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(54) METHOD OF PRODUCING A HEATER FOR AN AEROSOL GENERATING DEVICE, HEATER FOR AN AEROSOL GENERATING DEVICE AND AEROSOL GENERATING DEVICE

(57) In a method of producing a heater for an aerosol generating device a protective layer (14) is applied directly or indirectly on one or more heater tracks (13), such as resistively heated filaments, by a vacuum-deposition process with a thickness of less than 100 μm, preferably less than 10 μm.

A heater for an aerosol generating device has a protective layer (14) applied directly or indirectly on one or more heater tracks (13), such as resistively heated filaments, by a vacuum-deposition process, with a thickness of less than 100 μm, preferably less than 10 μm.

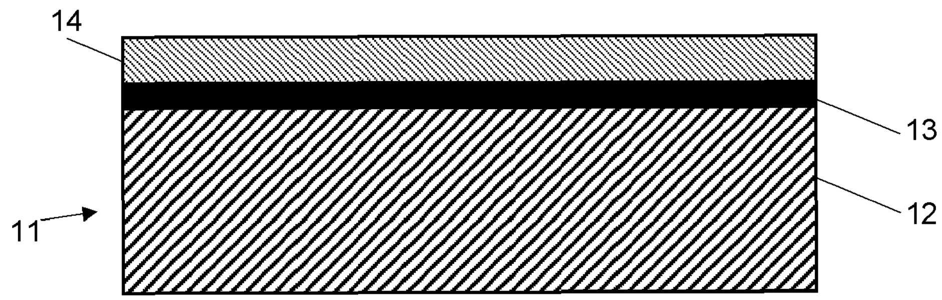

Fig. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to a method of producing a heater for an aerosol generating device, heater for an aerosol generating device and aerosol generating device.

BACKGROUND

[0002] Several types of aerosol generating or inhalation devices are known and continuously replace traditional cigarettes. Such devices usually have a heater adapted to transmit heat to a wick provided in a separate part containing a consumable. In this context, the consumable part can further comprise a thermal interface material which is, in use, in contact with the heater and enhances heat transfer from the heater to the wick and ultimately to a substance to be vaporized. In this context, a low heat-up time is desired for the heater, in order to enable puffs, which are satisfying for the consumer from the very first puff.

[0003] DE 2020 150 06 397 U1 is related to a heater essentially as described, which is plasma oxidized to create a porous layer. According to KR 2022 0098841 A a metallic heater is coated with an alkoxide-based ceramic containing agent. Finally, CN 114947220 A shows a heating needle, which can be coated with a nano-infrared ceramic coating, which may have a thickness of 0.1 to 1 μm.

SUMMARY OF THE INVENTION

[0004] In view of the above, it is an object underlying the invention to provide a method of producing a heater for an aerosol generating device having one or more heater tracks, which had a reduced heat-up time.

[0005] The solution to this object is achieved by means of the method described in claim 1.

[0006] Accordingly, in a method of producing a heater for an aerosol generating device a protective layer is applied directly or indirectly on one or more heater tracks by a vacuum deposition process with a thickness of less than 100 μm. The heater tracks can for example be resistively heated filaments, and the thickness of the protective layer is preferably less than 10 μm.

[0007] In this manner, with a thickness of less than 100 μm, the thermal mass of the heater is significantly reduced as compared to conventional heaters which have a significantly thicker ceramic layer coating a heater track. In contrast, in accordance with the invention, heat is transferred quickly from the heater to the wick, and the protective layer at the same time provides protection for the heater tracks of the device which, consequently, have a long lifetime and can be used with an extensive number of consumables. The consumable can in this context be in the shape of a pod, card or stick. Further, one or more heater tracks can have a shape resembling a butterfly.

[0008] It should be mentioned that the wick of the consumable part can be made from cotton, glass fiber and/or ceramic. The device having the heater as described herein, and/or produced as described herein, has the advantage of having the heater in the reusable device and not the consumable part, so that the costs of the latter can be kept at a minimum. Moreover, the consumable part can be reduced with regard to complexity and waste as compared to consumable parts having the heater. According to the invention, the heater can overall be kept comparably small. As a further consequence, the heat transfer from the heater can advantageously penetrate comparably deep into the wick so that a sufficient amount of liquid can be vaporated, and a sufficient amount of aerosol can be produced.

[0009] The vapor deposition methods used in connection with the present invention advantageously allow the deposition of high-quality layers or films with the desired thickness of less than 100 μm, preferably less than 10 μm.

[0010] Moreover, energy efficiency as a whole is improved, as less energy is needed to heat up the coating of the heater and more energy can, consequently, be used to heat the liquid to be vaporized which advantageously increases the number of puffs per charging cycle of an energy source, such as a battery supplying the heater with electric energy.

[0011] Preferred embodiments are described in the further claims.

[0012] As regards the material of the thin protective layer according to the invention, ceramic and/or DLC (for Diamond-like carbon) are currently preferred as these can readily be deposited by means of a vacuum deposition process and at the same time constitute thin, hard and thermally conductive layers. At the same time, these materials advantageously serve as electric insulators. Preferred materials can also be described to be glass-like and/or amorphous.

[0013] The specific methods of claim 3 are expected to efficiently provide the protective layer according to the invention.

[0014] This also applies to the specific materials of claim 4.

[0015] As regards the layer structure of the heater according to the present invention, the protective layer can specifically be applied on a metal layer constituting a substrate, on which the one or more heater tracks are provided. This substrate advantageously has a comparably low thermal conductivity and can for example be made from hydroxy-apatite in order to encourage heat conduction towards the wick, through the protective layer, and not towards the substrate.

[0016] The protective layer can also be applied on an interlayer adapted to improve adhesion of the protective layer to the heater tracks and/or the substrate. Alternatively or additionally, the protective layer can further be coated with a metallic and/or electrically conductive layer, in particular when the protective layer is an insulator, such as a ceramic or DLC layer. In this case, the metallic and/or conductive layer can provide the heater with a pleasant metallic appearance and can comprise one or more of a zirconium, chrome and titanium nitride or carbonitride.

[0017] The heater according to the invention is described in claim 6, and preferred embodiments thereof essentially correspond to preferred embodiments of the method for producing same. In this context, any features mentioned above or below with regard to the method only, are equally applicable to the heater and vice versa.

[0018] In order to provide the desired protective effect of the protective layer, this preferably has a Mohs hardness of greater than 6 as determined by ASTM C 1895/20, preferably greater than 7, most preferred greater than 8.

[0019] Further, when the protective layer has a thermal conductivity of 1 to 2000 W/(mK), advantageous heat conductivity properties can be expected. This also applies to the thermal conductivity values of the substrate recited in claim 12, which serve to encourage heat transfer to the wick rather than the substrate.

[0020] Finally, the thin protective layer according to the present invention advantageously allows the heater to have a size of 20 mm^2 or more without significantly increasing the thermal mass thereof. The mentioned size is expected to allow enhanced heat transfer to the wick in order to quickly start producing an aerosol.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig.1 schematically show the layer structure of a heater for an aerosol generating device provided by means of the present invention;

Fig. 2 is a schematic cross-sectional view of an aerosol generating device comprising a base part comprising a heater according to the invention and a cartridge, shown with the base part and the cartridge disconnected;

Fig. 3 is a schematic cross-sectional view of an aerosol generating device comprising a base part comprising a heater according to the invention and a cartridge, shown with the base part and the cartridge connected.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0022] As can be taken from figure 1, the invention proposes a heater 11 for an aerosol generating device 1 such as an electronic cigarette or heat-not-burn device, the heater 11 having a substantially planar shape and a layered structure formed, at least, of a base substrate layer 12, a resistive heating layer 13 comprising one or more heater tracks, and a protective layer 14. In the embodiment shown, the protective layer 14 constitutes the outermost layer of the heater 11 and is adapted to transmit heat, in use, by conduction to a thermal interface material membrane 28 provided as the outermost layer in a consumable article 2 as described in relation to figs. 2 and 3 below

[0023] In this exemplary embodiment, the base substrate layer 12 is made of hydroxy-apatite, having a low thermal conductivity of 2 - 200 W/(mK), preferably less than 100, most preferred less than 10. The heater layer 13 is formed of a resistively heatable metal filament, for example of copper, silver or other conductive metal or metallic alloy typically used for thin-film deposition application to form thin-film or thick film heaters. In a preferred example, the heater tracks 13 may follow essentially a butterfly shaped pattern or serpentine shaped pattern deposited onto the hydroxy-apatite layer 12.

[0024] A diamond-like carbon (DLC) protective layer 14, also known as amorphous carbon (a-C), is provided over the heater layer 13. This protective layer has advantageously a thickness of about 5 to 8 μm and exhibits a Mohs hardness of about 8 to 10 as determined by ASTM C 1895-20. Advantageously, the protective layer 14 is applied by means of vacuum vapor deposition process, and more specifically a plasma-enhanced chemical vapor deposition (PECVD) process. The heater layer may also be provided to the hydroxy-apatite layer using a similar deposition method or another physical or chemical deposition layer, such as ion beam sputtering for example.

[0025] The DLC protective layer 14 has a high thermal conductivity allowing it to evenly spread heat from the heater tracks 13 across the entire surface of the heater 11 to avoid hot spots at the heater's surface. In practice, the protective layer 14 has thermal conductivity of 1 to 2000 W/(mK), and the heater 11 an active heating area of 20 mm2 or more.

[0026] Referring to Figure 2 and 3, there is shown one example of an aerosol generating device in the form of an electronic cigarette 1 for vaporizing a liquid L contained in a consumable article 2 in the form of a closed cartridge also referred to in the art as a "capsule" or "pod". The electronic cigarette 1 comprises a base part 10 and the cartridge 2 is thermically connectable to the base part 10 (See Fig.3). The base part 10 is thus the main body part of the electronic cigarette and is preferably re-usable.

[0027] The base part 10 comprises a housing 15 accommodating therein a power supply unit in the form of a battery 16 connected to the heater 11 located at a first end of the housing 15. The heater 11 is protruding out of the base part for partial receipt within a base part of the cartridge 2. The first end of the housing 15 has an interface configured for matching a corresponding interface of the cartridge 2 and comprises a connector for mechanically coupling the cartridge 2 to the base part. The battery 16 is configured for providing the heater 11, and more specifically the heater tracks 13 with the necessary power for its operation allowing it to become heated to a required temperature.

[0028] The battery 16 is also connected to a controller 17, enabling the required power supply for its operation and the controller 17 is operationally connected to the heater 11. In the illustrated example, the controller is located between the battery 16 and the heater 11 but it is to be appreciated that this arrangement is not compulsory and other arrangements of the components within the base part 10 are entirely within the scope of the present disclosure, such as the controller being located on an opposite side of the battery 16 to the heater 11, wherein the battery 16 acts as a divider between the heater 11 and other sensitive components of the electronic cigarette 1.

[0029] Referring still to Figure 2, the cartridge 2 comprises a cartridge housing 20 having a proximal end 21 and a distal end 22. The proximal end 21 may constitute a mouthpiece end configured for being introduced directly into a user's mouth (not shown). In some embodiments, a mouthpiece may be fitted to the proximal end 21. The cartridge 2 comprises a base portion and a liquid storage portion 23, where the liquid storage portion comprises a liquid store or reservoir configured for containing therein the liquid L to be vaporized. The liquid L may comprise an aerosol-forming substance such as propylene glycol and/or glycerol and may contain other substances such as nicotine and acids. The liquid L may also comprise flavourings such as e.g. tobacco, menthol or fruit flavour. The liquid store 23 may extend between the proximal end 21 towards the distal end 22, but is spaced from the distal end 22. In the illustrated embodiment, a vapour transfer channel 24 extends from an inlet 25 provided on one side of the base portion, across the base of the cartridge into which the heater 11 from the base part protrudes and up the side of the cartridge to an outlet 26 located centrally in the top part of the cartridge at the proximal end 21 thereof. However, other configurations for the vapour outlet channel are possible. For example, the liquid store 23 may surround, and coextend with, the vapour transfer channel 24.

[0030] The base portion of the cartridge 2 is provided with a porous wick 27, preferably a ceramic wick which extends between the liquid store 23 and the vapour transfer channel 24. A thermal interface membrane 28 is provided underneath the porous wick 27, thereby sealing the base part of the cartridge 2 and avoiding leakage of liquid by gravity out of the cartridge 2. The thermal interface membrane 28 may be a flexible, thin membrane spaced apart from the wick bottom's surface across the vapour channel (as represented) or may be arranged as a contacting surface to the wick. The thermal interface membrane is configured to ensure rapid and even heating of the wick 27 in use with minimal lateral thermal spreading (i.e. thermal losses).

[0031] Upon connection of the interfaces between the cartridge 2 and the base part 10 of the device 1, the heater 11 engages the thermal interface membrane 28 until the latter is compressed against the wick 27 to enable heating of the liquid in the wick by conduction until the liquid is transformed into vapour.

[0032] The protruding heater 11 deforms or at least presses against the membrane 28 when the cartridge 2 is connected to the base part 10 to provide a high contact pressure between the membrane 28 and heater 11, lowering the interface thermal resistance.

[0033] The layered heater 11 according to the invention, thanks to the protective layer 14, provides even heat spread from the heater tracks 13 to the heater's surface, thereby allowing even heat transfer to the wick 27 via the thermal interface membrane 28, which allows for more effective heat transfer to the wick compared to direct contacting of heater tracks to the thermal interface membrane. This allows in particular to compensate for thermal inertia of ceramic wicks, and thus a faster, more energy efficient heating of the wick and vaporisation of liquid. In addition, the protective layer 14 allows for preservation of the heater tracks 13, and longer lifespan of the base part of the aerosol generating device 1, while the heater tracks 13

Claims

1. A method of producing a heater for an aerosol generating device, in which a protective layer (14) is applied directly or indirectly on one or more heater tracks (13), such as resistively heated filaments, by a vacuum-deposition process with a thickness of less than 100 μm, preferably less than 10 μm.

2. The method of claim 1, in which the protective layer (14) is applied as a ceramic and/or DLC layer.

3. The method of claim 1 or 2, in which the protective layer (14) is applied by means of one or more of the following:
chemical vapor deposition (CVD), pulsed laser deposition, plasma-enhanced chemical vapor deposition (PECVD), sputtering, in particular magnetron or ion sputtering, laser plasma deposition, atomic layer deposition (ALD), molecular layer deposition (MLD), physically vapor deposition (PVD).

4. The method of one of the proceeding claims, in which the layer is applied as an oxide, such as Al_2O_3, AlSiOx, Ta_2O_5, AlOxNy and/or SiOx, a nitride, such as Si_3N_4, AlN, BN, AlOxNy and/or TiN, and/or a carbide, such as B_4C and/or SiC.

5. The method of one of the proceeding claims, in which the protective layer (14) is applied on a metal layer and/or an interlayer and/or the protective layer (14) is coated with a metallic and/or conductive layer.

6. A heater for an aerosol generating device having a protective layer (14) applied directly or indirectly on one or more heater tracks (13), such as resistively heated filaments, by a vacuum-deposition process, with a thickness of less than 100 μm, preferably less than 10 μm.

7. The heater of claim 6 in which the protective layer (14) comprises ceramic and/or DLC, in particular one or more of an oxide, such as Al2O3, AlSiOx, Ta2O5, AlOxNy and/or SiOx, a nitride, such as Si3N4, AlN, BN, AlOxNy and/or TiN, and/or a carbide, such as B4C and/or SiC.

8. The heater of claim 6 or 7, in which the protective layer (14) is present on a metal layer and/or an interlayer and/or the protective layer (14) is coated with a metallic and/or conductive layer.

9. The heater of one of claims 6 to 8, in which the protective layer (14) has a Mohs hardness of greater than 6 as determined by ASTM C 1895-20, preferably greater than 7, most preferred greater than 8.

10. The heater of one of claims 6 to 9, in which the protective layer (14) has a thermal conductivity of 1 to 2000 W/ (mK) .

11. The heater of one of claims 6 to 10, in which the heating area has a size of 20 mm2 or more.

12. The heater of one of claims 6 to 11, further comprising a substrate (12) with a thermal conductivity of 2 - 200 W/(mK), preferably less than 100, most preferred less than 10, preferably made of hydroxy-apatite.

13. An aerosol generating device having the heater of one of claims 6 to 12 and/or produced by the method of one of claims 1 to 5.

14. An aerosol generating system comprising an aerosol generating device according to claim 13 and at least one consumable article comprising an aerosol precursor material, the consumable article being preferably in the shape of a pod, card or stick and configured to generate an inhalable aerosol upon heating of the aerosol precursor material by the heater of the aerosol generating device.

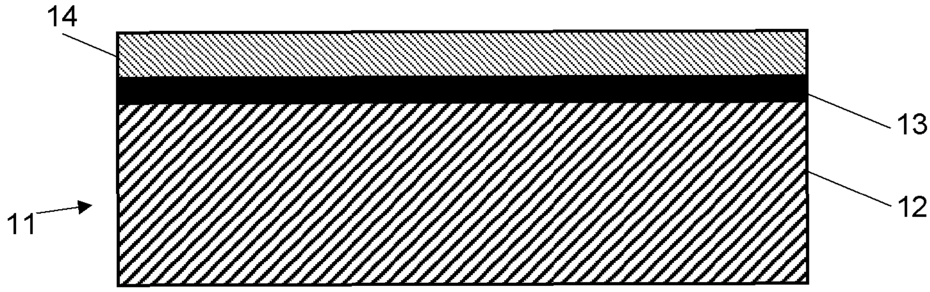

Fig. 1

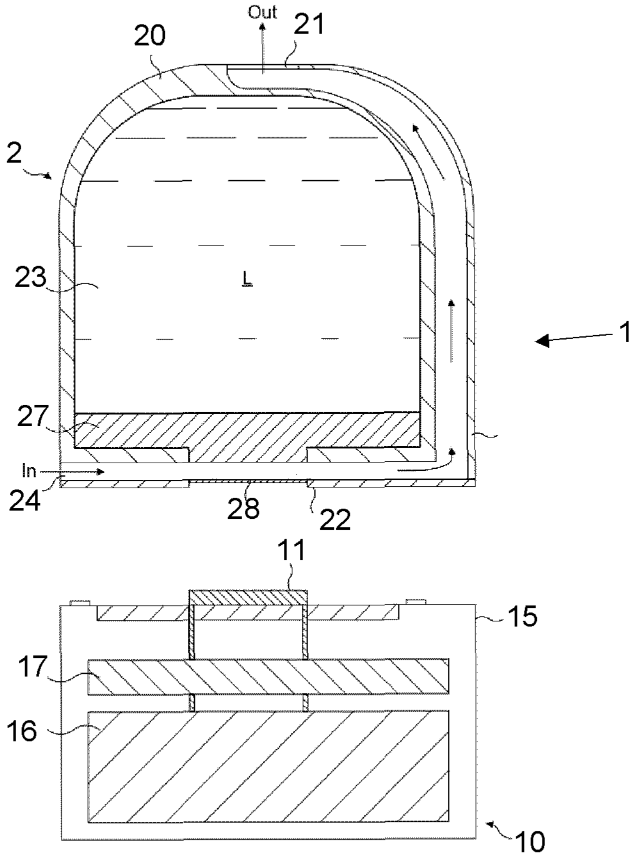

Fig. 2

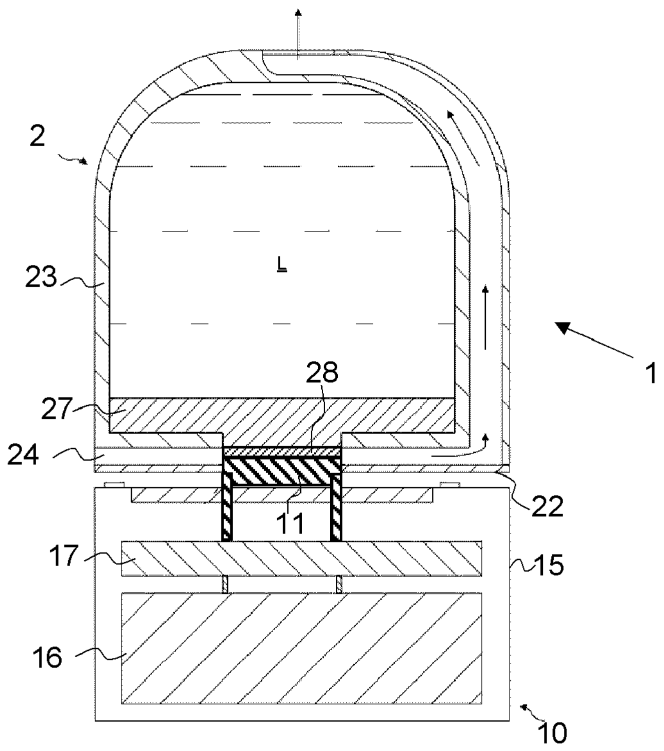

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 22 21 6477

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	1 June 2023	Chelbosu, Liviu

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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