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(54) DEVICE AND SYSTEM FOR CREATION OF OPTICAL BUBBLES IN NON-TRANSPARENT TOPICAL SUBSTANCES

(57) A personal care device, system and method for creating optical bubbles in non-transparent topical substances such as toothpaste foam for enhancing light and optical sensor transmission employed in dental and other personal care procedures by deploying treatment modules with one or more artifices including specialized bristles such as hollow cores through which air may be injected by a pressure source activated by a driving mechanism and may also be configured as cavities, protrusions such as broad plates or cylinders on bristle tips, or transparent capsules of anhydrous substances to thereby provide optical windows for both light treatment and optical sensing applications for enhanced light projection through non-transparent topical substances applied to a body tissue such as teeth or gum tissue.

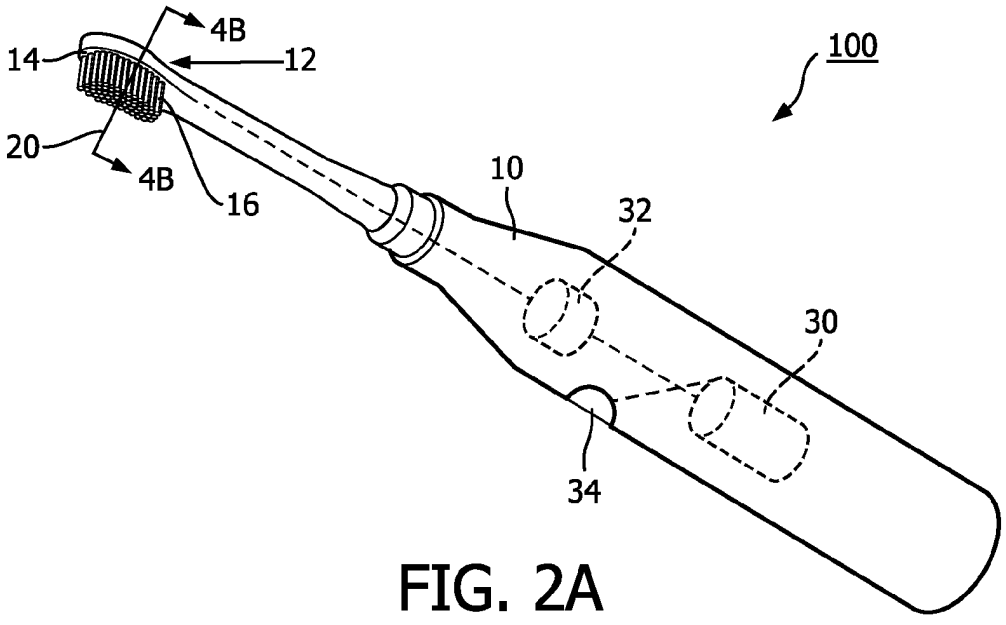

FIG. 2A

EP 4 458 208 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to personal care appliances including dental mouthpieces and related methods for enhancing performance of optical testing and treatments while applying a non-transparent topical substance on a body tissue such as teeth and gum tissue in a user's mouth.

BACKGROUND OF THE INVENTION

[0002] Light treatments can be used to treat or manage dental plaque and gum inflammation. Efficacious results of such techniques employing light have been observed to reduce the growth rate of oral biofilm and the inflammatory response of oral gum cells.

[0003] A particular application of optical sensors for oral healthcare is applying diffuse reflectance spectroscopy to detect gum inflammation or dental caries. Camera images have shown potential for use with artificial intelligence applications employing optical sensors to detect the level of gum inflammation.

[0004] A problem in such and other light diagnostic and therapeutic techniques employing optical sensors during brushing of the teeth is the presence of toothpaste. The particles and small air bubbles entrained in toothpaste scatter emitted light in the foam thus reducing light transmittance.

[0005] Further obscuring light transmittance are bubbles created by bristle movement of a power toothbrush due to continuously mixing in air from the environment into the toothpaste, causing foam formation. Typically, these bubbles are small, and refract or scatter light which results in decreased light penetration/transmittance .

[0006] Added colorants in toothpaste may also reduce transmittance by absorbing light. Such absorption, together with scattering, leads to toothpaste used with conventional toothbrushes and mouthpieces blocking light transmittance. Even a 1 mm layer of toothpaste foam is virtually impenetrable by the light.

[0007] Moreover, even optical sensing of light emitted in thinner layers has proven problematic due to the variability in the thickness of the toothpaste foam layer and particles in the sensor output path. Stable, precise optical measurement is undermined or disabled by the constantly changing layer thickness of the toothpaste during brushing.

[0008] Variable light transmission resulting from the toothpaste scattering and absorption of light impedes and/or prevents stable, precise operating of an optical sensor and therefore disrupts or disables reliably measuring tooth color during brushing. The variation of optical signal due to the toothpaste can be high, obscuring the teeth, in some areas while leaving them visible to some degree in other areas. Such light scattering and light absorbing properties of toothpaste have heretofore imposed substantial limitations to application of light transmission dental techniques while cleaning teeth with toothpaste.

[0009] Unfortunately, problems with techniques employing light transmittance and optical sensors to treat a user's teeth when simultaneously rubbing toothpaste with a toothbrush persist.

SUMMARY OF THE INVENTION

[0010] According to various embodiments of the present invention, a device, system and method is provided whereby a personal care appliance having one or more treatment modules includes one or more artifices that create one or more optical bubbles in a non-transparent topical substance including but not limited to toothpaste foam on a body tissue such as teeth or gum tissue, for enhancing light and optical sensor transmission applied in dental treatments and techniques.

[0011] In various embodiments, the personal care appliance may be a toothbrush having a plurality of bristles with one or more artifices, where the non-transparent topical substance is a toothpaste foam, configured to create one or more optical bubbles on teeth or gum tissue.

[0012] Various embodiments of the present invention provide optical bubbles by integrating active gas injection and/or one or more artifices including specialized bristle configurations in a personal care appliance such as a toothbrush or mouthpiece having a surface with a plurality of bristles disposed thereon configured to create optical bubbles while brushing the teeth or gum tissue in the mouth of a user.

[0013] In various embodiments, air bubbles of 1 mm or larger diameter provide optical windows for both light treatment and optical sensing applications where light path would otherwise be blocked by fluidic ingredients, such as saliva, foam, scattering gels, creams and light-absorbing colorants.

[0014] A wide range of artifices, as defined below, may be employed in or on the treatment modules. Some embodiments may feature toothbrushes with hollow cored bristles in communication with pressurized air. In such embodiments, an air or pneumatic pump activated by a driving mechanism injects air through the hollow cores of the bristle to provide "air nozzles" for blowing bubbles in the substance on the surface of the target tissue, e.g., teeth or gums. In some embodiments, the air flow source may be activated to inject air pulses of a predetermined volume such as, *e.g.,* 0.01 ml, to create large optical bubbles that may measure greater that 1 mm in diameter.

[0015] Among advantages provided by such pressurized toothbrush embodiments are enhanced control of bubble position, timing, and size. Due to the viscosity and surfactants of toothpaste imparting sufficient stability to the optical bubble, proper timing and synchronization of light or optic sensing through the optical bubble may be employed to enhance efficacious of the light-based sensing or treatment.

[0016] When used for dental treatment, employing air stream flow through a hollow bristle core with air blowing features in a toothbrush, efficacies of the embodiments may be enhanced by utilizing pulsed air injections. Advantages of employing pulses, rather than steady streams, of air includes reducing power needs and the size of a membrane and/or a piston pump entailed to create the air bubbles.

[0017] Efficacies of treatments and techniques may be enhanced by synchronized timing of the pulses that inject air providing bubbles, with optical sensor measurements or light treatment pulses. Synchronizing the air injection pulses with the light treatment pulses so bubble formation provides an optical window for enhancing a dental or other therapeutic treatment utilizing light transmittance and/or optical sensing such as, e.g., shooting a photograph, emitting a treatment light pulse or recording a spectrum parameter. Thus, synchronizing the optical bubble and light transmittance or optical sensing operation provides efficacious and efficient power consumption and reliable, consistent results.

[0018] Further efficacies and advantages of controlled bubble position, size and timing may be provided by synchronized combination of this personal care appliance such as a toothbrush or brushing mouthpiece with light treatments or optical sensors providing enhanced combinations.

[0019] For example, efficacious performance of light accelerated whitening (LAW) could be enhanced by combining or integrating an embodiment of the pressurized optical bubble toothbrush or mouthpiece into a whitening operation. Injection of larger optical bubbles, thereby providing an optical window for enhancing the intensity of light reaching the teeth of a user, offsets or reduces the attenuating of light transmittance caused by light scattering small oxygen bubbles resulting from the breakdown of hydrogen peroxide in whitening gels. Injecting optical bubbles into the whitening gel may thus improve the performance of a LAW mouthpiece and similar light treatment applications.

[0020] Various embodiments of this personal care appliance and system are capable of providing optical bubbles in non-transparent topical substances such as toothpaste foam without the need for a pressurized air mechanism. For example, optical bubbles may be provided in the form of encapsulated gas, such as air, stabilized in a transparent biocompatible shell. Embodiments utilizing such encapsulated gas configurations may support larger bubbles of greater than 2 mm diameter in toothpaste.

[0021] In some embodiments, one or more treatment modules such as toothbrush bristles may have artifices in the form of variously configured protuberances or concavities. For example, some bristle tips may feature a thickened end such as, for example, a broad plate. Some embodiments may include hollow cavities, such as apertures or holes, disposed through one or more of the plurality of the bristles. The hollow cavity may in some embodiments be disposed perpendicularly on or through a bristle tip. The hollow cavity may be disposed in a lower portion proximate to the base or between the bristle tip and base of the one or more of the plurality of bristles proximate to an upper portion of the base of the treatment module so as to clear a path for the light or optical sensing signal.

[0022] Various embodiments of the present invention may therefore employ a wide range of artifices or configurations such as, *e.g.,* holes, broader tips, semi-spherical or other shaped inlets or protuberances capable of creating air bubbles in of a sufficient size to create optical windows. That is, artifices of the various embodiments may be configured to enable mixing bubbles of suitable diameter into toothpaste with the application of apt trajectories. Artifice configurations could be disposed on the bottom portion of a toothbrush to provide a light path for sensing or treatment. Embodiments relying on such physical configurations offer advantages of a streamlined device and system eliminating the need for a pressure source such as, *e.g.,* an air pump.

[0023] Artifices such as holes, inlets and the like in treatment modules such as toothbrushes could be placed under the optical sensor or treatment illumination. Timing of sensing and light transmission may be synchronized with the artifice or bristle movements. For example, this system could provide a timing feature whereby an image, measurement or light emission is transmitted through an optical bubble immediately after the artifice or bristle is pushed past a treatment area.

[0024] A system for creating one or more optical bubbles in a non-transparent topical substance such as toothpaste or toothpaste foam applied to a surface of tooth or gum tissue in a mouth of a user is further provided. The system includes employing a personal care appliance with one or more artifices disposed on an upper surface of one or more treatment modules. Various exemplary embodiments of the personal care appliance may deploy a treatment module in the form of a toothbrush having a plurality of bristles configured to thereby inject the one or more optical bubbles in a toothpaste. Such and other embodiments may include a pressure source and/or a driving mechanism capable of activating the treatment modules.

[0025] A methodology for creating one or more optical bubbles in a non-transparent topical substance such as a toothpaste or toothpaste foam is also described and claimed herein. Such procedures include providing a personal care appliance having a driving mechanism coupled with one or more treatment modules with hollow cored bristles. Activating the driving mechanism and pressure source forces air through hollow cores so as to create one or more optical bubbles in the substance. Such optical bubble creation provides an optical window for project a light or optical sensing signal.

[0026] Various embodiments providing dental treatment applications may include anhydrous toothpastes capable of forming optical bubbles of 1 mm or more diameter when in contact with water and/or saliva. Some

embodiments might include combinations of bicarbonate and acidic powders emanating an effervescing effect when in contact with a liquid, such as, e.g., included in popping candy compositions.

[0027] It should be appreciated that all combinations of the foregoing concepts and additional concepts discussed in greater detail are contemplated as being part of the inventive subject matter disclosed herein. In particular, all combinations of claimed subject matter appearing at the end of this disclosure are contemplated as being part of the inventive subject matter disclosed herein.

[0028] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

Fig. 1A is an image of needle simulating a bristle of a tooth brush and an optical bubble created in toothpaste foam covering model black teeth.

Fig. 1B is a closeup of the optical bubble shown in Fig. 1A showing the transparent window wherethrough portion of the black surface of the model teeth is visible.

Fig. 2A is a simplified drawing of a power toothbrush according to a various embodiments featuring bristles with a hollow core for creating one or more optical bubbles.

Fig. 2B is a cross sectional view taken along lines 2B - 2B of Fig. 2A showing the concealed hollow core in dashed lines.

Fig. 2C is a plan bottom view of the bristles of the power toothbrush of Figs. 2A and 4B illustrating a composite of optical bubbles in a field of view.

Fig. 3A is a simplified diagram illustrating a specialized bristle in the form of a broad plate.

Fig. 3B is a simplified diagram illustrating a specialized bristle in the form of a hollow cavity.

Fig. 4 is a flow chart showing the successive steps employed to accomplish an optical bubble creation operation.

Fig. 5 is a schematic illustration of a transparent capsule creating optical bubbles when mixed with toothpaste.

Fig. 6 is a schematic illustration of an anhydrous substance creating optical bubbles when mixed with a non-transparent topical substance such as toothpaste.

DETAILED DESCRIPTION OF EMBODIMENTS

[0030] The disclosed subject matter will become better understood through review of the following detailed description in conjunction with the figures. The detailed description and figures provide example embodiments of the invention described herein. Those skilled in the art will understand that the disclosed examples may be varied, modified, and altered without departing from the scope of the invention described herein.

[0031] Throughout the following detailed description, representative examples of features of are disclosed to illustrate aspects of the claimed invention. Related features in the examples may be identical, similar, or dissimilar. The reader should understand that a given feature need not be the same or similar to the specific portrayal. It should therefore be understood that the representative embodiments illustrated in the figures are adapted to a power brushing toothbrush or mouthpiece. However, it should be understood that the claimed and described features of other embodiments of the claimed invention may be adaptable to other applications, including, for example, fluid ejection cleansers, and dental treatment and bleaching applications.

[0032] The terms "a" and "an," as used herein in the specification and in the claims, unless clearly indicated to the contrary, should be understood to mean "at least one. The phrase "and/or," as used herein in the specification and in the claims, should be understood to mean "either or both" of the elements so conjoined, *i.e.,* elements that are conjunctively present in some cases and disjunctively present in other cases. Multiple elements listed with "and/or" should be construed in the same fashion, *i.e.,* "one or more" of the elements so conjoined. Other elements may optionally be present other than the elements specifically identified by the "and/or" clause, whether related or unrelated to those elements specifically identified.

[0033] As used in the specification and in the claims, "or" is synonymous to "and/or" as defined above. For example, when separating items in a list, "or" or "and/or" shall be interpreted as being inclusive, *i.e.,* the inclusion of at least one, but also including more than one, of a number or list of elements, and, optionally, additional unlisted items. Only terms clearly indicated to the contrary, such as "only one of" or "exactly one of," or, when used in the claims, "consisting of," will refer to the inclusion of exactly one element of a number or list of elements. In general, the term "or" as used herein shall only be interpreted as indicating exclusive alternatives (*i.e.,* "one or the other but not both") when preceded by terms of exclusivity, such as "either," "one of," "only one of," or "exactly one of."

[0034] In the claims, as well as in the specification above, all transitional phrases such as "comprising," "including," "with," "having," "containing," "involving," "holding," "composed of," and the like are to be understood to be open-ended, *i.e.,* to mean including but not limited to.

[0035] As used herein, "artifice" is defined as a configuration, substance or mechanism incorporated or combined with a personal care appliance including without limitation a toothbrush, mouthpiece, including bristles and floss capable of use for or in connection with creating one or more optical bubbles in toothpaste. The term "ar-

tifice" includes without limitation a hole, inlet, indentation, semi-spherical or otherwise shaped concavity, protuberance, thickening, narrowing or any other configuration incorporated a specialized bristle. "Artifice" may further refer to an ingredient or aggregate incorporated in toothpaste including but not limited to a transparent capsule containing air or substance that is activated to effuse or create a fizzing action in toothpaste.

[0036] As used herein, a "driving mechanism" refers to any mechanical, electrical, electromechanical, vibratory, ultrasonic, pneumatic or computer-enabled power source or driving mechanism adaptable for intraoral applications. For example, batteries may drive electrical motors for intraoral embodiments. Facile embodiments may employ small coin batteries, alkaline or lithium, and rechargeable batteries. An off-the-shelf on/off switch 34 can be used to activate the driving mechanism. As can be readily seen, the driving mechanism may be activated and deactivated by an on/off switch 34 with depressible activator (push button, rocker, or membrane button).

[0037] As used herein, "non-transparent topical substance" refers to any therapeutic fluid, ointment, lotion, cream, salve or similar personal care product to the skin or other tissue of a person or animal.

[0038] As used herein, "optical bubble" is defined as a bubble filled with gas, such as, *e.g.,* air, in toothpaste, of a sufficient size to create an optical window capable of enhancing light transmittance and/or optical sensing utilized in a combined or synchronized diagnostic or therapeutic technique including a dental treatment or technique.

[0039] As used herein, the term "personal care appliance" and "treatment module" refers to a device or configuration having a treatment module including one or more artifices, such as described above, for applying a fluid, ointment, lotion, cream, salve or similar personal care product to the skin, tooth, gum or other tissue of a person or animal.

[0040] As used herein, a "pressure source" refers to manual or mechanical application of force to a toothbrush or other personal care device. As such, the resulting pressurization may be exerted by brushing or otherwise cleaning tissue by hand or by an electric toothbrush or dental appliance.

[0041] As used herein, "toothpaste" refers to any dental agent for cleaning, whitening, lightening, sanitizing or layering on the teeth and gum tissue, The term "toothpaste" explicitly includes toothpaste foam produced when toothpaste is combined with saliva and other additives, either naturally occurring in the mouth or added when the teeth and gum tissue are being brushed during dental cleaning or other treatment. As such, "toothpaste" includes, without limitation, commercially available dental cleaning compositions sold under numerous household brands, dental abrasives and bleaches, whiteners, lighteners or colorants, mouthwashes, gels, creams, lotions, ointments, and combinations thereof in a toothbrush foam.

[0042] The term "toothbrush" as used in the claims and specification is defined to include any manual or power dental cleaning appliance, including a conventional manual toothbrush or a commercially available power toothbrush or separate toothbrush head, such as, *e.g.,* the Philips Sonicare® power toothbrush and replacement brush heads, as well as dental mouthpieces that are fitted on the upper and/or lower teeth and gum tissue of a user.

[0043] As used herein, "toothpaste foam" refers to any derivative or combination of toothpaste, as defined above. The term "toothpaste" explicitly includes toothpaste foam produced when toothpaste is combined with saliva food particles or other residues, substances and/or colorants, either naturally occurring in the mouth or added when the teeth and gum tissue are being brushed during dental cleaning or other treatment.

[0044] Now referring to the exemplary embodiments illustrated in Figs. 1A - 2B, specialized bristles of a toothbrush 10 for creating one or more optical bubbles 2 in toothpaste 4 are discussed. Figs. 1A and 1B show optical bubbles 2 in a non-transparent topical substance 4 lying on a black surface which simulates tooth tissue. The foam in these figures is a toothpaste foam derived from a commercially available toothpaste. The bubbles were formed by compressing a syringe to inject air through a needle into the non-transparent topical substance, replicating a treatment module 14 in the form of hollow core 20 injecting air into the foam toothpaste 4 layer, thereby forming an optical bubble 2. As shown in Fig. 1B, this results in formation of a substantially transparent optical bubble 2 through which the underlying black surface is clearly seen.

[0045] It has been found that the viscosity of toothpaste foam 4 enables keeping the optical window hole largely intact for a few seconds following bursting of optical bubble 2 following its collapse. Therefore, efficacy of the optical bubble 2 is not directly dependent on the injected air volume or bubble stability. Although complete clearance of foam elements obfuscating transparency in a field of view 18 may not be achieved, adjacent optical bubbles 2 may enlarge the available area sufficiently for transmission of light employed in dental or other diagnostic and therapeutic treatments. To maximize the optical window area, an injected air pulse and resulting bubble volume can be increased.

[0046] Thus the effect imparted by the surface pressure of optical bubble 2 that pushes away toothpaste foam 4 locally and the stabilizing viscosity of toothpaste foam 4 typically enables optical bubble 2 to remain in place for several seconds. Such stability of optical bubble 2 thus keeps a substantially transparent optical window intact for a sufficient time to facilitate techniques employing light transmittance such as, for example, teeth lightening, and/or optical sensing for, *e.g.*, taking photographs in order to monitor, diagnose and treat dental disease such as, *e.g.*, periodontitis, while teeth and gum tissue are being brushed.

[0047] As described in detail and illustrated in Figs 3 -

3B, the number, spacing and artifice configurations may be adapted to adapted to create and position optical bubbles in accordance with the transmittance and field of view criteria of particular dental procedures. For example, procedures requiring less precision such as, *e.g.*, teeth bleaching, a larger number of adjacent optical bubbles with more light scattering and absorbing substances may obstruct the field of view may be suitable. A more closely abutted and smaller number of optical bubbles 2 providing commensurately less light scattering and absorbing foam elements and thereby a more transparent field of view could be employed for procedures requiring high levels of clarity in the field of view and corresponding precision such as, *e.g.,* dental x-rays or photography.

[0048] As illustrated in the exemplary embodiment shown in Figs. 2A - 2C, to further increase the optical window area, multiple hollow bristles 20 can be combined to clear an expanded field of view 18. As best shown in the schematic illustration of Figs. 2B and 2C, four hollow bristles 16 creating four adjacent spherical optical bubbles 2 to enlarge the portion of the field of view 18 provided by their respective optical windows thereby enhancing the light transmittance and optical sensing therethrough.

[0049] As illustrated in Figs. 2A - 2C, toothbrush 10 is configured with one treatment module 12 including a plurality of bristles 16 having one or more artifices. Various embodiments such as in a brushing mouthpiece may employ two or more treatment modules 12, for example, as when the mouthpiece has segmented arches.

[0050] Still referring to Figs. 2A - 2C, the exemplary artifice illustrated is configured as a hollow core 20 integrally disposed in four adjacent bristles 16, wherein the artifice is configured as a hollow cores 20 in communication with hollow cores 20 depicted by phantom lines in Fig. 2B. As shown by exemplary power toothbrush 10, switching on of actuator 34 powers driving mechanism 30 to activate treatment module 14. Driving mechanism 30 also activates pressure source 32 such that activation of the pressure source 30 forces or injects air through the hollow core 20 to thereby create the one or more optical bubbles 2.

[0051] In embodiments such as exemplified in Figs. 3 - 3B, lengths of bristles 16 are configured for creating optical bubbles 2 of diameters of about 1 mm. Compositions for bristles 16 may include, *e.g.*, nylon or other suitable biocompatible material. Optical bubble creation may be enhanced by pulses of air having a volume of about 0.01 ml, which may provide such optical bubble of 1mm or greater diameter. Suitable air pressure and volumes for creating optical bubbles 2 may by varied to accommodate toothpaste viscosity, type of dental procedure and other factors.

[0052] In various embodiments such as illustrated in Figs. 2A - 2C, dental appliance 100 is capable of delivering pulses of pressure for forcing air through the hollow core 2 into the toothpaste 4 at predetermined intervals. Such delivery of pulsed pressure may be directed so at least a portion of the optical bubbles are abutted such that an optical window of the combined adjacent bubble provide a field of view 18 diameter that is greater than any one of the optical bubbles 2.

[0053] By timing pulses of air pressure at predetermined intervals, optical bubbles 2 are capable of being synchronized so as to remain on a working surface 6 of the teeth or gum tissue of a user's mouth 8 for a sufficient time to allow a light or an optical sensing signal employed in a dental treatment to be projected through the one or more optical bubbles 2 once they are formed.

[0054] Such and other advantages imparted by an air pump as a pressure source, such as employed in the exemplary embodiment described above, enhancing control of bubble timing, size and position are substantial. An air pump provides a further advantage of enabling regular higher-pressure pulses to prevent blockage of the hollow bristles from dental plaque or other chemical residue within the hollow core 20 potentially impairing or disabling optical bubble creation by the dental appliance. This pressure cleaning cycle of the hollow core 20 of bristles 16 may be done when washing the brush under the tap, for example.

[0055] Some embodiments may employ bristle tips having artifices capable of creating larger bubble sizes in the toothpaste foam are illustrated such as the exemplary bristle tips shown in Figs. 3A and 3B. Fig. 3A illustrates a thickened bristle end in the form of broad plate 22, which may in some embodiments measure about 1 mm in width thick disposed on an end of one or more of the plurality of bristles for creating optical bubbles 2.

[0056] Now referring to Fig. 3B, bristles 16 may also include a holes or apertures with a pair opposed openings such as hollow cavity 24 for creating optical bubbles 2 disposed on a bristle tip as shown. For example, as illustrated in Fig. 3B, air cavities 24 are created by swinging and entraining the bristles 16 away in a direction B and captured within hollow cavity 24 with air. The return motion of the bristles into the toothpaste layer may induce the air from hollow cavity 24 to remain as a large bubble in the toothpaste foam 4, thus providing optical window capable of light and optical sensing transmittance. Swirling a bristle with hollow cavity 24 in toothpaste 4 in direction B may induct flow through hollow cavity 24 whereby one or more optical bubbles 2 having a diameter of greater than 1 mm may be created.

[0057] While Figs. 3A and 3B respectively depict broad plate 22 and hollow cavity 24 on a bristle tip, artifices may also be disposed adjacent to a bristle base or between a tip and base. In some embodiments, one or more of the bristles 16 may be configured to provide a hollow cavity 24 disposed in a lower portion of the one or more of the plurality of bristles 16 proximate to the upper portion of the base 12 of the treatment module 14 so as to clear a path for the light or the optical sensing signal.

[0058] Variously sized and shaped bristle configurations may be used to create useful optical window in the form of bubbles of a 1 mm diameter or larger optical bub-

bles 2. Artifices for creating optical bubbles 2 may be variously configured to incorporate a range of angled, curved, linear and curvilinear profiles. For example, the thickened bristle end may be curved, linear, curvilinear, and incorporate various geometric shapes such as parallelograms, polygons, circles, ovals and combinations thereof. While shown as perpendicularly adjoined on respective bristle tips in Figs. 3A and 3B, junctions of the exterior sidewalls of the bristles and such protuberances or cavity inlet walls may be tapered or configured in various angles.

[0059] Embodiments for creating optical bubbles 2 in toothpaste 4 employing specialized bristle design and brushing motion without an air pump as a pressure source 32 eliminate the cost and maintenance of an electromechanical component. As shown and described with respect to Fig. 3B, apt swirling of such and other specialized bristles 16 may create larger bubbles when passing through the toothpaste foam.

[0060] Now referring to Fig. 4, the various illustrated embodiments provide a system and method for creating one or more optical bubbles 2 in a toothpaste 4 applied to a surface 6 of a dental arch or gum tissue in a mouth 8 of a user. This entails providing a personal care appliance 100 including a driving mechanism 30 coupled with one or more treatment modules 14 with bristles 16 having hollow cores 20 disposed along a substantially longitudinal axis of the one or more of the plurality of bristles. Hollow cores 20 are in communication with a pressure source such that switching an actuator 34 and activating the driving mechanism 30 thereby activates treatment module 14 and pressurizes pressure source 32 to force air through hollow cores 20 so as to create one or more optical bubbles in toothpaste and transmitting a light or optical sensing signal of a dental procedure through the optical bubbles. When a dental treatment operation is complete, toothbrush 10 is removed from the user's mouth 8.

[0061] Now referring to schematic illustrations of Figs. 5 and 6, some embodiments may feature an artifice in the form of an substance added to a non-transparent topical substance 4 such as a toothpaste foam. Fig. 5 depicts a transparent capsule 28 enclosing air for integrating optical bubbles 2/28. The diameters of transparent capsules 28 are at least 1 mm and thereby can create optical bubbles when mixed with toothpaste. Since the capsules are not prone to spontaneous bursting, transparent capsules 28 provide stable and durable optical bubbles 2/28, which may be more stable and durable as compared to optical bubbles 2 created by directly injecting or forcing air into the toothpaste foam.

[0062] Now referring to Fig. 6, an artifice is provided in the form of an anhydrous substance 29 including a bicarbonate and an acidic component capable of effervescing when disposed in the toothpaste foam 4 to thereby create the one or more optical bubbles 2 when disposed in the toothpaste foam 4. Other substances capable of effervescing may be used.

Claims

1. A personal care appliance (100) for creating one or more optical bubbles (2) on a tissue of the body (6), comprising:
one or more treatment modules (14) having a surface whereon one or more artifices are disposed, wherein the one or more artifices are configured to create one or more optical bubbles (2) in a non-transparent topical substance (4) when the one or more treatment modules (14) is directed onto the tissue (6).

2. The personal care appliance (100) of claim 1, wherein the personal care appliance (100) is a toothbrush (10), wherein the one or more treatment modules (14) include a plurality of bristles (16) disposed on the toothbrush (10) and wherein the one or more artifices are configured to create one or more optical bubbles (2) in the non-transparent topical substance, and wherein the tissue (6) is a tooth or gum tissue.

3. The personal care appliance (10) of claim 2, wherein the one or more treatment modules (14) include a hollow core (20) that is longitudinally aligned within in one or more of the plurality of bristles (16), and wherein the hollow core (20) is in communication with a pressure source (32) such that activation of the pressure source (32) is capable of forcing air through the hollow core (20) to thereby create the one or more optical bubbles (2).

4. The personal care appliance (10) of claim 3, further comprising a driving mechanism (30) wherein the driving mechanism (30) activates the one or more treatment modules (14) and the pressure source (32), and wherein the hollow core (20) is longitudinally aligned within the one or more of the plurality of bristles (16), and wherein the hollow core (20) is in communication with the pressure source (32) such that activation of the pressure source (32) is capable of injecting air through the hollow core (20) to thereby create the one or more optical bubbles (2).

5. The personal care appliance (10) of claim 4, wherein the pressure source (32) is capable of pulsating pressure for forcing air through the hollow core (20) in the toothpaste foam (4) at predetermined intervals.

6. The personal care appliance (10) of claim 5, wherein the optical bubbles (2) are at least 1 mm in diameter.

7. The personal care appliance (10) of claim 5, wherein an air volume injected by the pressure source (32) is between about 0.01 and 0.015 ml.

8. The personal care appliance (10) of claim 5, wherein the pulsating pressure creates at least two of the one or more optical bubbles (2), wherein at least a portion

of the at least two optical bubbles (2) are abutted to thereby provide a field of view (18) traversing a diameter of greater than a one of the at least two of the one or more optical bubbles (2).

9. The personal care appliance (10) of claim 5, wherein the pulsating pressure is capable of being synchronized so the one or more optical bubbles (2) remain on the surface (6) of the tissue (6) for subsequent projecting of a light or optical sensing signal through the one or more optical bubbles (2).

10. A system for creating one or more optical bubbles (2) in a non-transparent topical substance (4) on a body tissue (6) by a personal care appliance (100), the system comprising:

one or more treatment modules (12) having one or more artifices in communication with a pressure source (32) such that the pressure source (32) is capable of forcing air through the one or more artifices to thereby create the one or more optical bubbles (2); and
wherein the personal care appliance (100) includes a driving mechanism (30) capable of activating the one or more treatment modules (14) and the pressure source (32) to thereby create the one or more optical bubbles (2) in the non-transparent topical substance (4) while applying the one or more treatment modules (14) to the tissue surface (6).

11. A method for creating one or more optical bubbles (2) in non-transparent topical substance (4) on a body tissue (6), comprising:

providing a personal care appliance (100) having one or more treatment modules (12) with an one or more artifices disposed thereon, and wherein the one or more artifices include a hollow core (20) disposed within the one or more treatment modules (14), wherein the personal care appliance (100) is coupled with a driving mechanism (30), and wherein the personal care appliance (100) includes a pressure source (32) in communication with the hollow core (20) of the one or more treatment modules (14);
applying the one or more treatment modules (12) to the tissue (6);
actuating the driving mechanism (30) to thereby activate the one or more treatment modules (12) and the pressure source (32) so as to create the one or more of optical bubbles (2) in the non-transparent topical substance (4);
projecting a light or optical sensing signal through the one or more optical bubbles (2); and
removing the personal care appliance (100) from the tissue (6) when a personal care treatment operation is completed.

12. The method of claim 11, further comprising:
activating a pressure source (32) to thereby inject pulses of air pressure at predetermined intervals such that the one or more optical bubbles (2) remain on the body tissue (6) for a sufficient time for subsequent projecting the light or optical sensing signal through the one or more optical bubbles (2).

13. An artifice for creating one or more optical bubbles (2/28) in a non-transparent topical substance (4) on a surface of a body tissue (6).
when disposed in the toothpaste (4).

14. The artifice of claim 13, wherein the artifice is a transparent capsule (28) enclosing air providing the one or more optical bubbles (2/28), and wherein the transparent capsule has a diameter of greater than 1 mm.

15. The artifice of claim 14, wherein the artifice is an anhydrous substance (29) including a bicarbonate and an acid, and wherein the anhydrous substance (29) is capable of effervescing when disposed in the non-transparent topical substance (4) to thereby create the one or more optical bubbles (2).

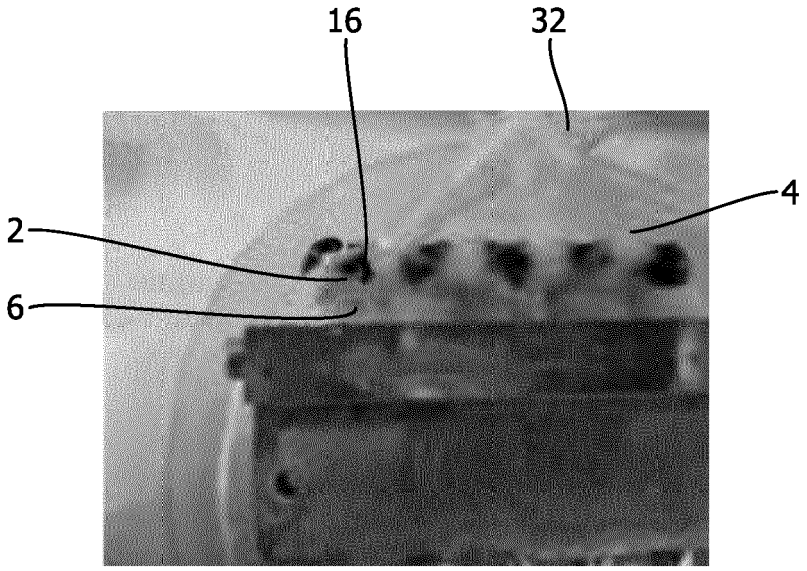

FIG. 1A

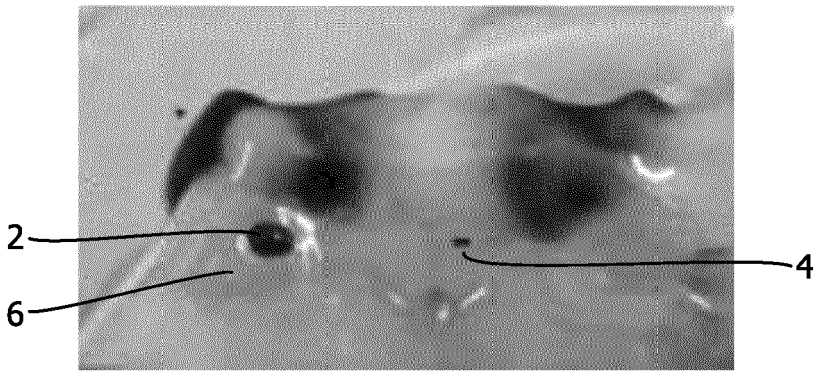

FIG. 1B

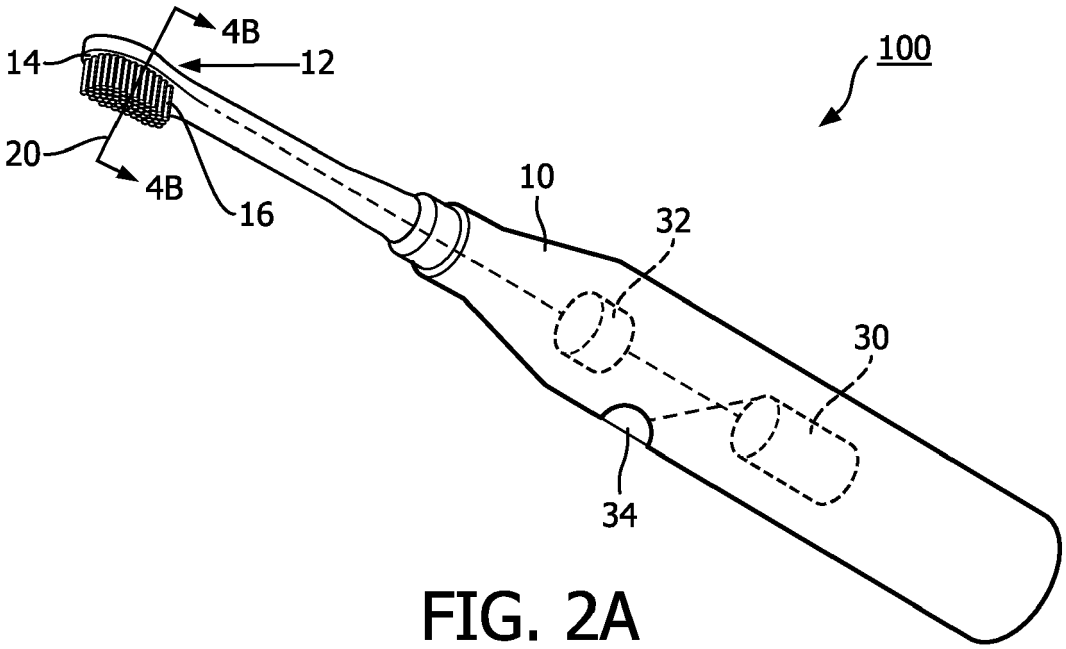

FIG. 2A

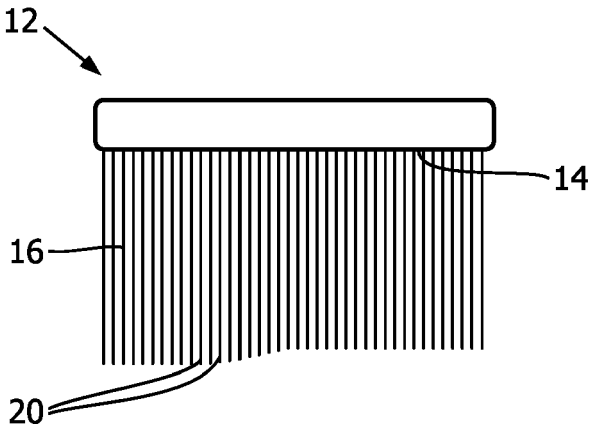

FIG. 2B

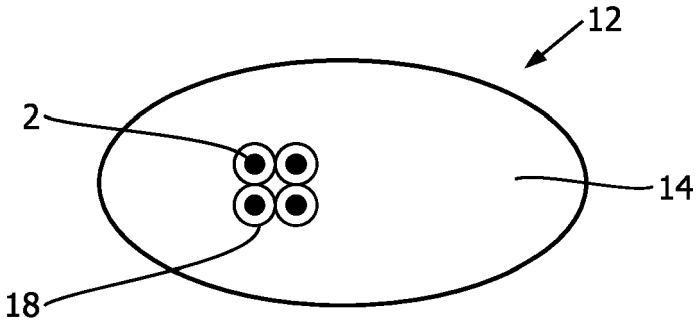

FIG. 2C

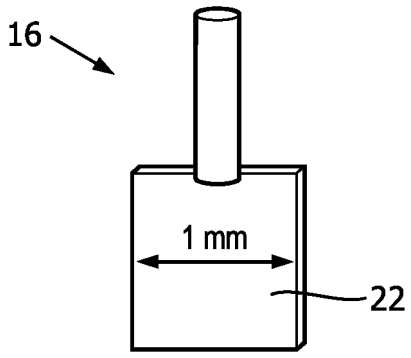

FIG. 3A

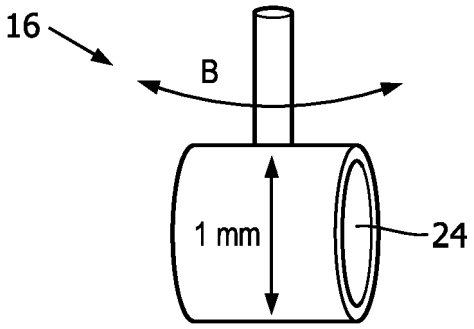

FIG. 3B

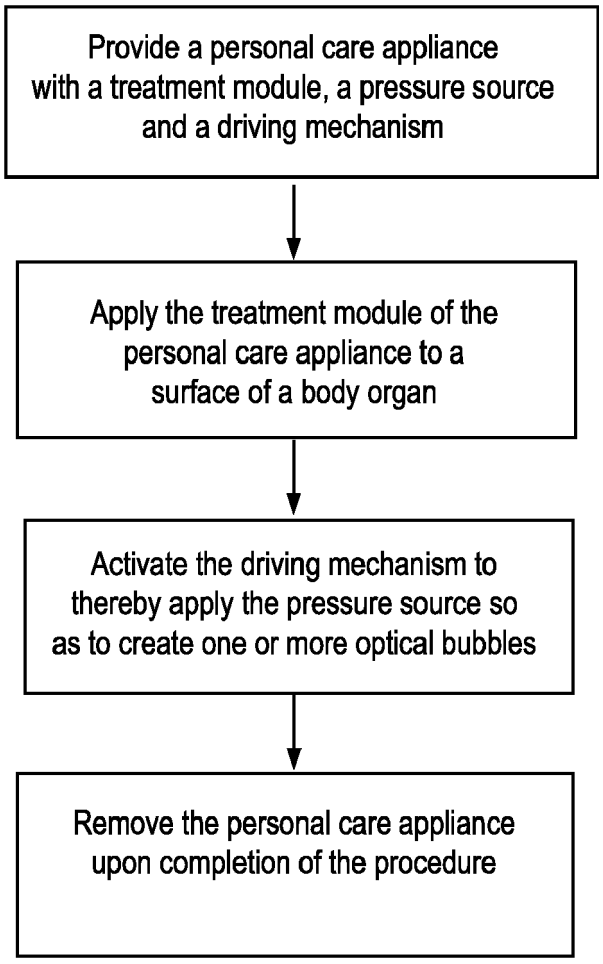
Provide a personal care appliance with a treatment module, a pressure source and a driving mechanism
Apply the treatment module of the personal care appliance to a surface of a body organ
Activate the driving mechanism to thereby apply the pressure source so as to create one or more optical bubbles
Remove the personal care appliance upon completion of the procedure

FIG. 4

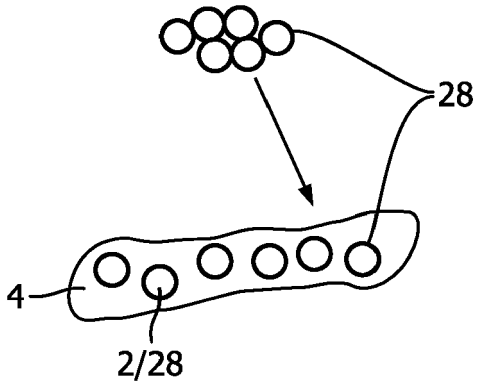

FIG. 5

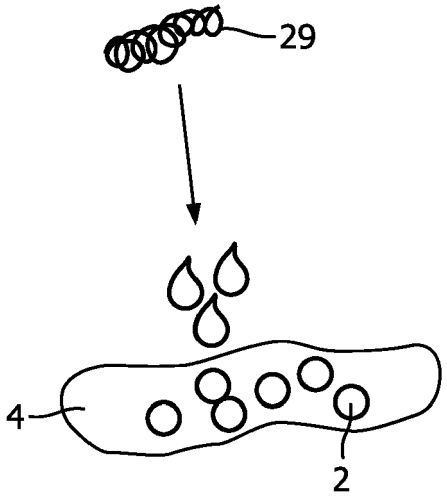

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 1074

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2015/282912 A1 (PRINS MENNO WILLEM JOSE [NL] ET AL) 8 October 2015 (2015-10-08) * paragraphs [0008], [0016], [0052] - [0061], [0101], [0102], [0105]; figures 1-3, 4a, 5, 10, 11 *	1-12	INV. A46B11/00 A46B15/00
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X	US 6 203 320 B1 (WILLIAMS DAVID ROBERT [US] ET AL) 20 March 2001 (2001-03-20) * column 2, lines 6-16, 28-29, 50; figures 1,2 *	1-5	
X	US 2005/091770 A1 (MOURAD PIERRE D [US] ET AL) 5 May 2005 (2005-05-05) * paragraphs [0055], [0075]; figure 1 *	1	TECHNICAL FIELDS SEARCHED (IPC) A46B
X	CN 202 698 200 U (MA YIWEI) 30 January 2013 (2013-01-30) * paragraph [0018]; figure 1 *	1	

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
The Hague	24 November 2023	Rossini, Marco

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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Application Number
EP 23 18 1074

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-12

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 23 18 1074

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-12

   A personal care appliance for creating optical bubbles and a system thereof

   ---

2. claims: 13-15

   Artifice for creating optical bubbles disposable in a toothpaste

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 18 1074

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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24-11-2023

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82