toilets and the like.

[0010] Preferred features of the invention as recited in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG 1a is an exploded view of an ultraviolet sterilization device according to an embodiment of the present invention.

FIG 1b is a cross-sectional view of an ultraviolet sterilization device according to an embodiment of the present invention.

FIG 1c is a schematic structural diagram of a hollow pipe of an ultraviolet sterilization device according to an embodiment of the present invention.

FIG 1d is a schematic structural diagram of an ultraviolet light source of an ultraviolet sterilization device according to an embodiment of the present invention.

FIG 1e is a schematic structural diagram of a shell of an ultraviolet sterilization device according to an embodiment of the present invention.

FIG 1f is a schematic diagram of illuminance distribution of an ultraviolet light source in a pipe of an ultraviolet sterilization device according to an embodiment of the present invention.

FIG 2a is a cross-sectional view of another ultraviolet sterilization device according to an embodiment of the present invention.

FIG 2b is a schematic diagram of illuminance distribution of an ultraviolet light source in a pipe of another ultraviolet sterilization device according to an embodiment of the present invention.

FIG 3a is a cross-sectional view of another ultraviolet sterilization device according to an embodiment of the present invention.

FIG 3b is a schematic diagram of illuminance distribution of another ultraviolet sterilization device according to an embodiment of the present invention.

List of reference numbers:

[0012] 100-ultraviolet sterilization device; 110-liquid passing pipe assembly; 111-shell; 1112-outer wall surface; 1114-inner wall surface; 112-hollow pipe; 1121-liquid inlet end; 1122-liquid outlet end; 113-accommodating groove; 114-upper cover; 1131-second light transmitting hole; 130-reflective film; 13 1-first light transmitting hole; 140-ultraviolet light source; 141-LED lamp; 142-substrate; 150-joint.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0013] Because ultraviolet rays can inactivate bacteria and viruses, ultraviolet sterilization has become a common sterilization method. There are mainly two types of existing liquid sterilization devices. One liquid sterilization device is provided with a liquid storage tank to sterilize the liquid in the liquid storage tank by using ultraviolet rays, but this method easily causes yellowing of the tank body of the liquid storage tank. Based on this problem, the prior art also proposes a flow-through sterilization device, which sterilizes the liquid by external irradiation of the sterilization cavity when the liquid flows through the sterilization cavity. However, the existing flow-through sterilization devices generally use light sources with high ultraviolet power, and are correspondingly provided with a complex heat dissipation structure and a liquid flow structure, which are bulky and costly, and are not conducive to large-scale popularization and application.

[0014] Embodiments of the present invention will be described with reference to the accompanying drawings hereinafter.

[0015] The present invention provides an ultraviolet sterilization device 100, as shown in FIGS. 1a-1e, which includes a liquid passing pipe assembly 110 and an ultraviolet light source 140. The liquid passing pipe assembly 110 includes a shell 111 and a transparent hollow pipe 112, the shell 111 is sleeved on the hollow pipe 112, the shell 111 is provided with an accommodating groove 113, and the ultraviolet light source 140 is provided in the accommodating groove 113. One end of the hollow pipe 112 is provided as a liquid inlet end 1121, and the other end thereof is provided as a liquid outlet end 1122, and the hollow pipe 112 is used for circulating liquid. The wall surface of the hollow pipe 112 is covered with a reflective film 130, the reflective film 130 is provided with first light transmitting holes 131 at the position corresponding to the ultraviolet light source 140, the first light transmitting holes 131 are communicated with the accommodating groove 113, so that the ultraviolet light emitted by the ultraviolet light source 140 is incident into the hollow pipe 112 and sterilizes the liquid circulating in the hollow pipe 112, and the reflective film 130 is used for scattering the ultraviolet light in different areas in the hollow pipe 112.

[0016] It should be noted that the ultraviolet light source 140 is provided in the accommodating groove 113 provided on the shell 111. The transparent hollow pipe 112 is used for the liquid to be sterilized to flow. The wall of the hollow pipe 112 is covered with the reflective film 130. Ultraviolet light enters the hollow pipe 112 and irradiates on the wall surface of the hollow pipe 112, and the light ray is reflected by the reflective film 130 covered on the wall surface. Under the action of the reflective film 130, ultraviolet rays are scattered to various areas in the hollow pipe 112, such as the vicinity of the liquid inlet end 1121, the middle area of the hollow pipe 112 and the vicinity of the liquid outlet end 1122, so as to sterilize the water in various areas in the hollow pipe 112 and obtain a good sterilization effect. Since the reflective film 130 is an opaque or partially transparent film layer, it is necessary to provide the first light transmitting holes 131 in the reflective film 130 so that the ultraviolet light emitted by the ultraviolet light source 140 can enter the hollow pipe 112 through the first light transmitting holes 131.

[0017] In this embodiment, the reflective film 130 is covered on the hollow pipe 112, and the ultraviolet light source 140 is scattered to different areas in the hollow pipe 112, so as to realize the sterilization and disinfection function of the liquid flowing through the hollow pipe 112. The device is simple in structure and low in cost, and can be widely applied to scenes such as household water dispensers, faucets, pet water dispensers, humidifiers, smart toilets and the like.

[0018] In a possible embodiment, there are two groups of ultraviolet light sources 140, and the two groups of ultraviolet light sources 140 are provided on the opposite sides of the circumferential outer wall of the shell 111, respectively.

[0019] It can be understood that if the ultraviolet light source 140 is only provided at one side of the circumferential outer wall of the shell 111, although the ultraviolet rays are scattered by the reflective film 130, the illumination (i.e., the illumination intensity) of the ultraviolet light on the opposite sides of the circumferential outer wall of the hollow pipe 112 may not be uniform enough, and the illumination on the side where the ultraviolet light source 140 is provided is stronger, which will lead to the uneven sterilization degree of each area of the flowing liquid. Therefore, one group of ultraviolet light sources 140 is provided on each of the opposite sides of the circumferential outer wall of the shell 111, respectively. On the one hand, the illumination of ultraviolet light can be improved, and on the other hand, the uniformity of the illumination of ultraviolet light on the opposite sides of the circumferential outer wall of the hollow pipe 112 can be ensured, thereby ensuring the consistency of sterilization degree of all areas of the water.

[0020] In an alternative embodiment, as shown in FIGS. 1b and 1d, the ultraviolet light source 140 includes LED lamps 141, and LED lamps 141 in each group of ultraviolet light sources 140 include one or two LED lamps.

[0021] The ultraviolet light source 140 is formed by welding an LED lamp 141 capable of emitting ultraviolet light on a ceramic or metal substrate 142. A circuit is preset on the ceramic or metal substrate 142. The circuit is used to control turning on or off the LED lamp 141.

[0022] It should be noted that there may be a single LED lamp or a plurality of LED lamps 141, but because the reflective film 130 is opaque or not completely transparent, in order to make the ultraviolet light emitted by the ultraviolet light source 140 enter the hollow pipe 112 through the reflective film 130, it is necessary to provide the first light transmitting holes 131 on the reflective film 130. It can be understood that the larger the number of LED lamps 141 is, the larger the area of the first light transmitting holes 131 is and the more incomplete the reflective film 130. Moreover, because there is more than one group of ultraviolet light sources 140, the area of the first light transmitting holes 131 is larger. The incompleteness of the reflective film 130 will affect its reflection effect on ultraviolet light. In order to protect the integrity of the reflective film 130, it is necessary to limit the number of LED lamps 141 of each group of ultraviolet light sources 140, and then control the number and area of the first light transmitting holes 131.

[0023] In this embodiment, by limiting the number of LED lamps 141, under the condition of meeting the irradiation intensity of ultraviolet light, the area of the first light transmitting hole 131 is reduced as much as possible, so as to ensure the integrity of the reflective film 130, thereby ensuring the better reflection effect of the reflective film 130 on light.

[0024] In some embodiments, as shown in FIG 1b, the LED lamps 141 are correspondingly provided in the middle of the hollow pipe 112.

[0025] It should be noted that the LED lamp 141 can be provided at any position of the circumferential outer wall of the hollow pipe 112. However, when the LED lamp is provided in the middle of the hollow pipe 112, the ultraviolet light emitted by the LED lamp 141 can be uniformly distributed on both ends of the hollow pipe 112 under the action of the reflective film 130. It can be understood that the LED lamp 141 directly irradiates the middle of the hollow pipe 112. Therefore, the intensity of ultraviolet light is the strongest. The ultraviolet light at both ends of the hollow pipe 112 is obtained by reflecting the ultraviolet light in the middle of the hollow pipe 112 through the reflective film 130, so that the intensity of ultraviolet light at both ends of the hollow pipe 112 is weak. However, in this arrangement mode, because the distance between each area of the areas at both ends of the hollow pipe 112 and the middle area is the same and not far away, the intensity of ultraviolet light on both ends symmetrical along the middle of the hollow pipe 112 is basically the same, and the intensity of ultraviolet light in the areas at both ends is not too weak. The areas at both ends also have certain sterilization ability. When the liquid flows into the hollow pipe 112 from the liquid inlet end 1121, the ultraviolet light at the liquid inlet end 1121 first preliminarily sterilizes the liquid. When the liquid flows into the middle area of the hollow pipe 112, because of the strong intensity of ultraviolet light here, the liquid can be thoroughly sterilized. When the liquid flows to the liquid outlet end 1122 through the middle area of the hollow tube 112, the ultraviolet light at the liquid outlet end 1122 can further sterilize the liquid. In this way, in the whole process of liquid flowing through the hollow pipe 112, the liquid is sterilized by ultraviolet light with a certain intensity, thus ensuring that the ultraviolet sterilization device 100 has a good sterilization effect.

[0026] On the other hand, the LED lamp 141 is correspondingly provided in the middle of the hollow pipe 112, so that the LED lamp 141 is as far away from the liquid inlet end 1121 and the liquid outlet end 1122 as possible, which can prevent ultraviolet light from being reflected to the outside of the hollow pipe 112 as much as possible, thereby avoiding the lost energy of ultraviolet light, and the harm caused by ultraviolet light leakage.

[0027] In addition, in order to prevent ultraviolet light from being emitted from both ends of the hollow pipe 112 to the outside of the hollow pipe 112, it is not necessary to provide reflective films 130 in the areas near the liquid inlet end 1121 and the liquid outlet end 1122 of the hollow pipe 112, so that the ultraviolet light cannot be reflected at the ends of the hollow pipe 112, thereby further ensuring that the ultraviolet light remains in the ultraviolet sterilization device 100 without leakage.

[0028] In some embodiments, the radial size of the LED lamp 141 is less than or equal to 5 mm.

[0029] The radial size of the LED lamp 141 should be selected according to the demand for the power of the LED lamp 141. Generally speaking, the larger the power of the LED lamp 141 is, the larger the size is, and the stronger the intensity of ultraviolet light is. However, in this embodiment, since the radial size of the LED lamp 141 will affect the size of the first light transmitting hole 131 provided in the reflective film 130, the larger the radial size of the LED lamp 141 is, the larger the first light transmitting hole 131 is. In order to ensure the integrity of the reflective film as much as possible, the radial size of the LED lamp 141 needs to be selected in an appropriate range. In this embodiment, according to the application scenario of the ultraviolet sterilization device 100 provided by the present invention, the radial size of the LED lamp 141 can be selected to be less than or equal to 5mm to meet the demand. For example, the size of the LED lamp 141 can be a lamp bead with a size of ≤5mmX5mm, and a smaller lamp bead with a size of ≤3.5 mmX3.5 mm can be selected.

[0030] Accordingly, the radial size of the first light transmitting hole 131 is greater than or equal to one time the size of the LED lamp 141 in the radial direction and less than or equal to three times the size of the LED lamp 141 in the radial direction.

[0031] It can be understood that the radial size of the first light transmitting hole 131 is not less than the size of the LED lamp 141 in the radial direction, so as to ensure that all the ultraviolet light emitted by the LED lamp 141 passes through the first light transmitting hole 131 and irradiates into the hollow pipe 112, thus making full use of the light energy of the ultraviolet light. The radial size of the first light transmitting hole 131 is less than or equal to three times the size of the LED lamp 141 in the radial direction. For example, the radial size of the first light transmitting hole 131 can be set to twice the size of the LED lamp 141 in the radial direction, so as to maintain the integrity of the reflective film 130 while ensuring that the ultraviolet light passes through the first light transmitting hole 131 as much as possible.

[0032] As for the specific arrangement position and arrangement mode of the ultraviolet light source 140, the ultraviolet light source 140 is provided in the accommodating groove 113 of the shell.

[0033] As shown in FIGS. 1a-1b, the accommodating groove 113 is provided on the outer wall surface 1112 of the shell 111. The opening of the accommodating groove 113 is away from the hollow pipe 112. The bottom of the accommodating groove 113 is provided with a second light transmitting hole 1131 at the position corresponding to the first light transmitting hole 131. The second light transmitting hole 1131 is communicated with the first light transmitting hole 131, so that the ultraviolet light emitted by the ultraviolet light source 140 is incident into hollow pipe 112 after passing through the second light transmitting hole 1131 and the first light transmitting hole 131. For the specific arrangement mode of the second light transmitting holes 1131, for example, the second light transmitting holes 1131 are provided at the bottom of the accommodating groove 113 at the position corresponding to the LED lamps 141 of the ultraviolet light source 140. The number of the second light transmitting holes 1131 is the same as that of the LED lamps 141, and a plurality of second light transmitting holes 1131 are provided at intervals. The purpose of this arrangement is to ensure the integrity of the shell 111 as much as possible. Of course, an integral second light transmitting hole 1131 can also be directly provided at the bottom of the accommodating groove 113, so that the ultraviolet light emitted by each LED lamp 141 can pass through the second light transmitting hole 1131, which is not particularly limited here.

[0034] As shown in FIG 1a, FIG 1b and FIG 2a, an upper cover 114 is provided at the opening of the accommodating groove 113, and the upper cover 114 is used for protecting the ultraviolet light source 140.

[0035] In another embodiment out of the invention, as shown in FIG 3a, the accommodating groove 113 is provided on the inner wall surface 1114 of the shell 111, the opening of the accommodating groove 113 faces the hollow pipe 112, and the ultraviolet light emitted by the ultraviolet light source 140 is incident into the hollow pipe 112 through the first light transmitting hole 131. At this time, because the accommodating groove 113 is provided inside the shell 111, and the opening of the accommodating groove 113 faces the hollow pipe 112, the accommodating groove 113 does not need to be provided with the second light transmitting hole 1131. The ultraviolet light can directly enter the first light transmitting hole 131 through the opening of the accommodating groove 113, and then be incident into the hollow pipe 112 from the first light transmitting hole 131. It can be understood that this arrangement mode makes the ultraviolet light source 140 closer to the hollow pipe 112, and the liquid circulating in the hollow pipe 112 can play a good cooling role to keep the excellent performance of the ultraviolet light source 140.

[0036] In an alternative embodiment, the wavelength range of ultraviolet light emitted by the LED lamp 141 is 240-340 nm. Ultraviolet light in this wavelength range is referred to as deep ultraviolet light. Because bacteria have wavelength selectivity, ultraviolet light in this wavelength range generally has a better sterilization effect. Therefore, selecting the ultraviolet light source 140 in this wavelength range can effectively improve the sterilization effect of the ultraviolet sterilization device 100.

[0037] Accordingly, the reflective film 130 is made of any one of inorganic material coating with diffuse reflectivity higher than 95%, fluorine-based organic material film with diffuse reflectivity higher than 95% or reflective medium film with specular reflectivity higher than 98%. Specifically, from the view of difficulty and cost of the process, the expanded polytetrafluoroethylene film with diffuse reflectivity higher than 95% is generally selected, which is relatively cheap and easy to process. However, if a better sterilization ability and a smaller size are required, the dielectric film of a distributed Bragg reflector with specular reflectivity greater than 99% can be selected.

[0038] For example, as shown in FIGS. 1b and 2a, the reflective film 130 is provided on the outer wall surface of the hollow pipe 112. In fact, the reflective film 130 can also be provided on the inner wall surface 1114 of the hollow pipe 112. However, in actual process, since it is difficult to provide the reflective film 130 on the inner wall surface 1114 of the hollow pipe 112, and the liquid flowing in the hollow pipe 112 may chemically react with the reflective film 130, the reflective film 130 can generally be provided on the outer wall surface of the hollow pipe 112.

[0039] In order to prevent ultraviolet rays from escaping from the liquid inlet end 1121 or the liquid outlet end 1122 of the hollow pipe, the length of the hollow pipe 112 generally ranges from 40 mm to 100 mm. The inner diameter of the hollow pipe 112 ranges from 4 mm to 20 mm. The light emitting angle of the LED lamp 141 is less than or equal to 140 degrees. It can be understood that the length of the hollow pipe 112, the inner diameter of the hollow pipe 112 and the light emitting angle of the LED lamp 141 should be selected based on comprehensive consideration, so as to prevent the ultraviolet light emitted by the LED lamp 141 from escaping as much as possible, thereby making full use of the energy of the LED lamp 141 to sterilize the liquid flowing through the hollow pipe 112.

[0040] It should be noted that the length of the hollow pipe 112 can be 40 mm to 100 mm according to the light emitting angle of the LED light source and the reflectivity of the reflective film 130. When the length of the hollow pipe 112 is below 40mm, although the sterilization device for flowing water can be made smaller, the cumulative ultraviolet dose when the water flows through the hollow straight pipe is low, which will affect the sterilization rate. When the length of the hollow pipe 112 is above 100mm, the size of the sterilization device for flowing water will also be significantly increased, but the cumulative ultraviolet dose does not significantly increase, which does not improve the sterilization effect obviously.

[0041] In addition, when the inner diameter of the hollow pipe 112 is larger than 10mm, because the ultraviolet light will easily escape from both ends of the hollow pipe 112 due to the long path of each reflection of the ultraviolet light, it is possible to consider selecting the LED lamp 141 with a small light emitting angle. For example, the LED lamp 141 with a light emitting angle less than 90 degrees is selected, so as to restrict excessive ultraviolet light from escaping from both ends of the hollow pipe 112. On the contrary, when the diameter of the hollow pipe 112 is smaller than 10mm, the path of each reflection of ultraviolet light is short, and it is not easy for ultraviolet light to escape from both ends of the hollow pipe 112. Therefore, the LED lamp 141 with a large light emitting angle can be selected. For example, the LED lamp 141 with a light emitting angle greater than 90 degrees can be selected to ensure that the energy of ultraviolet light can be fully utilized, so as to obtain ultraviolet light irradiation with higher intensity when the liquid flows through the hollow pipe 112.

[0042] In addition, it should be noted that the ultraviolet light source 140 can also be provided at both ends of the hollow pipe 112, that is, the liquid inlet end or the liquid outlet end. However, since there is liquid flowing through both ends, it is necessary to provide a waterproof structure to separate the ultraviolet light source 140 from the liquid. At this time, if the inner diameter of the hollow pipe 112 is relatively small, the space at the end of the hollow pipe is relatively small, so that it is generally difficult to provide the ultraviolet light source 140 at the end. When the inner diameter of the hollow pipe 112 is relatively large, the ultraviolet light source 140 can be provided at the end of the hollow pipe because the space at the end of the hollow pipe 112 is relatively large at this time. When the inner diameter is large, it is generally required to process liquid with a large flow rate, and the power of the ultraviolet light source 140 used at this time is relatively high. However, when the ultraviolet light source 140 is provided at the end, the liquid circulating in the hollow pipe 112 cannot cool the ultraviolet light source 140, so that it is necessary to additionally provide a heat dissipation base to dissipate heat from the ultraviolet light source 140, thus obtaining better optical characteristics. The smaller the inner diameter is, the more delicate the ultraviolet sterilization device 100 can be, but the corresponding flow rate that can be processed is also smaller. Generally, considering the sterilization ability and space requirements of the ultraviolet sterilization device 100 in practical application scenarios, the inner diameter range of the hollow pipe 112 can be set to 6 mm to 15 mm.

[0043] The ultraviolet sterilization device 100 provided in this embodiment has certain advantages in sterilizing flowing water with a small flow rate of 2L/min or less because of its small size.

[0044] In some embodiments, the hollow pipe 112 is made of any one of quartz, alumina or fluorine-based organic ultraviolet transparent material. It can be understood that in order to make the light of the ultraviolet light source 140 incident into the hollow pipe 112 to sterilize the water body flowing in the hollow pipe 112, the hollow pipe 112 should be made of transparent materials, and all the above materials can be used to make the transparent hollow pipe 112. Because the process of manufacturing the hollow pipe 112 of quartz is more mature and the cost is lower, a quartz hollow pipe 112 can generally be used.

[0045] In order to facilitate the connection of the hollow pipe 112 to a liquid source, such as a faucet, the liquid inlet end 1121 of the hollow pipe 112 is provided with a detachable joint 150. As shown in FIGS. 1a, 1b and 2a, the end of the joint 150 is provided with an external thread, the end of the shell 111 corresponding to the liquid inlet end 1121 is correspondingly provided with an internal thread, and the end of the joint 150 is screwed and fixed to the shell 111. With this arrangement, it is convenient to replace the joint 150 according to the model of the liquid source, so that the ultraviolet sterilization device 100 provided by the present invention can be used more flexibly and is suitable for a wider range of application scenarios.

[0046] In addition, in order to facilitate the manufacturing of the shell 111, the shell 111 can be made of heat shrinkable material. The heat shrinkable material has a memory function and covers the outer surface of the hollow pipe 112 after being heated and shrunk, and can play the roles of insulation, moisture protection, sealing and protection. Especially when the accommodating groove 113 is provided on the inner wall surface 1114 of the shell 111, the ultraviolet light source 140 is provided between the hollow pipe 112 and the shell 111, and with the heat shrinkable material, it is easier to fix the ultraviolet light source 140. In addition, the shell 111 can also be made of other metals, plastics and other materials, and it is generally considered to select materials that are not easy to yellow under irradiation of ultraviolet light.

[0047] Therefore, the ultraviolet sterilization device 100 provided by the present invention is modulated, with the selected length and inner diameter of the hollow pipe 112, by the light emitting angle of the ultraviolet light source 140 and the reflectivity of the reflective film 130. The ultraviolet light emitted by the ultraviolet light source 140 is irradiated into the hollow pipe 112 through the first light transmitting hole 131 on the reflective film 130, and is reflected by the reflective film 130 for many times, so that the illuminance of the ultraviolet light in the hollow pipe 112 is greatly enhanced, and in the straight pipe the illuminance in the middle is high and the illuminance at both ends is low. At this time, the area with the strongest ultraviolet illumination is concentrated in the center of the hollow pipe 112, and the illumination at both ends of the hollow pipe 112 is relatively weak. It can be understood that after the ultraviolet light is reflected by the reflective film 130, the superposition of the ultraviolet light may occur, thus enhancing the illumination of the ultraviolet light in the hollow pipe 112 to a certain extent.

[0048] The specific size of the ultraviolet sterilization device 100 provided by the present invention will be illustrated by three specific examples hereinafter.

[0049] In a first example, as shown in FIGS. 1a-1e, the hollow pipe 112 of the ultraviolet sterilization device 100 is made of quartz. The quartz pipe has a length of 80mm, an inner diameter of 8mm, and a wall thickness of 1 mm. The reflective film 130 is an expanded polytetrafluoroethylene film with diffuse reflectivity of 95% in the ultraviolet wavelength range of 250-350 nm. The film thickness of the reflective film 130 is 0.5mm, and the reflective film 130 is provided with first light transmitting holes 131 with a size of 1mmX1mm. The ultraviolet light source 140 contains two LED lamps 141. The distance between two LED lamps 141 is 10mm, the bead size of the LED lamp 141 is 0.5mmX0.5mm, the radiation power of the LED lamp 141 is 15mW, and the light emitting angle is 140 degrees. The substrate 142 is an aluminum substrate 142. The outer shell 111 uses a plastic injection molding process to fix and protect the inner structure.

[0050] It should be noted that another function of the reflective film 130 is to fill the gap between the shell 111 and the hollow pipe 112, so that the thickness of the reflective film 130 can be selected according to the actual structural requirements.

[0051] The distribution of ultraviolet illumination in the hollow pipe 112 of the ultraviolet sterilization device 100 provided in this example is analyzed hereinafter, and the actual sterilization test is carried out on the manufactured sample.

[0052] As shown in FIG 1f, it can be seen from the figure that the area with the strongest ultraviolet illuminance is in the middle of the quartz pipe. The illuminance at this position reaches about 100mW/cm^2 (the two dark areas in the middle of the figure correspond to two LED lamps), and the illuminance decreases gradually towards both ends, and drops to about 5mW/cm^2 within the range of 1cm from each end of the quartz pipe. Considering that the sterilization effect is the accumulation effect of illumination and time, the average illumination in the quartz pipe can be used as one of the important performance indexes to measure the sterilization ability. The average illuminance in the quartz pipe of this embodiment is about 35.6mW/cm^2. It should be noted that, compared with the numerical values shown in FIG 1f, the above illuminance values need to be converted into units.

[0053] In order to show the actual sterilization effect, the actual sterilization rate of the ultraviolet sterilization device 100 provided in this example is tested. This sterilization rate test is to use Escherichia coli 8099 solution with a concentration of 4.5×10^4 cfu/ml (the unit of the number of colonies is cfu/ml). The solution flows in from the liquid inlet end 1121 of the quartz pipe at a flow rate of 1L/min, and then flows out from the liquid outlet end 1122 of the quartz pipe after sterilization in the cavity. In addition, the Escherichia coli 8099 solution which does not flow through the sterilization device is taken as the positive control solution. 100uL of sterilized solution (i.e. experimental samples) and 100ul of positive control solution are taken and are put into a constant temperature incubator at 37°C for culture after being smeared uniformly on the surface of eosin methylene blue agar. After 24 to 48 hours, the number of colonies of sterilized solution and positive control solution samples are observed and calculated. The sterilization rate can be calculated in at least two ways:

(1)

sterilization rate = (number of colonies of positive control - number of colonies of experimental samples)/number of colonies of positive control X100%;

(2) It is expressed by Logarithm Reduction Value (LRV), and the calculation formula is: LRV =-log (number of colonies of experimental sam-

ples/number of colonies of positive control).

[0054] After the experiment, the results are as follows (the unit of number of colonies is cfu/ml):
The number of colonies of the positive control solution is 4.5×10^4, while the number of colonies of the sterilized solution is 5. According to the above first formula, the sterilization rate can reach 99.99%. According to the above first formula, the LRV value can reach 4.

[0055] According to the above sterilization experiment data, it can be seen that the ultraviolet sterilization device 100 provided by this example can effectively sterilize the flowing water of 1L/min.

[0056] In the second example, as shown in FIG 2a, the hollow pipe 112 of the ultraviolet sterilization device 100 is made of quartz. The quartz pipe has a length of 10mm, an inner diameter of 16.5mm, and a wall thickness of 2.5mm. The reflective film 130 is an expanded polytetrafluoroethylene film with diffuse reflectivity of 95% in the ultraviolet wavelength range of 250-350 nm. The film thickness of the reflective film 130 is 0.5mm, and the reflective film 130 is provided with first light transmitting holes 131 with a size of 2mmX2mm. The ultraviolet light source 140 contains two LED lamps 141. The bead size of the LED lamp 141 is 0.7mmX0.7mm, the radiation power of the LED lamp 141 is 30mW, and the light emitting angle is 120 degrees. The substrate 142 is a copper substrate 142. The main body of the shell 111 is made of aviation aluminum, and the joint at both ends of the shell 111 is made of plastic. Considering the thick wall thickness of the quartz pipe in this example, although the reflection of the reflective film 130 can make the whole quartz pipe have higher ultraviolet illumination, because the thickness range of the wall surface of the quartz pipe is not an effective sterilization space, in this embodiment the reflective film 130 preferably is attached to the inner wall of the quartz pipe, so that ultraviolet light can be reflected without passing through the side wall of the quartz pipe, avoiding the consumption of ultraviolet light energy, and thus ensuring a better reflection effect.

[0057] As shown in FIG 2b, it can be seen from the figure that the area with the strongest ultraviolet illumination is in the middle of the quartz pipe, where the illumination reaches about 40mW/cm^2, and the illumination decreases gradually towards both ends, and drops to about 3mW/cm^2 within the range of 1cm from each end of the quartz pipe. The average illumination in the quartz pipe is about 12.5/cm^2. Although compared with the first example, the average illuminance in the cavity is reduced, but the sterilization space in the quartz pipe is increased, that is, the quartz pipe becomes thicker, and the flow rate of the liquid in the quartz pipe will slow down, that is, the irradiation time when the liquid flows into the ultraviolet sterilization device 100 will be increased. Actually, the test is also conducted at a flow rate of 1L/min, and the irradiation dose (illumination multiplied by time) of water flowing into the ultraviolet sterilization device 100 in this example is nearly twice that of the first example. That is to say, the larger the effective sterilization space is, the longer the corresponding sterilization time is, and the higher the corresponding processing capacity is.

[0058] In the third example, as shown in FIG 3a, the hollow pipe 112 of the ultraviolet sterilization device 100 is made of quartz, and the length of the quartz pipe is 60mm. The quartz pipe is a square pipe with the inner dimension of 8mmX8mm and the wall thickness of 1 mm. The reflective film 130 is formed by evaporating distributed Bragg reflection (DBR) on the outer wall of the quartz pipe by optical coating. The reflective film 130 is formed by alternating 15 pairs of MgO layers and ZrO_2 layers, and has a reflectivity of 99% for ultraviolet light in the wavelength range of 250-350 nm. The reflective film 130 is provided with first through holes 131 with a size of 3.5mmX3.5mm. The ultraviolet light source 140 contains two LED lamps 141. The bead size of the LED lamp 141 is 3.5mmX3.5mm, the radiation power of the LED lamps 141 is 15mW, and the light emitting angle is 30 degrees. The substrate 142 is an aluminum substrate 142. The main body of the shell 111 is made of heat shrinkable sleeve, and the joint at both ends of the shell 111 is made of plastic.

[0059] In this example, DBR is used as the reflective film 130. Although the manufacturing process is relatively complicated, the specular reflectivity of DBR is close to 100%, and higher ultraviolet illumination is obtained inside the quartz pipe. As shown in FIG 3b, the average illumination inside the quartz pipe reaches about 100mW/cm^2, thus obtaining a better sterilization effect.

[0060] As the ultraviolet sterilization devices of the second example and the third example have their own advantages compared with the ultraviolet sterilization device 100 of the first example, and have a sterilization effect not lower than that of the first example, the detection experiment of the actual sterilization effect will not be described in detail here.

Claims

1. An ultraviolet sterilization device (100), comprising a liquid passing pipe assembly (110) and an ultraviolet light source (140), wherein the liquid passing pipe assembly (110) comprises a shell (111) and a transparent hollow pipe (112), the shell (111) is sleeved on the hollow pipe (112) and an accommodating groove (113) is provided on an outer wall surface of the shell (111), and the ultraviolet light source (140) is provided in the accommodating groove (113); wherein an opening of the accommodating groove (113) is away from the hollow pipe (112) and an upper cover (114) is provided at the opening of the accommodating groove (113), wherein the hollow pipe (112) has an end configured as a liquid inlet end (1121) and another end configured as a liquid outlet end (1122), and the hollow pipe (112) is con-

figured for circulating liquid; a wall surface of the hollow pipe (112) is covered with a reflective film (130), the reflective film (130) is provided with first light transmitting holes (131) at a position corresponding to the ultraviolet light source (140), the first light transmitting holes (131) are communicated with the accommodating groove (113), a bottom of the accommodating groove (113) is provided with second light transmitting holes (1131) at positions corresponding to the first light transmitting holes (131), and the second light transmitting holes (1131) are communicated with the first light transmitting holes (131) so that ultraviolet light emitted by the ultraviolet light source (140) is incident into the hollow pipe (112) after passing through the second light transmitting holes (1131) and the first light transmitting holes (131) and sterilizes the liquid circulating in the hollow pipe (112), and the reflective film (130) is used for scattering the ultraviolet light in different areas in the hollow pipe (112).

2. The ultraviolet sterilization device (100) according to claim 1, wherein the ultraviolet light source (140) comprises two groups of ultraviolet light sources (140), and the two groups of ultraviolet light sources (140) are provided on a circumferential wall of the shell (111) opposite to each other with respect to a middle area of the hollow pipe arranged between the liquid inlet end and the liquid outlet end."

3. The ultraviolet sterilization device (100)according to claim 2, wherein the ultraviolet light source (140) comprises LED lamps (141), and a number of the LED lamps (141) in each group of ultraviolet light sources (140) is less than or equal to two; the LED lamps (141) are correspondingly provided in a circumferential outer wall of the hollow pipe (112) at a middle area of the hollow pipe (112) arranged between the liquid inlet end (1121) and the liquid outlet end (1122).

4. The ultraviolet sterilization device (100) according to claim 3, wherein a radial size of each LED lamp (141) is less than or equal to 5 mm.

5. The ultraviolet sterilization device (100) according to claim 4, wherein a radial size of each first light transmitting hole (131) is greater than or equal to one time a size of the LED lamp (141) in the radial direction and less than or equal to three times the size of the LED lamp (141) in the radial direction.

6. The ultraviolet sterilization device (100) according to claim 5, wherein a wavelength range of ultraviolet light emitted by the LED lamp (141) is 240-340 nm.

7. The ultraviolet sterilization device (100) according to any of claims 1 to 6, wherein the reflective film (130) is made of any one of inorganic material coating with diffuse reflectivity higher than 95%, fluorine-based organic material film with diffuse reflectivity higher than 95% or reflective medium film with specular reflectivity higher than 98%.

8. The ultraviolet sterilization device (100) according to claim 7, wherein the reflective film (130) is provided on an outer wall surface (1112) of the hollow pipe (112).

9. The ultraviolet sterilization device (100) according to any of claims 1 to 6, wherein a length of the hollow pipe (112) ranges from 40 mm to 100 mm; an inner diameter of the hollow pipe (112) ranges from 4 mm to 20 mm; the hollow pipe (112) is made of any one of quartz, alumina or fluorine-based organic ultraviolet transparent material.

10. The ultraviolet sterilization device (100) according to claim 3, wherein the LED lamp (141) has a light emitting angle less than or equal to 140 degrees.

11. The ultraviolet sterilization device (100) according to claim 1, wherein the liquid inlet end (1121) of the hollow pipe (112) is provided with a detachable joint (150), an end of the joint (150) is provided with an external thread, an end of the shell (111) corresponding to the liquid inlet end (1121) is provided with an internal thread, and the end of the joint (150) is screwed and fixed to the shell (111).

12. The ultraviolet sterilization device (100) according to claim 1, wherein the shell (111) is made of heat shrinkable material.

Patentansprüche

1. Ultraviolettsterilisierungsvorrichtung (100), die eine flüssigkeitsdurchlässige Rohrbaugruppe (110) und eine Ultraviolettlichtquelle (140) umfasst, wobei die flüssigkeitsdurchlässige Rohrbaugruppe (110) einen Mantel (111) und ein transparentes Hohlrohr (112) umfasst, der Mantel (111) auf dem Hohlrohr (112) ummantelt ist und eine Aufnahmenut (113) an einer Außenwandfläche des Mantels (111) bereitgestellt ist und die Ultraviolettlichtquelle (140) in der Aufnahmenut (113) bereitgestellt ist; wobei eine Öffnung der Aufnahmenut (113) dem Hohlrohr (112) abgewandt ist und eine obere Abdeckung (114) an der Öffnung der Aufnahmenut (113) bereitgestellt ist, wobei das Hohlrohr (112) ein Ende, das als Flüssigkeitseinlassende (1121) konfiguriert ist, und ein anderes Ende, das als Flüssigkeitsauslassende (1122) konfiguriert ist, aufweist und das Hohlrohr (112) zum Zirkulieren von Flüssigkeit konfiguriert ist; eine Wandfläche des Hohlrohrs (112) ist mit einer reflek-

tierenden Folie (130) bedeckt, die reflektierende Folie (130) ist mit ersten lichtdurchlässigen Löchern (131) an einer Position versehen, die der Ultraviolettlichtquelle (140) entspricht, die ersten lichtdurchlässigen Löcher (131) kommunizieren mit der Aufnahmenut (113), ein Boden der Aufnahmenut (113) ist mit zweiten lichtdurchlässigen Löchern (1131) an Positionen versehen, die den ersten lichtdurchlässigen Löchern (131) entsprechen und die zweiten lichtdurchlässigen Löcher (1131) kommunizieren mit den ersten lichtdurchlässigen Löchern (131), so dass ultraviolettes Licht, das von der ultravioletten Lichtquelle (140) emittiert wird, nach dem Durchgang durch die zweiten lichtdurchlässigen Löcher (1131) und die ersten lichtdurchlässigen Löcher (131) in das Hohlrohr (112) einfällt und die in dem Hohlrohr (112) zirkulierende Flüssigkeit sterilisiert, und die reflektierende Folie (130) zur Streuung des ultravioletten Licht in verschiedenen Bereichen im Hohlrohr (112) benutzt wird.

2. Ultraviolettsterilisierungsvorrichtung (100) nach Anspruch 1, wobei die Ultraviolettlichtquelle (140) zwei Gruppen von Ultraviolettlichtquellen (140) umfasst und die zwei Gruppen von Ultraviolettlichtquellen (140) auf eine Umfangswand des Mantels (111) bereitgestellt sind, die in Bezug auf einen mittleren Bereich des Hohlrohrs, der zwischen dem Flüssigkeitseinlassende und dem Flüssigkeitsauslassende angeordnet ist, einander gegenüberliegen.

3. Ultraviolettsterilisierungsvorrichtung (100) nach Anspruch 2, wobei die Ultraviolettlichtquelle (140) LED-Lampen (141) umfasst und eine Anzahl der LED-Lampen (141) in jeder Gruppe von Ultraviolettlichtquellen (140) kleiner oder gleich zwei ist; die LED-Lampen (141) sind entsprechend in einer umlaufenden Außenwand des Hohlrohrs (112) an einem mittleren Bereich des Hohlrohrs (112) bereitgestellt, das zwischen dem Flüssigkeitseinlassende (1121) und dem Flüssigkeitsauslassende (1122) angeordnet ist.

4. Ultraviolettsterilisierungsvorrichtung (100) nach Anspruch 3, wobei eine radiale Größe jeder LED-Lampe (141) kleiner oder gleich 5 mm ist.

5. Ultraviolettsterilisierungsvorrichtung (100) nach Anspruch 4, wobei eine radiale Größe jedes ersten lichtdurchlässigen Lochs (131) größer oder gleich einem Mal einer Größe der LED-Lampe (141) in der radialen Richtung und kleiner oder gleich dem Dreifachen der Größe der LED-Lampe (141) in der radialen Richtung ist.

6. Ultraviolettsterilisierungsvorrichtung (100) nach Anspruch 5, wobei ein Wellenlängenbereich des von der LED-Lampe (141) emittierten ultravioletten Lichts 240-340 nm beträgt.

7. Ultraviolettsterilisierungsvorrichtung (100) nach einem der Ansprüche 1 bis 6, wobei die reflektierende Folie (130) aus einer beliebigen Beschichtung aus anorganischem Material mit einem diffusen Reflexionsvermögen höher als 95 %, einer Folie aus organischem Material auf Fluorbasis mit einem diffusen Reflexionsvermögen höher als 95 % oder einer reflektierenden Mediumfolie mit einem spiegelnden Reflexionsvermögen höher als 98 % hergestellt ist.

8. Ultraviolettsterilisierungsvorrichtung (100) nach Anspruch 7, wobei die reflektierende Folie (130) an einer Außenwandfläche (1112) des Hohlrohrs (112) bereitgestellt ist.

9. Ultraviolettsterilisierungsvorrichtung (100) nach einem der Ansprüche 1 bis 6, wobei eine Länge des Hohlrohrs (112) im Bereich von 40 mm bis 100 mm liegt; ein Innendurchmesser des Hohlrohrs (112) liegt im Bereich von 4 mm bis 20 mm; das Hohlrohr (112) ist aus einem beliebigen von Quarz, Aluminiumoxid oder Fluor-basiertem organischen ultraviolett-transparenten Material hergestellt.

10. Ultraviolettsterilisierungsvorrichtung (100) nach Anspruch 3, wobei die LED-Lampe (141) einen Lichtemissionswinkel kleiner als oder gleich 140 Grad aufweist.

11. Ultraviolettsterilisierungsvorrichtung (100) nach Anspruch 1, wobei das Flüssigkeitseinlassende (1121) des Hohlrohrs (112) mit einem lösbaren Gelenk (150) versehen ist, ein Ende des Gelenks (150) mit einem Außengewinde versehen ist, ein Ende des Mantels (111), der dem Flüssigkeitseinlassende (1121) entspricht, mit einem Innengewinde versehen ist und das Ende des Gelenks (150) am Mantel (111) verschraubt und befestigt ist.

12. Ultraviolettsterilisierungsvorrichtung (100) nach Anspruch 1, wobei der Mantel (111) aus wärmeschrumpfbarem Material hergestellt ist.

Revendications

1. Dispositif de stérilisation aux ultraviolets (100), comprenant un ensemble de tuyau de passage de liquide (110) et une source de lumière ultraviolette (140), dans lequel l'ensemble de tuyau de passage de liquide (110) comprend une coquille (111) et un tuyau creux transparent (112), la coquille (111) est manchonnée sur le tuyau creux (112) et une rainure de logement (113) est prévue sur une surface de paroi extérieure de la coquille (111), et la source de lumière ultraviolette (140) est prévue dans la rainure de

logement (113) ; dans laquelle une ouverture de la rainure de logement (113) est éloignée du tuyau creux (112) et un couvercle supérieur (114) est fourni à l'ouverture de la rainure de logement (113), dans laquelle le tuyau creux (112) a une extrémité configurée comme une extrémité d'entrée de liquide (1121) et une autre extrémité configurée comme une extrémité de sortie de liquide (1122), et le tuyau creux (112) est configuré pour faire circuler le liquide ; une surface de paroi du tube creux (112) est recouverte d'un film réfléchissant (130), le film réfléchissant (130) est pourvu de premiers trous de transmission de lumière (131) à une position correspondant à la source de lumière ultraviolette (140), les premiers trous de transmission de la lumière (131) sont en communication avec la rainure de logement (113), un fond de la rainure de logement (113) est pourvu de seconds trous de transmission de la lumière (1131) à des positions correspondant aux premiers trous de transmission de la lumière (131), et les seconds trous de transmission de lumière (1131) sont mis en communication avec les premiers trous de transmission de lumière (131) de sorte que la lumière ultraviolette émise par la source de lumière ultraviolette (140) est incidente dans le tuyau creux (112) après avoir traversé les seconds trous de transmission de lumière (1131) et les premiers trous de transmission de lumière (131) et stérilise le liquide circulant dans le tuyau creux (112), et le film réfléchissant (130) est utilisé pour diffuser la lumière ultraviolette dans différentes zones du tube creux (112).

2. Dispositif de stérilisation aux ultraviolets (100) selon la revendication 1, dans lequel la source de lumière ultraviolette (140) comprend deux groupes de sources de lumière ultraviolette (140), et les deux groupes de sources de lumière ultraviolette (140) sont fournis sur une paroi circonférentielle de la coque (111) opposée l'une à l'autre par rapport à une zone médiane du tube creux disposée entre l'extrémité d'entrée du liquide et l'extrémité de sortie du liquide.

3. Dispositif de stérilisation aux ultraviolets (100) selon la revendication 2, dans lequel la source de lumière ultraviolette (140) comprend des lampes LED (141), et un nombre de lampes LED (141) dans chaque groupe de sources de lumière ultraviolette (140) est inférieur ou égal à deux ; les lampes LED (141) sont fournies dans une paroi extérieure circonférentielle du tube creux (112) dans une zone centrale du tube creux (112) disposée entre l'extrémité d'entrée du liquide (1121) et l'extrémité de sortie du liquide (1122).

4. Dispositif de stérilisation aux ultraviolets (100) selon la revendication 3, dans lequel la taille radiale de chaque lampe LED (141) est inférieure ou égale à 5 mm.

5. Dispositif de stérilisation aux ultraviolets (100) selon la revendication 4, dans lequel la taille radiale de chaque premier trou de transmission de la lumière (131) est supérieure ou égale à une fois la taille de la lampe à DEL (141) dans la direction radiale et inférieure ou égale à trois fois la taille de la lampe à DEL (141) dans la direction radiale.

6. Dispositif de stérilisation aux ultraviolets (100) selon la revendication 5, dans lequel la longueur d'onde de la lumière ultraviolette émise par la lampe LED (141) est comprise entre 240 et 340 nm.

7. Dispositif de stérilisation aux ultraviolets (100) selon l'une des revendications 1 à 6, dans lequel le film réfléchissant (130) est constitué d'un revêtement en matériau inorganique dont la réflectivité diffuse est supérieure à 95 %, d'un film en matériau organique à base de fluor dont la réflectivité diffuse est supérieure à 95 % ou d'un film en matériau réfléchissant dont la réflectivité spéculaire est supérieure à 98 %.

8. Dispositif de stérilisation aux ultraviolets (100) selon la revendication 7, dans lequel le film réfléchissant (130) est placé sur une surface de paroi extérieure (1112) du tube creux (112).

9. Dispositif de stérilisation aux ultraviolets (100) selon l'une des revendications 1 à 6, dans lequel la longueur du tube creux (112) est comprise entre 40 mm et 100 mm ; le diamètre intérieur du tube creux (112) est compris entre 4 mm et 20 mm ; le tube creux (112) est constitué de quartz, d'alumine ou d'un matériau organique transparent aux ultraviolets à base de fluor.

10. Dispositif de stérilisation aux ultraviolets (100) selon la revendication 3, dans lequel la lampe LED (141) a un angle d'émission de lumière inférieur ou égal à 140 degrés.

11. Dispositif de stérilisation aux ultraviolets (100) selon la revendication 1, dans lequel l'extrémité d'entrée de liquide (1121) du tube creux (112) est pourvue d'un joint détachable (150), une extrémité du joint (150) est pourvue d'un filetage externe, une extrémité de la coque (111) correspondant à l'extrémité d'entrée de liquide (1121) est pourvue d'un filetage interne, et l'extrémité du joint (150) est vissée et fixée à la coque (111).

12. Dispositif de stérilisation aux ultraviolets (100) selon la revendication 1, dans lequel la coque (111) est faite d'un matériau thermorétractable.

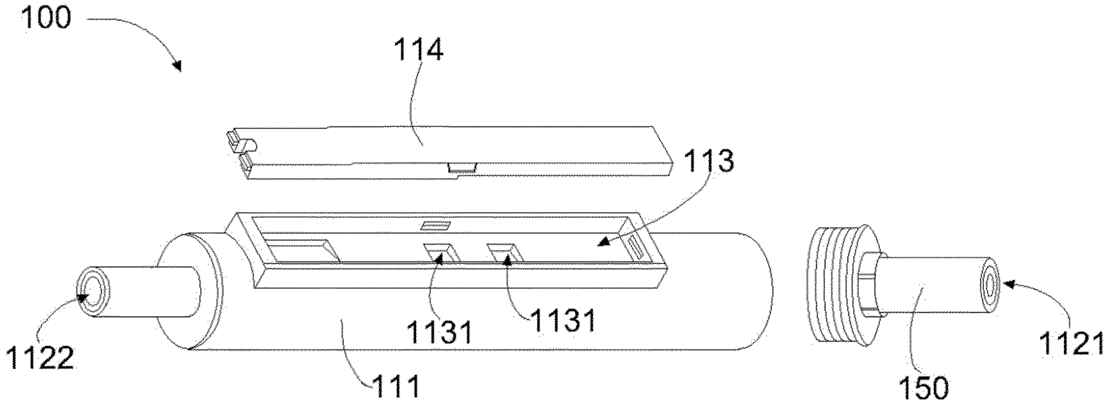


FIG. 1a

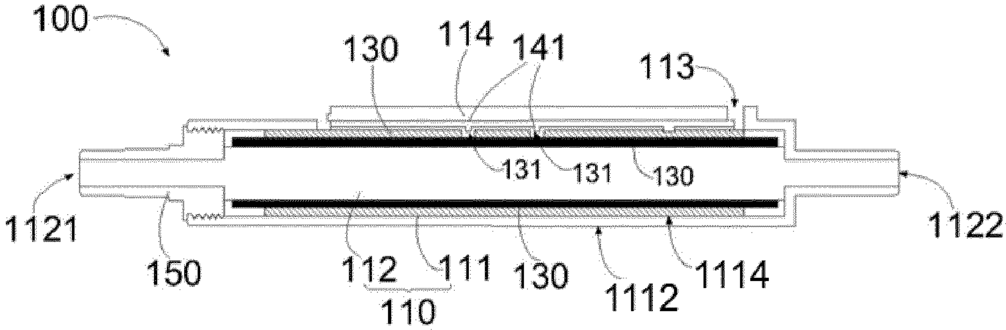


FIG. 1b

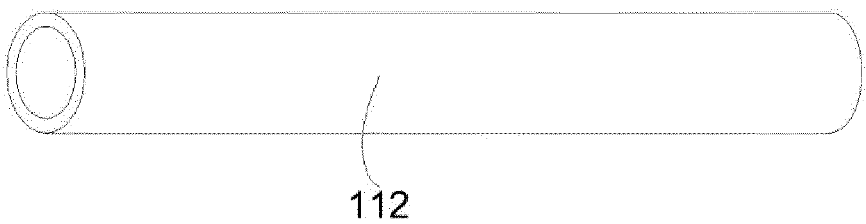


FIG. 1c

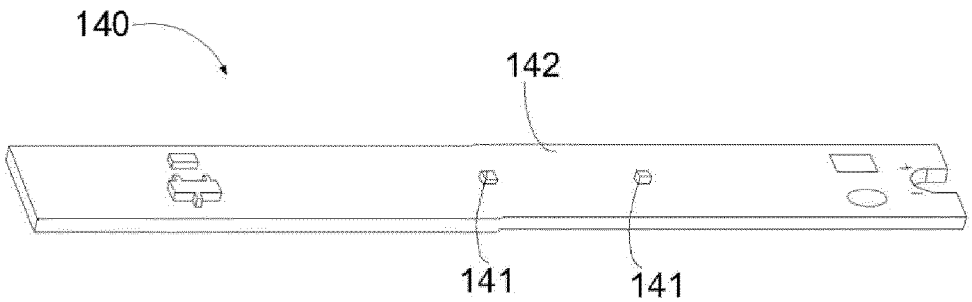


FIG. 1d

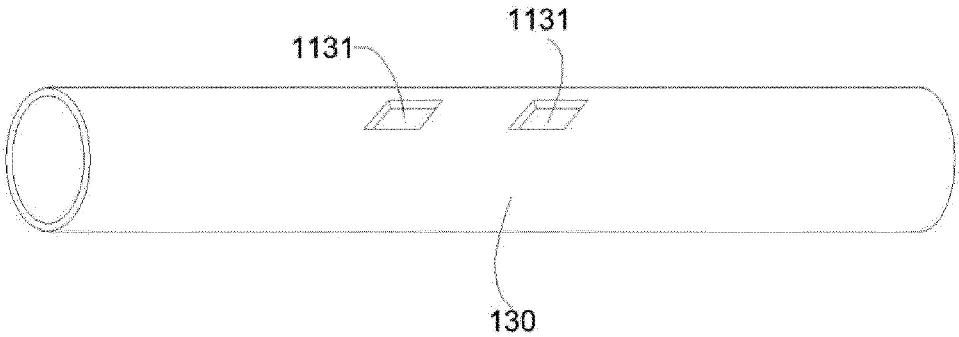
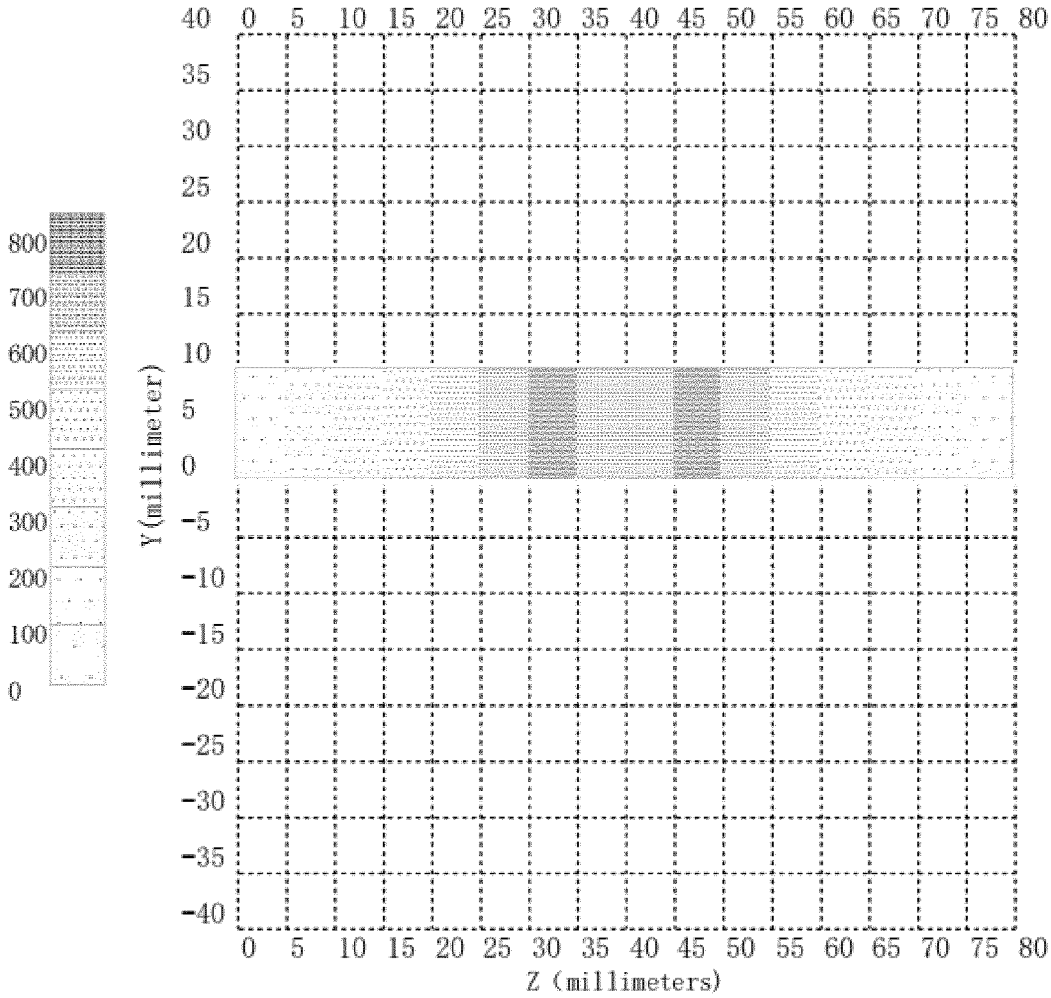
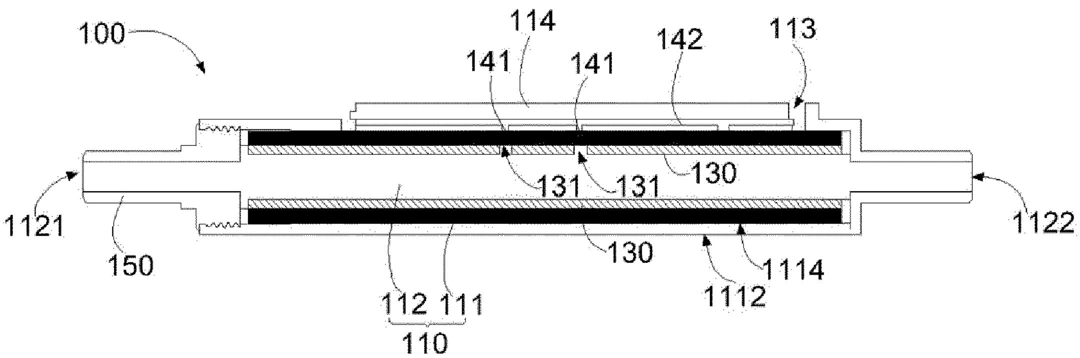


FIG. 1e



800
700
600
500
400
300
200
100
0
Y(millimeter)
Z (millimeters)

FIG. 1f



100
114
141
141
142
113
131
131
130
1121
150
1122
112
111
110
130
1114
1112

FIG. 2a

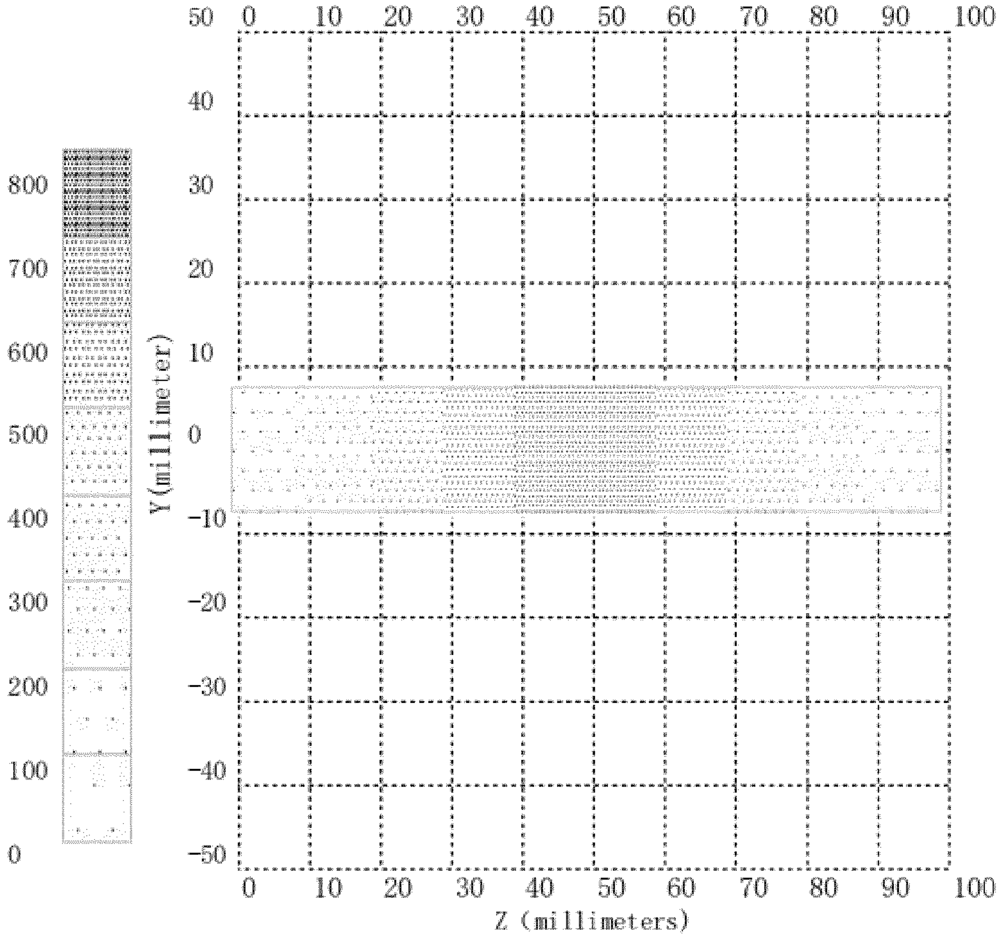

800
700
600
500
400
300
200
100
0
50
40
30
20
10
0
−10
−20
−30
−40
−50
0 10 20 30 40 50 60 70 80 90 100
Y(millimeter)
Z (millimeters)

FIG. 2b

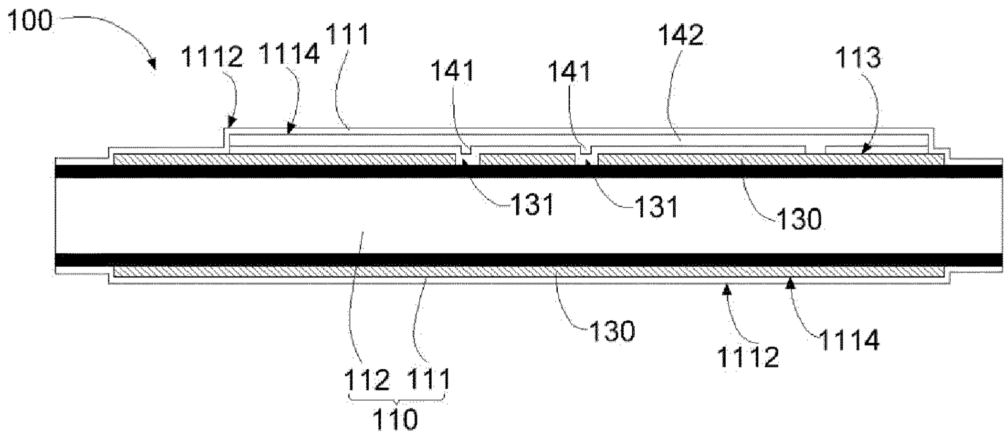

100
1112
1114
111
141
141
142
113
131
131
130
130
1112
1114
112
111
110

FIG. 3a

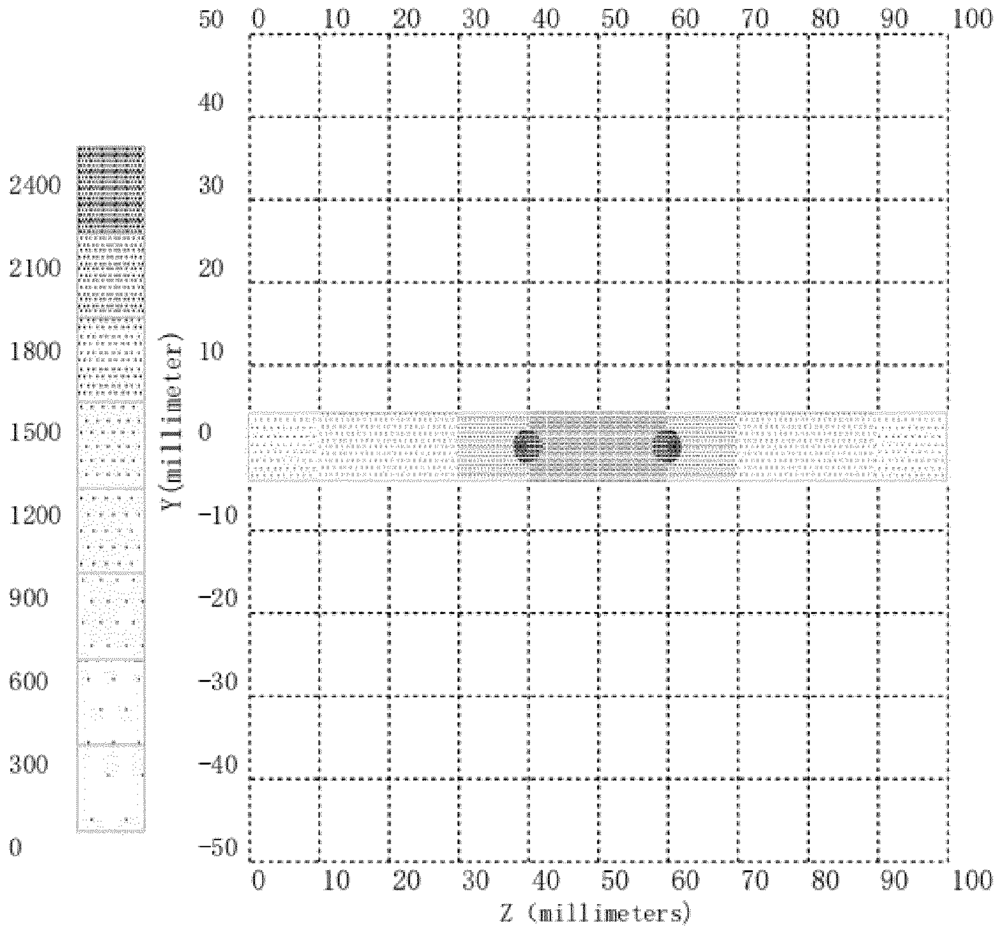

2400
2100
1800
1500
1200
900
600
300
0
Y(millimeter)
Z (millimeters)
50
40
30
20
10
0
-10
-20
-30
-40
-50
0
10
20
30
40
50
60
70
80
90
100

FIG. 3b

REFERENCES CITED IN THE DESCRIPTION

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- WO 2020163733 A1 **[0004]**
- US 2016052802 A1 **[0005]**
- US 2020189936 A1 **[0006]**