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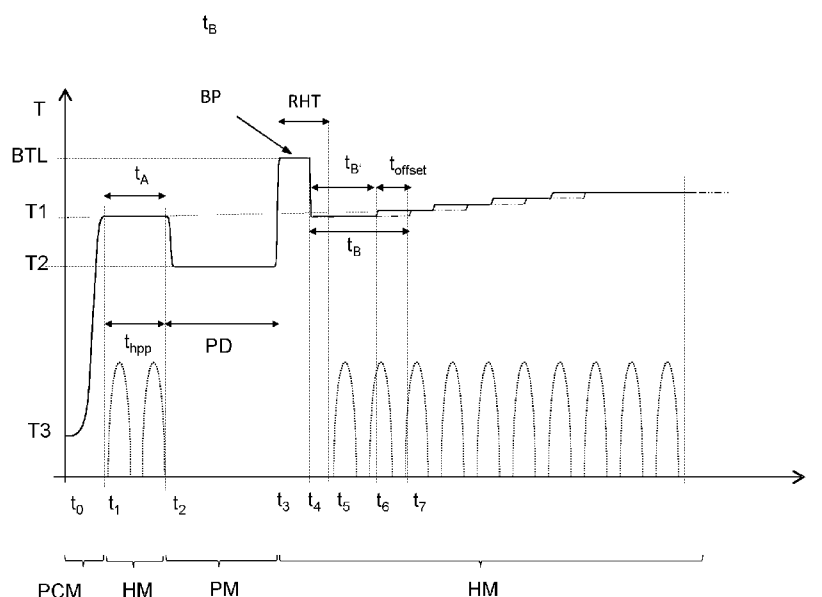


Fig. 2

(57) Abstract: The present disclosure related to an aerosol-generating device comprising a controller configured to control a heater for heating an aerosol-forming substrate in order to generate an aerosol. The controller is configured to selectively operate in a heating mode in which the controller controls the heater according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the controller controls the heater according to a pause mode temperature profile for pausing operation in the heating mode. The controller is further configured to adapt the pause mode temperature profile depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode.

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Aerosol-generating device operable in an aerosol-releasing mode and in a pause mode

The present disclosure relates to an aerosol-generating device and an aerosol-generating system for heating an aerosol-forming substrate that is capable to form an inhalable aerosol when heated. The disclosure further relates to a method of operating such an aerosol-generating device.

Aerosol-generating systems for generating an inhalable aerosol by heating an aerosol-forming substrate capable to form an aerosol when heated are generally known from prior art. Such systems comprise, on the one hand, the aerosol-forming substrate and, on the other hand, an aerosol-generating device enabling the substrate to be heated by means of a heater. For aerosol generation, the substrate is heated up to an operating temperature sufficient to allow volatile compounds to be released from the substrate. Once started, a user experience typically is continued without ceasing until the aerosol-forming substrate is depleted. Nevertheless, a user may wish to interrupt a user experience and to resume the experience at a later stage with the same article, preferably until fully depleting the substrate. However, a user experience – once having been interrupted – may be resumed only with degraded quality of the aerosol generated from the non-depleted substrate.

Therefore, it would be desirable to have an aerosol-generating device and a method of operating an aerosol-generating system with the advantages of prior art solutions, whilst mitigating their limitations. In particular, it would be desirable to have an aerosol-generating device and a method of operating an aerosol-generating system allowing a user to interrupt a user experience and to resume the experience at a later stage with still acceptable quality of the aerosol.

According to the present disclosure, there is provided an aerosol-generating device comprising a controller configured to control a heater for heating an aerosol-forming substrate in order to generate an aerosol. The controller is configured to selectively operate in a heating mode in which the controller controls the heater according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the controller controls the heater according to a pause mode temperature profile for pausing operation in the heating mode. The controller is further configured to adapt the pause mode temperature profile depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode.

As used herein, the "heating mode" refers to the actively used operation of the device, that is, when a user experience takes place, in particular when aerosol generation takes place. More particularly, in the heating mode, the aerosol-forming substrate may be heated to a temperature at or above the volatilization temperature of the aerosol-forming substrate, in particular the

volatilization temperature of aerosol-forming material included in the aerosol-forming substrate. In general, aerosol generation may take place continuously or on demand, in particular on a puff basis, that is, on demand of a user when taking a puff. Accordingly, in the heating mode, the aerosol-forming substrate may be heated continuously to generate aerosol. Likewise, in the heating mode, the heater may be powered continually to generate aerosol.

Vice versa, the "pause mode" refers to an operational mode in which a user experience is paused and aerosol generation does not take place, or at least is reduced to a lower or minimum level. That is, in the pause mode the aerosol-generating device is in a pause operation. In the pause mode, the aerosol-forming substrate may be heated continuously to not generate aerosol, or to generate a lower amount of aerosol than in the heating mode. Likewise, in the pause mode, the heater may be powered continually to not generate aerosol or to generate a lower amount of aerosol than in the heating mode. In particular, in the pause mode, the aerosol-forming substrate may be heated to a lower temperature than in the heating mode. That is, the heating mode temperature profile and the pause mode temperature profile may be chosen such that an operation temperature of the heater during operation in the pause mode is lower than during operation in the heating mode.

As used herein, a "temperature profile" may be defined as one or more target temperatures (or maximum temperatures) for the heater to be applied with respect to the duration of a user experience, number of puffs taken during a user experience and/or aerosol produced during a user experience. The target or maximum temperatures may be defined as a measured temperature of the heater, e.g., measured by a thermistor attached to or in proximity to the heater. The target or maximum temperatures may be defined as an electrical parameter indicative of the resistance, conductance, inductance or susceptance of the heater and/or a heating arrangement comprising the heater.

In addition to the heating mode and the pause mode, the controller may be configured to operate in a preparation mode in which the controller controls the heater according to a preparation mode temperature profile. The preparation mode temperature profile may comprise a pre-heating phase and/or a calibration phase. In the pre-heating phase, the controller may control the heater to heat up, thus enabling heat to spread within the substrate. The pre-heating phase may have a predetermined duration. In the pre-heating phase, the controller may control the heater to cause an increase of the operation temperature. In addition, the controller may be configured to monitor a temperature dependent property of the heater, i.e. a parameter indicative of an operation temperature of the heater, wherein the property has at least one characteristic feature at a specific temperature, for instance an extremal value, which may be used as a temperature reference. The controller may further be configured to interrupt the heat up of the heater when the monitored property reaches the characteristic feature, e.g. an extremal value,

wherein the monitored parameter at the characteristic feature (e.g. extremal value) corresponds to a predefined temperature of the heater. In the calibration phase, the controller may control the heater such that an operation temperature of the heater passes through one or more reference points at which the controller measures one or more calibration values of a temperature dependent property of the heater, i.e. one or more calibration values of a parameter that is indicative of an operation temperature of the heater. Based on the one or more calibration values, the controller may adjust the temperature of the heater. Operation in the preparation mode may be performed at the very beginning of a user experience, in particular prior to operation in the heating mode. It is also possible that operation in the preparation mode is performed during an ongoing user experience. In this case, the preparation mode may only include the calibration phase. For example, operation in the preparation mode (in particular when only including the calibration phase) may be performed periodically based on one or more of: a predetermined duration of time, a predetermined number of user puffs, a predetermined duration of operation in the heating mode, and a measured parameter associated with a power source of the aerosol-generating device. If operation in the preparation mode is performed during an ongoing user experience, operation in the heating mode or in the pause mode may be interrupted by operation in the preparation mode. WO 2023/2854458 A1 – the content of which is hereby incorporated entirely into the present specification by reference – describes such a calibration process for an inductively heating aerosol-generating system.

In order allow a user to interrupt a user experience and to resume the experience at a later stage with still acceptable quality of the aerosol, it was found advantageous to reduce the temperature during the pause mode to a certain level which is chosen such that it enables, on the one hand, to reduce depletion of the substrate during the pause mode as well as the overall energy consumption but, on the other hand, still enables to return to an operation in the heating mode within a reasonable time in order to resume a paused user experience. The temperature level of the pause mode temperature profile to which the temperature of the heater is lowered in response to initiating operation in the pause mode may in particular dependent on the substrate type.

To this extent, it has proven advantageous that a temperature level of the pause mode temperature profile to which the temperature of the heater is lowered in response to initiating operation in the pause mode may be less than 150 °C, in particular equal or less than 145 °C. Likewise, a temperature level of the pause mode temperature profile to which the temperature of the heater is lowered in response to initiating operation in the pause mode may be at most 145 °C, in particular at most 140 °C, more particularly at most 135 °C. For example, a temperature level of the pause mode temperature profile to which the temperature of the heater is lowered in response to initiating operation in the pause mode may be in a range between 100 °C and 145 °C,

in particular between 110 °C and 145°C or between 110 °C and 140 °C or between 120 °C and 145 °C or between 125 °C and 145 °C or between 125°C and 140 °C or between 125°C and 135 °C, preferably around 130 °C. Yet, the temperature level of the pause mode temperature profile may be also higher. Accordingly, it is also possible that the temperature level of the pause mode temperature profile to which the temperature of the heater is lowered in response to initiating operation in the pause is in a range between 100 °C and 250 °C, in particular between 110 °C and 225 °C or between 110 °C and 170 °C or between 120 °C and 170 °C or between 125 °C and 170 °C or between 130 °C and 150 °C, in particular 130 °C.

All aforementioned values and ranges are particularly applicable for aerosol-forming substrates containing no tobacco material, i.e. for non-tobacco aerosol-forming substrates. However, this does not exclude that the mentioned values are also applicable for any other substrate types. Examples of such non-tobacco aerosol-forming substrates are given further below. Non-tobacco substrates typically have a different chemical composition and physical behavior as compared to tobacco containing substrates, in particular a lower thermal stability and higher thermal mass.

A lower thermal stability generally requires lower temperatures, both during operation in the heating mode as well as during operation in the pause mode. Therefore, the pause mode temperature for substrates comprising no tobacco material may be generally lower than for aerosol-forming substrates containing tobacco material.

While tobacco containing aerosol-forming substrates typically may comprise a total aerosol-former content that is lower than 30 percent by weight, in particular lower than 25 percent by weight, preferably lower than 20 percent by weight, aerosol-forming substrates comprising no tobacco material, i.e. non-tobacco aerosol-forming substrates may comprise a total aerosol-former content that is greater than or equal 30 percent by weight, in particular greater than 35 percent by weight, more particularly greater than 40 percent by weight or greater than 45 percent by weight. Accordingly, the aforementioned values and ranges for the temperature level in the pause mode may be in general (i.e. irrespective of whether the substrate contains tobacco or not) particularly applicable for aerosol-forming substrates comprising a total aerosol-former content that is greater than or equal 30 percent by weight, in particular greater than 35 percent by weight, more particularly greater than 40 percent by weight or greater than 45 percent by weight.

Aerosol-forming substrates comprising no tobacco material may have a higher thermal mass as compared to tobacco containing substrates. One reason is that non-tobacco aerosol-forming substrates and tobacco containing aerosol-forming substrates may have different grammages and different thicknesses. Therefore, the aforementioned temperature values and ranges for the temperature level in the pause mode may be particularly applicable for aerosol-forming substrates having a higher thermal mass.

A higher thermal mass may require a larger surface of the heater used for heating the substrate. A larger surface of surface area of the heater in contact with the substrate also ensures a sufficient heat diffusion across the substrate in the article. To this extent it has been found that an appropriate surface area of a heater in contact with the substrate, in particular in case of a strip-like heater, should be greater than 50 square millimeters for non-tobacco aerosol-forming substrates, and below 50 square millimeters for tobacco containing aerosol-forming substrates. As a result, the aforementioned temperature values and ranges for the temperature level in the pause mode may be particularly applicable when using a heater that has a surface area in contact with the substrate greater than 50 square millimeters.

The aforementioned temperature values and ranges for the temperature level of the pause mode temperature profile may also be the result of a compromise between – on the one hand – a temperature level that is sufficiently low to reduce depletion of the substrate during the pause mode but still sufficiently high to increase the deliveries of the first puff after resumption of the user experience, and – on the other hand – a temperature level that is within a technically feasible regulation range of the controller. The latter may be determined by the physical properties of the heater, as will be discussed in more detail further below.

Vice versa, for example for aerosol-forming substrates containing tobacco material or a combination of tobacco material and other botanical material(s), the temperature level of the pause mode temperature profile to which the temperature of the heater is lowered in response to initiating operation in the pause mode may be higher, for instance in a range between 240 °C and 280 °C, in particular in a range between 250 °C and 270 °C, more particularly 260 °C. Examples of such tobacco-containing aerosol-forming substrates are also given further below. The aforementioned values may also be applicable for other substrate types. Following the above discussion for the lower temperature values and ranges, the aforementioned higher temperature values and ranges for the pause mode temperature may also be particularly applicable for aerosol-forming substrates having a lower thermal mass. Likewise, these higher temperature values and ranges may be particularly applicable for aerosol-forming substrates comprising a total aerosol-former content that is lower than 30 percent by weight, in particular lower than 25 percent by weight, preferably lower than 20 percent by weight (in particular irrespective of whether the substrate contains tobacco or not). Also, these higher temperature values and ranges may be particularly applicable when using a heater that has a surface area in contact with the substrate smaller than 50 square millimeters.

The temperature level of the pause mode temperature profile in said ranges may either be combined with any other aspect of the present invention disclosed herein, or may constitute an independent aspect of the present invention. According to this independent aspect, there is provided an aerosol-generating device comprising a controller configured to control a heater for

heating an aerosol-forming substrate in order to generate an aerosol. The controller is configured to selectively operate in a heating mode in which the controller controls the heater according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the controller controls the heater according to a pause mode temperature profile for pausing operation

5 in the heating mode, wherein the heating mode temperature profile and the pause mode temperature profile are chosen such that a temperature of the heater during operation in the pause mode is lower than during operation in the heating mode, and wherein a temperature level of the pause mode temperature profile to which the temperature of the heater is lowered in response to initiating operation in the pause mode is higher, for instance in a range between 240

10 °C and 280 °C, in particular in a range between 250 °C and 270 °C, more particularly 260 °C; or is less than 150 °C, in particular equal or less than 145 °C; or is at most 145 °C, in particular at most 140 °C, more particularly at most 135 °C; or is in a range between 100 °C and 145 °C, in particular between 110 °C and 145 °C or between 110 °C and 140 °C or between 120 °C and 145 °C or between 125 °C and 145 °C or between 125 °C and 140 °C or between 125 °C and

15 135 °C, preferably around 130 °C; or is in a range between 100 °C and 250 °C, in particular between 110 °C and 225 °C or between 110 °C and 170 °C or between 120 °C and 170 °C or between 125 °C and 170 °C or between 130 °C and 150 °C, in particular 130 °C.

Whether in combination in with any other aspect of the present invention or as an independent aspect of the present invention, the temperature level of the pause mode

20 temperature profile in said ranges may in particular be an initial temperature level of the pause mode temperature profile to which the temperature of the heater is initially lowered in response to initiating operation in the pause mode.

The absolute temperature of the heater during operation in the heating mode is higher than during operation in the pause and may also dependent on the substrate type, in particular on its

25 constituents, the thermal stability of the substrate, the total aerosol-former content, and/or the thermal mass of the substrate; and/or the surface area of the heater in contact with the substrate.

For example, the temperature of the heater during operation in the heating mode (except for a possible operation in a temperature boost phase – see below) may be in a range between 200 °C and 300 °C, in particular between 220 °C and 280 °C, more particularly between 250 °C

30 and 260 °C, preferably around 255 °C. These values have proven particularly advantageous for aerosol-forming substrates containing no tobacco material, i.e. for non-tobacco aerosol-forming substrates, and/or for aerosol-forming substrates having a higher thermal mass, and/or for aerosol-forming substrates comprising a total aerosol-former content that is greater than or equal 30 percent by weight, in particular greater than 35 percent by weight, more particularly greater

35 than 40 percent by weight or greater than 45 percent by weight, and/or when using a heater that has a surface area in contact with the substrate greater than 50 square millimeters.

For aerosol-forming substrates comprising tobacco material or a combination of tobacco material and other botanical material(s), and/or for aerosol-forming substrates comprising a total aerosol-former content that is lower than 30 percent by weight, in particular lower than 25 percent by weight, preferably lower than 20 percent by weight, and/or for aerosol-forming substrates having a lower thermal mass, and/or when using a heater that has a surface area in contact with the substrate smaller than 50 square millimeters, the temperature of the heater during operation in operation in the heating mode (except for a possible operation in a temperature boost phase – see below), may be in a range between 300 °C and 400 °C, in particular between 320 °C and 380 °C, more particularly between 340 °C and 380 °C.

All values mentioned before may refer to a temperature of the heater as measured at a single point on a surface of the heater, or as measured at and averaged over a plurality of points on a surface of the heater. For example, all values mentioned before may refer to a temperature of the heater as measured at a geometrical center point of a main surface of the heater or as averaged along a geometrical center line on a main surface of the heater.

In terms of a temperature difference, the temperature level of the pause mode temperature profile to which the temperature of the heater is lowered upon initiating operation in the pause mode may be at least 20 °C, at least 50 °C, at least 100°C, at least 120°C, at least 125 °C or at least 130 °C (preferably around 125 °C or 130 °C) lower than a temperature of level of the heating mode temperature profile, in particular a temperature of level of the heating mode temperature profile before, more particularly immediately before initiating operation in the pause mode.

The controller may be configured to identify a substrate type that is received in the device for heating. For this, the controller may be configured to identify a type of an aerosol-generating article containing the aerosol-forming substrate to be heated based on an identification means attached to the article or a physical property associated with the article. For example, as described in WO 2022/069582 A1 with respect to an inductively heating aerosol-generating device, the controller may be configured to identify an article type of the aerosol-generating article received by the device based on a specific property that is associated with a susceptor arrangement disposed in the article to heat the substrate, wherein the specific property may be different for different articles containing different types of substrate and accordingly different types of susceptor arrangements. The content of WO 2022/069582 A1 is hereby incorporated entirely into the present specification by reference. Thus, based on the properties of the respective susceptor arrangement used for a specific substrate type, the controller may be able to differentiate between different substrate types, for instance, between aerosol-forming substrates containing no tobacco material and aerosol-forming substrates containing tobacco material or a combination of tobacco material and other botanical material(s).

The controller may be further configured to select a respective pause mode temperature profile and/or heating mode temperature profile associated with a specific substrate type based on the identified substrate type.

As mentioned before with respect to the calibration phase, the controller may control the temperature of the heater based on one or more calibration/reference values of a temperature dependent property of the heater, each of which is given by a characteristic feature of the property, such as an extremal value, at a respective specific temperature. For example, as described in WO 2023/285458 A1 with respect to an inductively heating aerosol-generating system, the temperature dependent property of the heater may be the apparent resistance or the apparent conductance of a susceptor that is used as a heater for heating an aerosol-forming substrate by interaction with a varying magnetic field generated by an aerosol-generating device. There, the susceptor comprises a first and a second susceptor material, wherein the second susceptor material comprises a Curie temperature chosen such as to be close to a desired heating temperature. This susceptor shows a strictly monotonic relationship between its apparent resistance/conductance and its temperature occurring between a first characteristic feature at a first specific temperature and a second characteristic feature at a second specific temperature, both serving as calibration/reference value. The first specific temperature is lower than the second specific temperature. The first specific temperature corresponds to a temperature greater than or equal to the temperature of the susceptor at which the skin depth of the second susceptor material begins to increase, leading to a temporary lowering of the conductance, which causes a first extremal value, here a minimum in the conductance (valley). The second specific temperature is the Curie temperature of the second susceptor material that is associated with a second extremal value, in particular a maximum in the conductance (hill). Further details are described in WO 2023/285458 A1, the content of which is hereby incorporated entirely into the present specification by reference. For controlling the temperature during operation in the heating mode, in particular in a feedback loop, the controller may be configured to monitor the conductance and regulate the power provided to the susceptor such that the conductance is at a specific value between the minimum (valley) and the maximum (hill), where the conductance is a strictly monotonic function of the temperature.

As generalization of the example described before, the controller according to the present invention may be configured to control the temperature of the heater based on monitoring a temperature dependent property of the heater. The property may have at least a first characteristic feature at a first specific temperature, for instance a first extremal value, used as a first temperature reference. Preferably, the property further has at least a second characteristic feature at a second specific temperature, for instance a second extremal value, used as a second temperature reference. For controlling the temperature during operation in the heating mode, in

particular in a feedback loop, the controller may be configured to monitor the property of the heater and regulate the power provided to the heater such that the property is at a specific value between the first characteristic feature, e.g. the first extremal value, and the second characteristic feature, e.g. the second extremal value. Accordingly, the heating mode temperature profile preferably includes, in particular exclusively includes, temperature values between the first specific temperature and the second specific temperature. Vice versa, the temperature level of the pause mode temperature profile to which the temperature of the heater is lowered upon initiating operation in the pause mode preferably may be below the first specific temperature, at a temperature where depletion of the substrate is sufficiently reduced.

Again with reference to the example described before, the specific value for the temperature regulation during the heating mode should be chosen such that it is sufficiently distanced from the minimum (valley) and the maximum (hill) in order to ensure appropriate regulation. The same issue applies to the specific value for regulation at lower temperatures during the pause mode, in particular at temperatures below the minimum. Hence, with reference to the present invention, the temperature level of the pause mode temperature profile to which the temperature of the heater is lowered in response to initiating the operation in the pause mode preferably is chosen such that it is as high as possible in order to resume to the paused user experience within a reasonable time, but still sufficiently distanced from the first specific temperature to ensure appropriate regulation. Advantageously, the temperature level of the pause mode temperature profile to which the temperature of the heater is lowered upon initiating operation in the pause mode may be at least 20 °C, at least 50 °C, at least 100 °C, at least 120 °C, at least 125 °C or at least 130 °C (preferably around 125 °C or 130 °C) below the first specific temperature.

According to the present invention, it was found that the temperature profile used during the pause mode is of significant importance, on the one hand, to avoid or minimize depletion of the substrate during the pause mode and, on the other hand, to ensure an optimal user experience when operation in the heating mode is resumed. A proper choice of the temperature profile used during the pause mode, in particular a low temperature during the pause mode, may also help to minimize the overall energy consumption of the device. In this regard, it was further found that – again preferably depending on the substrate type – the temperature profile used during the pause mode advantageously may be either fixed or, alternatively, not fixed but adaptable. The choice to adapt or not adapt the pause mode temperature profile may be also depend on the thermal stability of the substrate, the total aerosol-former content, the grammage of the substrate, the surface area of the heater in contact with the substrate, a desired aerosol intensity of the first puff after operation in the pause mode, and/or the availability of a technically feasible regulation range of the controller.

In particular, for aerosol-forming substrates containing tobacco material or a combination of tobacco material and other botanical material(s), and/or for aerosol-forming substrates comprising a total aerosol-former content that is lower than 30 percent by weight, in particular lower than 25 percent by weight, preferably lower than 20 percent by weight, and/or for aerosol-forming substrates having a lower thermal mass, and/or when using a heater that has a surface area in contact with the substrate smaller than 50 square millimeters, the present invention suggests that the temperature profile used during the pause mode advantageously is not fixed but adaptable, in particular adaptable depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode. That is, the pause mode temperature profile may be dynamically adjusted depending on the stage of the user experience at which the pause mode was launched and/or the duration of operation in the pause mode.

For this, the controller may be configured to determine and/or record the operation history during operation in the heating mode prior to operation in the pause mode. Likewise, the controller may be configured to determine and/or record the duration of operation in the pause mode.

As used herein, the term "operation history during operation in the heating mode prior to operation in the pause mode" relates to the prior course of operation in the heating mode prior to operation in the pause mode. The operation history may include one or more parameters characterizing the operation of the aerosol-generating device until the pause mode is launched. In particular, the operation history may include at least one of the following parameters: a number of puffs during operation in the heating mode prior to operation in the pause mode, and a time period of operation in the heating mode prior to operation in the pause mode. In addition or alternatively, the operation history may include one or more other parameters, such as an interval between puffs (for example individual, average, cumulative), a puff strength (e.g. individual, average, cumulative), an amount of aerosol generated, an amount of power/energy delivered to the heater, or a type of aerosol-forming substrate or type of aerosol-generating article being used with the aerosol-generating device. For example, the controller may be configured to detect a puff and thus to determine the number of puffs by detecting a change of power/energy delivered to the heater that is indicative of the occurrence of a user's puff. Accordingly, the controller may be configured to detect a change of power/energy delivered to the heater that is indicative of the occurrence of a user's puff.

In general, it was found that the temperature profile used during the pause mode should be a compromise between, on the one hand, reducing the overall energy consumption and depletion of the substrate during the pause mode and, on the other hand, an optimal first user experience when operation in the heating mode is resumed. While the first two aspects can be achieved by reducing the temperature during the pause mode, the latter aspect requires that the temperature

during the pause mode be high enough to return to temperatures at or above the volatilization temperature of the aerosol forming substrate within a reasonable time to meet user requirements.

In order to avoid or minimize depletion of the substrate during the pause mode, the controller may be configured to adapt the pause mode temperature profile such that an operation
5 temperature of the heater is progressively decreased as the duration of operation in the pause mode progresses. As mentioned, this may be particularly advantageous when the substrate comprises tobacco material or a combination of tobacco material and other botanical material(s), and/or for aerosol-forming substrates comprising a total aerosol-former content that is lower than
10 30 percent by weight, in particular lower than 25 percent by weight, preferably lower than 20 percent by weight, and/or for aerosol-forming substrates having a lower thermal mass, and/or when using a heater that has a surface area in contact with the substrate smaller than 50 square millimeters.

Advantageously, the progression of the decrease of the operation temperature of the heater is not fixed, but also adaptable in due consideration of the operation history during operation in
15 the heating mode prior to operation in the pause mode. Accordingly, the controller may be configured to adapt the pause mode temperature profile such that a progression of a decrease of the operation temperature of the heater is adapted depending on the operation history during operation in the heating mode prior to operation in the pause mode. In this respect, it has proven advantageous that the more puffs already taken during operation in the heating mode prior to
20 operation in the pause mode, the more the decrease of the temperature during operation of the pause mode can be retarded. The same applies to the time period of operation in the heating mode prior to operation in the pause mode. Therefore, the controller advantageously may be configured to adapt the pause mode temperature profile such that a decrease of the operation temperature of the heater is less progressive with an increasing number of puffs during operation
25 in the heating mode prior to operation in the pause mode and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode.

Preferably, the controller is configured to adapt the pause mode temperature profile such that an operation temperature of the heater is decreased in successive temperature steps as the duration of operation in the pause mode progresses. Advantageously, successive temperature
30 steps are technically easy to implement and allow the temperature of the aerosol-forming substrate to follow the pause mode temperature profile.

During the decrease a decrement of the operation temperature of the heater between successive temperature steps may be in a range between 2 °C and 25 °C, in particular between 5 °C and 20 °C, more particularly between 7 °C and 15 °C, for example 10 °C. Decrements in
35 these ranges have proven advantageous to avoid or minimize depletion of the substrate during the pause mode.

A respective time period of the successive temperature steps during the decrease may be in a range between 1 minute and 6 minutes, in particular between 2 minutes and 3 minutes.

The respective time period of the successive temperature steps may depend – inter alia – on the number of sequence of a respective temperature step. In general, the longer the pause mode has been active, the longer the respective time period of a temperature step can be. In particular, the respective time period of the successive temperature steps during the decrease may increase from temperature step to temperature step. Increasing the time period from temperature step to temperature step effectively makes the decrease of the operation temperature of the heater less progressive, which facilitates resumption of the user experience within a reasonable time.

The respective time period of the successive temperature steps may also depend on the operation history during operation in the heating mode prior to operation in the pause mode. Accordingly, the controller may be configured to adapt a respective time period of the successive temperature steps depending on the operation history during operation in the heating mode prior to operation in the pause mode. In particular, the controller may be configured to adapt a respective time period of the successive temperature steps such that a respective time period of the successive temperature steps is/gets longer with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode. In this regard, it was found that the temperature decrease can be made less progressive in favor of a faster resumption of the user experience, the further the user experience has progressed prior to pausing it. This is because more and more aerosol-forming substrate is depleted as the user experience progress. The more of the aerosol-forming substrate has already been used up, the less need to avoid or minimize depletion of the non-depleted substrate. Accordingly, for larger numbers of puffs during operation in the heating mode prior to operation in the pause mode, for example greater than 3, the pause mode temperature profile may comprise only two or even a single temperature step.

The pause mode temperature profile may be such that the decrease of the operation temperature of the heater is continued until the end of operation in the pause mode, (unless - due to the operation history - the progression of the decrease is not retarded to such an extent that hardly or no decrease of the operation temperature of the heater takes place during operation in the heating mode).

Alternatively, the pause mode temperature profile may be such that the decrease of the operation temperature of the heater stops after a pre-defined time of operation in the pause mode, in particular a pre-defined decrease time period, and/or a predefined number of temperature steps, and that subsequently the operation temperature of the heater is kept constant until the

end of operation in the pause mode. The pre-defined time of operation in the pause mode, in particular the pre-defined decrease time period, and/or the predefined number of temperature steps may depend on the operation history during operation in the heating mode prior to operation in the pause mode, in particular on the number of puffs during operation in the heating mode prior to operation in the pause mode and/or the time period of operation in the heating mode prior to operation in the pause mode. Accordingly, the controller may be configured to adapt the pre-defined time of operation in the pause mode, in particular the pre-defined decrease time period, and/or the predefined number of temperature steps depending on the operation history during operation in the heating mode prior to operation in the pause mode.

According to another alternative, the pause mode temperature profile may be such that after decreasing the operation temperature over a pre-defined decrease time period an operation temperature of the heater is progressively increased as the duration of operation in the pause mode further progresses. In this regard, it was found that maintaining the aerosol-forming substrate at a low temperature for a prolonged time period in the pause mode may risk to negatively affect the quality of the first puff after resumption of the user experience. Increasing the operation temperature again after a certain time period of decrease can help to prepare the aerosol-forming substrate in advance such as to be ready again for aerosol generation in suitable time. Accordingly, the controller may be configured to adapt the pause mode temperature profile such that after decreasing the operation temperature over a pre-defined decrease time period an operation temperature of the heater is progressively increased as the duration of operation in the pause mode further progresses.

The decrease time period may be fixed. Alternatively, as already mentioned above with respect to the other alternative, the decrease time period may depend on the operation history during operation in the heating mode prior to operation in the pause mode, in particular on the number of puffs during operation in the heating mode prior to operation in the pause mode and/or the time period of operation in the heating mode prior to operation in the pause mode. Again, the further the user experience has progressed prior to pausing it, the less attention needs to be paid to avoid or minimize depletion of the non-depleted substrate, and the more focus can be placed on getting the substrate ready to resume the user experience more quickly. In general, the further the user experience has progressed prior to pausing it, in particular the greater the number of puffs during operation in the heating mode prior to operation in the pause mode and/or the longer the time period of operation in the heating mode prior to operation in the pause mode, the shorter the decrease time period can be. Accordingly, the controller may be configured to adapt the decrease time period depending on the operation history during operation in the heating mode prior to operation in the pause mode. Advantageously, the decrease time period may be in a range, in particular may be adapted/adaptable in a range between range between 15 seconds

and 6 minutes, in particular 3 minutes and 6 minutes, more particularly between 3.5 minutes and 4 minutes.

Like the decrease, the progression of the (re-)increase of the operation temperature of the heater may depend on the operation history during operation in the heating mode prior to operation in the pause mode. In particular, the increase of the operation temperature of the heater may be less progressive with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode. Therefore, the controller may be configured to adapt the pause mode temperature profile such that a progression of an increase of the operation temperature of the heater is adapted depending on the operation history during operation in the heating mode prior to operation in the pause mode. In particular, the controller may be configured to adapt the pause mode temperature profile such that an increase of the operation temperature of the heater is less progressive with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode.

Like the step-wise decrease, the increase of the operation temperature may be step-wise, too. Accordingly, the controller may be configured to adapt the pause mode temperature profile such that after decreasing the operation temperature over a pre-defined decrease time period an operation temperature of the heater is increased in successive temperature steps as the duration of operation in the pause mode progresses.

During the increase, an increment of the operation temperature of the heater between successive temperature steps may be in a range between 2 °C and 25 °C, in particular between 5 °C and 20 °C, more particularly between 7 °C and 15 °C, for example 10 °C. Increments in these ranges have proven advantageous to adequately prepare the aerosol-forming substrate such as to ensure proper quality of the first puff after resumption of the user experience.

Like the time period of the decreasing steps, a respective time period of the successive temperature steps during the increase may be either fixed or adaptable, in particular adaptable depending on the operation history during operation in the heating mode prior to operation in the pause mode. Accordingly, the controller may be configured to adapt a respective time period of the successive temperature steps during the increase depending on the operation history during operation in the heating mode prior to operation in the pause mode, especially on the number of puffs during operation in the heating mode prior to operation in the pause mode and/or the time period of operation in the heating mode prior to operation in the pause mode. In particular, the controller may be configured to adapt a respective time period of the successive temperature steps during the increase such that a respective time period of the successive temperature steps during the increase gets longer with an increasing number of puffs during operation in the heating

mode prior to operation in the pause mode and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode.

The respective time period of the successive temperature steps during the increase may depend – inter alia – on the number of sequence of a respective temperature step. Preferably, a
5 respective time period of the successive temperature steps may increase from temperature step to temperature step. Thus, the increase is less progressive in order to avoid unwanted depletion of the substrate due to a too rapid temperature rise. In general, the longer the pause mode has been active, the longer the respective time period of a temperature step during the increase can be. The respective time period of the successive temperature steps during the increase may be
10 or may be adaptable in a range between 15 seconds to 6 minutes, in particular 1 minute and 6 minutes. These values have been proven beneficial for a proper resumption of a user experience.

As mentioned, the idea of adapting the pause mode temperature profile depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode may be particularly advantageous for aerosol-
15 forming substrates containing tobacco material or a combination of tobacco material and other botanical material(s), and/or for aerosol-forming substrates comprising a total aerosol-former content that is lower than 30 percent by weight, in particular lower than 25 percent by weight, preferably lower than 20 percent by weight, and/or for aerosol-forming substrates having a lower thermal mass, and/or when using a heater that has a surface area in contact with the substrate
20 smaller than 50 square millimeters

For other substrate types, for aerosol-forming substrates containing no tobacco material, i.e. for non-tobacco aerosol-forming substrates, and/or for aerosol-forming substrates having a higher thermal mass, and/or for aerosol-forming substrates comprising a total aerosol-former content that is greater than or equal 30 percent by weight, in particular greater than 35 percent
25 by weight, more particularly greater than 40 percent by weight or greater than 45 percent by weight; and/or when using a heater that has a surface area in contact with the substrate greater than 50 square millimeters, it may be advantageous to keep the temperature profile used during the pause mode fixed, i.e. to keep the temperature of the heater during operation in the pause mode constant at the temperature level of the pause mode temperature profile to which the
30 temperature of the heater is lowered upon initiating operation in the pause mode. However, the temperature of the heater during operation in the pause mode may also be kept constant when using any other substrate type or heater. In addition, the temperature of the heater during operation in the pause mode may also be kept constant if there is no technically feasible regulation range of the controller in the lower pause mode temperature regime that would allow a
35 reasonable adaption of the pause mode temperature profile. Thus, keeping the temperature of the heater during operation in the pause mode constant offers a simpler mechanism for

temperature regulation. Accordingly, where there is no adaption to take place, the controller may be configured such that the temperature of the heater during operation in the pause mode is kept constant at the temperature level of the pause mode temperature profile to which the temperature of the heater is lowered upon initiating operation in the pause mode. In particular, the pause mode temperature profile, in particular the temperature level of the pause mode temperature profile to which the temperature of the heater is lowered upon initiating operation in the pause mode may be independent from an operation history during operation in the heating mode prior to operation in the pause mode and/or independent from a duration of operation in the pause mode.

Furthermore, it was found that it may be more advantageous in favor a proper first puff after resumption of a user experience that the operation temperature during operation in the pause mode is not changed, but kept constant, if the pause mode is initiated at an advanced stage of the user experience, i.e. when the aerosol-forming substrate has already been at least partially or mostly depleted. Hence, the controller may be configured to adapt the pause mode temperature profile such that an operation temperature of the heater is kept constant depending on the operation history, for instance, if the number of puffs during operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold number and/or if the time period of operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold time. The pre-defined threshold number of puffs may be in a range between 4 and 8, for instance 6. The pre-defined threshold time of operation in the heating mode prior to operation in the pause mode may be in a range between 2 minutes and 8 minutes, in particular 3 minutes and 4 minutes, for instance 3.5 minutes.

As defined further above, the heating mode refers to an operational mode in which a user experience is paused and aerosol generation does not take place, or at least is reduced to a lower or minimum level. That is, in the pause mode the aerosol-generating device is in pause operation. In particular, in the pause mode, the aerosol-forming substrate may be heated to a lower temperature than in the heating mode. Hence, the heating mode temperature profile and the pause mode temperature profile may generally be chosen such that an operation temperature of the heater during operation in the pause mode is lower than during operation in the heating mode. This may also apply to the case where the operation temperature of the heater is kept constant depending on the operation history, in particular if the pause mode is initiated at an advanced stage of the user experience. That is, the constant operation temperature of the heater pause mode temperature profile preferably is lower than an operation temperature during operation in the heating mode immediately prior to pausing it.

For a single user experience and/or for a single operation pause, operation in the pause mode may have a defined total duration, which may be referred to as a defined maximum total duration. The defined total duration of operation in the pause mode may be in a range between 1

minute and 15 minutes, in particular between 2 minutes and 10 minutes, preferably between 6 minutes and 9 minutes, for example 8 minutes. The defined total duration may be fixed, e.g., at a fixed duration in the range between 1 minute and 15 minutes, in particular between 2 minutes and 10 minutes, preferably between 6 minutes and 9 minutes, for example 8 minutes, irrespective of the operation history of the device prior to initiating a pause. Preferably, the defined total duration may be fixed at around 8 minutes.

The defined total duration of operation in the pause mode may be predefined before the start of operation in the heating mode and/or may depend on the operation history during operation in the heating mode prior to operation in the pause mode. Accordingly, the controller may be configured to adapt the total duration of operation in the pause mode depending on the operation history during operation in the heating mode prior to operation in the pause mode. For example, the controller may be configured to adapt the total duration of operation in the pause mode such that the total duration of operation in the pause is shorter, the greater the number of puffs during operation in the heating mode prior to operation in the pause mode and/or the longer the time period of operation in the heating mode prior to operation in the pause mode.

The controller may be configured to resume operation in the heating mode after operation in the pause mode is ended, for instance after the defined total duration has elapsed.

The controller may be configured to cease providing power to the heater after operation in the pause mode is ended, for instance after the defined total duration of operation in the pause mode has elapsed.

The aerosol-generating device may further comprise an indicator. The indicator may comprise at least one of a visual indicator, for example a display or a light signal, such as, one or more LEDs, a haptic indicator (haptic output unit), an audio indicator (audio output unit), and an audiovisual indicator. The indicator may be operatively coupled to the controller. Furthermore, the controller may be configured to indicate to a user, via the indicator, a remaining time before operation in the pause mode is ended.

Operation in the pause mode may be user-terminable. That is, the user may be able to determine the end of the pause mode and to initiate the resumption of the heating mode to continue the user experience. The same applies may apply for initiating the pause mode. That is, operation in the pause mode may be user-initiable.

For this, the aerosol-generating device may comprise a user interface operatively coupled with the controller enabling a user to initiate and/or resume and/or terminate operation in the pause mode. In addition or alternatively, the user interface be configured to enable a user to initiate and/or terminate and/or resume operation in the heating mode.

The user interface may comprise a user switch or a user button enabling a user of the device to initiate and/or terminate operation in the pause mode, and/or to initiate and/or resume and/or

terminate operation in the heating mode. For the same purpose, the user interface may comprise a touch screen.

The aerosol-generating device may comprise at least one sensor configured to output a sensor signal indicative of the device being in operation by a user or in an operation pause.

Advantageously, such a sensor may facilitate to automatically detect whether operation of the controller can be switched into the pause mode since the device is currently not in use, but in an operation pause. Thus, aerosol generation may be stopped in a timely manner in order to avoid an ongoing but undesired depletion of the aerosol-forming substrate. Likewise, such a sensor may facilitate to automatically detect whether aerosol generation, in particular the heating mode is to be started or resumed.

The at least one sensor may comprise at least one of a puff sensor for detecting a user's puff, a motion sensor for detecting a movement of the device, and an orientation sensor for detecting an orientation of the device. A puff sensor advantageously allows for detecting whether a user intends to start or resume a user experience, that is, aerosol generation. A motion sensor advantageously may enable to monitor the device for movements and thus, for example, to detect a user handling the device. That is, if the motion sensor detects any movements of the aerosol-generating device, this may indicate that a user is holding the device and therefore that a user probably is currently having a user experience or about to start or resume a user experience. For example, the motion sensor may detect movements of the aerosol-generating device when the device is picked up again after lying on a table. If no movements are detected, this typically means that the aerosol-generating device is in an idle phase. This might be the case, when the aerosol-generating device is placed in a power charging unit or is lying idle on a table. Consequently, operation may be switched into the pause mode in order to avoid degradation of the non-depleted substrate. As an example, the motion sensor may comprise at least one of an accelerometer for measuring accelerations or a gyroscope for measuring an angular orientation or an angular velocity of the device. That is, the motion sensor may be configured to detect at least one of accelerations, an angular orientation and or an angular velocity of the aerosol-generating device, in particular due to a user handling the device. Likewise, an orientation sensor may be used for detecting an orientation of the device which in turn may be indicative for a specific situation. For example, a horizontal orientation of the device (for example, with respect to a length axis of the aerosol-generating device) may be indicative of the device lying idle on a table. Likewise, a vertical orientation of the device or an orientation of the device between a vertical orientation and a horizontal orientation may be indicative of the device being in use during a user experience.

It is possible that the aerosol-generating device comprises a single sensor or a plurality of sensors, in particular a plurality of sensors of different types. A plurality of sensors may be provided, for example, for reasons of redundancy. Using a plurality of sensors of different types

may also facilitate to detect different situations. In particular, the device may comprise at least one sensor configured to output a sensor signal indicative of the device being in operation by a user, and at least one other sensor configured to output a sensor signal indicative of the device being in an operation pause.

5 In order to resume a paused user experience with acceptable quality of the aerosol, it may be essential to suitably prepare the aerosol-forming substrate for optimizing the deliveries with respect to the first puff after the pause. For this, it may be advantageous to provide an energy boost to the heater when the user experience is about to be resumed. Accordingly, it is proposed that in response to termination of operation in the pause mode, the controller may be configured
10 to control the heater to resume operation in the heating mode starting with a temperature boost phase. Preferably, the boost phase is designed such that a temperature of the heater during operation in the temperature boost phase is higher than an initial temperature level at the beginning of the heating mode temperature profile, more particularly an initial temperature level at the beginning of the heating mode temperature profile subsequent to a possible operation in a preparation mode as described further above; and/or than a temperature level in the heating mode
15 before activation of the pause mode. In doing so, it is achieved that the first puff after resuming the paused user experience is as high as possible in terms of aerosol delivery, preferably almost as high as or even as high as the first puff at the beginning of the user experience. This is an important aspect in order to satisfy the user who wants to promptly experience a proper puff as soon as the paused user experience is resumed. The boost phase follows termination of
20 operation in the pause mode, i.e. is not part of the pause mode temperature profile, but may rather form part of the heating mode temperature profile, more particularly an initial part of the heating mode temperature profile after termination of operation in the pause mode when operation in the heating mode is resumed.

25 The idea of the temperature boost phase may either be combined with any other aspect of the present invention disclosed herein, or may constitute an independent aspect of the present invention. According to this independent aspect, there is provided an aerosol-generating device comprising a controller configured to control a heater for heating an aerosol-forming substrate in order to generate an aerosol. The controller is configured to selectively operate in a heating mode
30 in which the controller controls the heater according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the controller controls the heater according to a pause mode temperature profile for pausing operation in the heating mode. In response to termination of operation in the pause mode, the controller is configured to control the heater to resume operation in the heating mode starting with a temperature boost phase. The boost phase
35 is designed such that a temperature of the heater during operation in the temperature boost phase is higher than an initial temperature level at the beginning of the heating mode temperature profile,

more particularly an initial temperature level at the beginning of the heating mode temperature profile subsequent to a possible operation in a preparation mode as described further above; and/or higher than a temperature level in the heating mode before activation of the pause mode.

The following advantageous details and features relate to the temperature boost phase either in combination with any other aspect of the present invention disclosed herein, or as independent aspect of the present invention.

In order to achieve a satisfying first puff when resuming the user experience, it has proven beneficial that a temperature of the heater during operation in the temperature boost phase preferably is higher by at least 10 °C, in particular by at least 30 °C, more particularly by at least 40 °C, especially by at least 50 °C, than an initial temperature level at the beginning of the heating mode temperature profile, more particularly an initial temperature level at the beginning of the heating mode temperature profile subsequent to a possible operation in a preparation mode; and/or than a temperature level in the heating mode before activation of the pause mode.

For the same purpose, it is also preferred that a temperature of the heater during operation in the temperature boost phase preferably is higher than during operation in the heating mode immediately before operation in the pause mode. Advantageously, a temperature of the heater during operation in the temperature boost phase may be higher by at least 10 °C, in particular by at least 30 °C, more particularly by at least 40 °C, especially by at least 50 °C, than during operation in the heating mode immediately before operation in the pause mode.

The temperature boost phase primarily may be used to provide a proper first puff after resumption of the user experience, and thus can be followed by operation at lower temperatures. Continuing at a lower temperature after the temperature boost phase may help to avoid excessive depletion of the substrate and to reduce energy consumption. Accordingly, the temperature during operation in the temperature boost phase preferable may be higher than during subsequent operation in the heating mode after the temperature boost phase; or vice versa, the temperature during subsequent operation in the heating mode immediately after the temperature boost phase may be lower than during operation in the temperature boost phase. Preferably, a temperature of the heater during operation in the temperature boost phase is higher by at least 10 °C, in particular by at least 30 °C, more particularly by at least 40 °C, especially by at least 50 °C, than during subsequent operation in the heating mode immediately after the temperature boost phase. In another example, the temperature of the heater during operation in the temperature boost phase is substantially the same as the temperature in the subsequent operation in the heating mode immediately after the temperature boost phase.

It is also possible that the temperature during operation in the temperature boost phase is equal to the temperature during subsequent operation in the heating mode immediately after the temperature boost phase, in particular immediately after the temperature boost phase. This may

be the case for long durations of operation in the pause mode and/or for user experiences being paused at a late stage in the heating mode temperature profile, where immediately before the pause the temperature level may already be increased, especially to the maximum possible, as compared to the initial temperature level at the beginning of the heating mode temperature profile.

5 In general, the temperature boost phase has a finite length in terms of time, that is a finite duration. Although being finite, the duration of the temperature boost phase may be adaptable. In this regard, it was found that the adaptability of the duration of the temperature boost phase may have a significant impact on the aerosol quality of the resumed user experience. Preferably, the duration of the temperature boost phase may be adaptable depending on an operation history
10 during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode. Accordingly, the controller may be configured to adapt a duration of the temperature boost phase, in particular depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode.

15 In general, the further the user experience has progressed prior to pausing it, in particular the greater the number of puffs during operation in the heating mode prior to operation in the pause mode and/or the longer the time period of operation in the heating mode prior to operation in the pause mode, the longer the temperature boost phase should be. Therefore, the controller may be configured to adapt a duration of the temperature boost phase so that the duration is
20 increased with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode.

Likewise, the longer the duration of operation in the pause mode, the longer the temperature boost phase should be in order to provide a proper first puff for the resumed user experience.
25 Accordingly, the controller may be configured to adapt a duration of the temperature boost phase so that the duration is increased with an increasing duration of operation in the pause mode.

Vice versa, it is also possible that the duration of the temperature boost phase may be fixed, that is, the temperature boost phase may have a fixed duration.

For very short durations of operation in the pause mode, for example below 30 seconds,
30 there may be no need for a temperature boost. Accordingly, the duration of the temperature boost phase may be zero, if the duration of operation in the pause mode is below a pre-defined threshold pause mode duration. Accordingly, the controller may be configured to determine the duration of the temperature boost phase to be zero, if the duration of operation in the pause mode is below a pre-defined threshold pause mode duration. The pre-defined threshold pause mode duration
35 may be in a range between 0 seconds and 40 seconds, in particular between 15 seconds and 30 seconds.

Vice versa, for longer pause durations, in particular above the aforementioned pre-defined threshold pause mode duration, the operation history during operation in the heating mode prior to operation in the pause mode may be the dominant factor, in particular the only factor, in adapting the duration of the temperature boost phase. In contrast, the duration of operation in the pause mode may have less or even no influence thereon. In particular, for a given operation history, e.g. for a given number of puffs taken before the pause, the duration of the temperature boost phase may be constant, i.e. always the same, for any duration of operation in the pause mode larger than the aforementioned pre-defined threshold pause mode duration.

The duration of the temperature boost phase may be in or may be adaptable in a range between 1 second and 90 seconds, in particular between 5 seconds and 90 seconds, more particularly between 15 seconds and 60 seconds, even more particularly in a range between 15 seconds and 50 seconds, preferably between 20 seconds and 50 seconds or between 20 seconds and 30 seconds.

In general, the controller may also be configured to control a temperature of the heater during operation in the temperature boost phase. Preferably, the temperature of the heater during operation in the temperature boost phase is fixed or constant (non-adaptable), that is, at a fixed or constant (non-adaptable) boost temperature level. Advantageously, this simplifies the control effort. Accordingly, the controller may be configured to control a temperature of the heater during operation in the temperature boost phase at a constant boost temperature level. This may be particularly advantageous when the aerosol-forming substrate to be heated comprises no tobacco material, i.e. for non-tobacco aerosol-forming substrates, and/or for aerosol-forming substrates having a higher thermal mass, and/or for aerosol-forming substrates comprising a total aerosol-former content that is greater than or equal 30 percent by weight, in particular greater than 35 percent by weight, more particularly greater than 40 percent by weight or greater than 45 percent by weight. These substrates have a rather high thermal mass and therefore require more energy for resumption of the user experience. Nevertheless, this may be also applicable for any other substrate, in particular for aerosol-forming substrates comprising tobacco material or a combination of tobacco material and other botanical material(s), and/or for aerosol-forming substrates comprising a total aerosol-former content that is lower than 30 percent by weight, in particular lower than 25 percent by weight, preferably lower than 20 percent by weight, and/or for aerosol-forming substrates having a lower thermal mass.

In order to have the quality of the first puff after resuming the user experience as high as possible, the temperature of the heater during operation in the temperature boost phase preferably is as high as possible, that is, at a maximum temperature reachable by the heater during the heating mode. Again, this may be particularly advantageous for aerosol-forming substrates comprising no tobacco material, i.e. for non-tobacco aerosol-forming substrates, due

to their high thermal mass, and/or for aerosol-forming substrates having a higher thermal mass, and/or for aerosol-forming substrates comprising a total aerosol-former content that is greater than or equal 30 percent by weight, in particular greater than 35 percent by weight, more particularly greater than 40 percent by weight or greater than 45 percent by weight. Nevertheless, this may be also applicable for any other substrate, in particular for aerosol-forming substrates comprising tobacco material or a combination of tobacco material and other botanical material(s), and/or for aerosol-forming substrates comprising a total aerosol-former content that is lower than 30 percent by weight, in particular lower than 25 percent by weight, preferably lower than 20 percent by weight, and/or for aerosol-forming substrates having a lower thermal mass. The maximum temperature reachable by the heater during the heating mode may be given by at least one of: a maximum allowable temperature defined by the substrate to be heated in order to avoid overheating of the substrate, or a maximum temperature within a pre-defined (technically feasible) regulation range of the controller (see below).

As mentioned further above, where temperature regulation during operation in the heating mode, which the temperature boost phase belongs to, is based on a monotonic relationship between a property of the heater and its temperature occurring between a first characteristic feature at a first specific temperature and a second characteristic feature at a second specific temperature, care has to be taken that the specific value for the temperature regulation during the heating mode is not too close to the first and second specific temperatures. Accordingly, the temperature of the heater during operation in the temperature boost phase should be still sufficiently distanced from the second specific temperature – which marks the upper limit of the regulation range – in order to ensure appropriate regulation. The required distance for regulation may thus define a technically feasible regulation range of the controller, and consequently also a maximum temperature reachable by the heater during the heating mode. As an example, the temperature of the heater during operation in the temperature boost phase may be chosen such that the corresponding value of the monitored property of the heater at this temperature corresponds to the value of the property at the first specific temperature (first reference temperature) plus 80% to 85% of the difference between the respective values of the property at the first and second specific temperatures (first and second reference temperatures). Here, the difference may be either positive or negative, depending on which one of the respective values of the property at the first and second specific temperatures is higher.

Vice versa, it is also possible that the temperature of the heater during operation in the temperature boost phase is adaptable. Accordingly, the controller may be configured to adapt a temperature/boost temperature level of the heater during operation in the temperature boost phase. More particularly, the controller may be configured to adapt a temperature/boost temperature level of the heater during operation in the temperature boost phase depending on an

operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode. More particularly, the controller may be configured to adapt a boost temperature level so that the boost temperature level is increased with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode.

In particular if the number of puffs during operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold number and/or if the time period of operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold time, a boost temperature level preferably corresponds to a maximum temperature reachable by the heater during the heating mode. That is, the controller may be configured to adapt a boost temperature level so that the boost temperature level corresponds to a maximum temperature reachable by the heater during the heating mode, if the number of puffs during operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold number and/or if the time period of operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold time. The pre-defined threshold number of puffs may be in a range between 4 and 8, for instance 6. The pre-defined threshold time of operation in the heating mode prior to operation in the pause mode may be in a range between 2 minutes and 8 minutes, in particular 3 minutes and 4 minutes, for instance 3.5 minutes.

The absolute temperature of the heater during operation in the temperature boost phase may in particular dependent on the substrate type. For example, the temperature of the heater during operation in the temperature boost phase, in particular the boost temperature level, may be in or may be adaptable in a range between 300 °C and 500 °C, in particular between 375 °C and 400 °C, preferably around 390 °C. These values have proven particularly advantageous for aerosol-forming substrates comprising tobacco material or a combination of tobacco material and other botanical material(s), and/or for aerosol-forming substrates comprising a total aerosol-former content that is lower than 30 percent by weight, in particular lower than 25 percent by weight, preferably lower than 20 percent by weight, and/or for aerosol-forming substrates having a lower thermal mass. As another example, the temperature of the heater during operation in the temperature boost phase, in particular the boost temperature level, may be in or may be adaptable in a range between 250 °C and 400 °C, in particular between 250 °C and 300 °C, more particularly between 260 °C and 275 °C, for example 270 °C.

After resumption of operation in the heating mode, the aerosol-generating device may generally need some time to thermally prepare the aerosol-forming substrate for a proper first user puff of the resumed user experience. It was found that the time to prepare the substrate may

strongly depend on the operation history during operation in the heating mode prior to operation in the pause mode and/or on the duration of operation in the pause mode. Accordingly, it is proposed that operation in the heating mode is resumed by activating the heater to reheat the substrate for aerosol generation over a variable reheating time, wherein the controller is configured to determine the reheating time depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or a duration of operation in the pause mode.

The general idea of activating the heater to reheat the substrate for aerosol generation over a variable reheating time - depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or a duration of operation in the pause mode - may either be combined with any other aspect of the present invention disclosed herein, or may constitute an independent aspect of the present invention. According to this independent aspect, there is provided an aerosol-generating device comprising a controller configured to control a heater for heating an aerosol-forming substrate in order to generate an aerosol. The controller is configured to selectively operate in a heating mode in which the controller controls the heater according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the controller controls the heater according to a pause mode temperature profile for pausing operation in the heating mode. In response to termination of operation in the pause mode the controller is configured to resume operation in the heating mode by activating the heater to reheat the substrate for aerosol generation over a variable reheating time, wherein the controller is configured to determine the reheating time depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or a duration of operation in the pause mode.

The following advantageous details and features relate to the variable reheating time either as independent aspect of the present invention, or in combination with any other aspect of the present invention disclosed herein.

As described above, the reheating time generally is defined as the time required by the aerosol-generating device to prepare the aerosol-forming substrate for a proper first user puff after termination of operation in the pause mode. In other words, after the variable reheating time, a user experience is or can be resumed. That is, after the variable reheating time the devices resumes aerosol generation, in particular an optimal user experience. Although the reheating time generally defines the time after which a user experience should be resumed at the earliest, it does not preclude that a user experience can be resumed before the reheating time has ended, in particular that a user takes a puff before the reheating time has ended.

In particular, the controller may be configured to determine the reheating time depending on a number of puffs during operation in the heating mode prior to operation in the pause mode and/or a time period of operation in the heating mode prior to operation in the pause mode.

5 In general, the further the user experience has progressed prior to pausing it, in particular the greater the number of puffs during operation in the heating mode prior to operation in the pause mode and/or the longer the time period of operation in the heating mode prior to operation in the pause mode, the longer the reheating time should be. Therefore, the controller may be configured to adapt the reheating time so that the reheating time is increased with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode and/or
10 with an increasing time period of operation in the heating mode prior to operation in the pause mode.

Likewise, the longer the duration of operation in the pause mode, the longer the reheating time may be in order to provide a proper first puff for the resumed user experience. Accordingly, the controller may be configured to adapt the reheating time so that the reheating time is
15 increased with an increasing duration of operation in the pause mode. Vice versa, for very short durations of operation in the pause mode, in particular for durations below a pre-defined threshold pause mode duration in a range between 0 seconds and 40 seconds, in particular between 15 seconds and 30 seconds, the reheating time may have a fixed value, for example, in a range between 2 seconds and 10 seconds, in particular between 4 seconds and 8 seconds, preferably
20 5 seconds.

Vice versa, for longer pause durations, in particular above the aforementioned pre-defined threshold pause mode duration, the operation history during operation in the heating mode prior to operation in the pause mode may be the dominant factor, in particular the only factor, in adapting the reheating time. In contrast, the duration of operation in the pause mode may have
25 less or even no influence thereon. In particular, for a given operation history, e.g. for a given number of puffs taken before the pause, the reheating time may be constant, i.e. always the same, for any duration of operation in the pause mode larger than the aforementioned pre-defined threshold pause mode duration.

The reheating time may be or may be adaptable in a range between 1 second and 90
30 seconds, in particular between 5 seconds and 60 seconds, more particularly in a range between 5 seconds and 50 seconds or between 15 seconds and 50 seconds, preferably between 20 seconds and 50 secs or between 20 seconds and 30 seconds. These values of the reheating time have proven advantageous to provide a satisfying first user puff.

The controller may be further configured to generate a signal indicating that the variable
35 reheating time has ended and/or that a user is permitted to resume puffing to generate aerosol from the device.

Furthermore, the aerosol-generating device may comprise an indicator for indicating to a user information associated with the reheating time and/or the readiness of the device for a user to resume puffing after termination of operation in the pause mode, in particular for indicating to a user that the variable reheating time has ended and/or for indicating to a user that a user is permitted to resume puffing to generate aerosol from the device and/or for indicating a remaining time before the variable reheating time is ended.

In this respect, the controller may be configured to notify, via the indicator, that a user is permitted to resume puffing to generate aerosol from the device and/or that the variable reheating time has ended. Alternatively or in addition, the controller may be configured to indicate to a user, via the indicator, a remaining time before the variable reheating time is ended.

The indicator may comprise at least one of a visual indicator, for example a display or a light signal, such as, one or more LEDs, a haptic indicator (haptic output unit), an audio indicator (audio output unit), and an audiovisual indicator.

As mentioned above, operation in the heating mode may be resumed by starting with a temperature boost phase. Further details and aspects of the temperature boost phase have been described further above and equally apply to the presently discussed aspect of the invention, that is, the reheating time.

In general, the temperature boost phase, in particular the duration of the temperature boost phase, and the reheating time are independent from each other. Accordingly, the duration of the temperature boost phase may be shorter than the reheating time. Hence, upon termination of operation in the pause mode a user would take a first puff after the temperature boost phase has ended. In particular, where the duration of the temperature boost phase is zero (for very short durations of operation in the pause mode), the reheating time may nevertheless be non-zero, in particular may have a fixed value, for example, in a range between 2 seconds and 10 seconds, in particular between 4 seconds and 8 seconds, preferably 5 seconds. Vice versa, the reheating time may be shorter than a duration of the temperature boost phase, in which case the user would take a first puff after termination of operation in the pause mode during the temperature boost phase. In another example, the temperature boost phase is applied for the reheating time. That is, the reheating time may be as long as the duration of the temperature boost phase. This is particularly advantageous when the temperature during the boost phase is close to or at a maximum temperature reachable by the heater during the heating mode in order to avoid overheating.

It is also possible that the reheating time is dependent from the duration of the temperature boost phase, i.e. coupled to the duration of the temperature boost phase, in particular such that the reheating time is a pre-defined function of the duration of the temperature boost phase, in particular such that the reheating time is always as long as the duration of the temperature boost

phase. Again, the latter configuration is particularly advantageous when the temperature during the boost phase is close to or at a maximum temperature reachable by the heater during the heating mode in order to avoid overheating.

Furthermore, it was found that the position in the heating mode temperature profile at which the temperature of the heater restarts after termination of operation in the pause mode (and after an initial temperature boost) may have a significant impact on the quality of the first puff after resumption of the user experience. To this extent, it was found that the temperature of the heater after the pause mode (and after the initial temperature boost) should ideally restart at about the same temperature level as at the time of pausing operation in the heating mode, yet shifted in the heating mode temperature profile by a variable time offset that depends on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode. In general, it is however also possible that there is no shift.

The general idea of resuming operation in the heating mode at a shifted position in the heating mode temperature profile - depending the operation history during operation in the heating mode prior to operation in the pause mode and/or the duration of operation in the pause mode - may either be combined with any other aspect of the present invention disclosed herein, or may constitute an independent aspect of the present invention. According to this independent aspect, there is provided an aerosol-generating device comprising a controller configured to control a heater for heating an aerosol-forming substrate in order to generate an aerosol. The controller is configured to selectively operate in a heating mode in which the controller controls the heater according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the controller controls the heater according to a pause mode temperature profile for pausing operation in the heating mode. In response to termination of operation in the pause mode, the controller is configured to resume operation in the heating mode by resuming operation at a shifted position in the heating mode temperature profile which corresponds to a position in the heating mode temperature profile at the time of pausing operation in the heating mode shifted by a variable time offset. The controller is configured to determine the time offset depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode.

The following advantageous details and features relate to the variable time offset either as independent aspect of the present invention, or in combination with any other aspect of the present invention disclosed herein.

The offset time may be associated with a time shift backwards in the heating mode temperature profile and/or with a time shift forward in the heating mode temperature profile.

In particular, the controller may be configured to determine the time offset depending on a number of puffs during operation in the heating mode prior to operation in the pause mode and/or a time period of operation in the heating mode prior to operation in the pause mode.

In general, the further the user experience has progressed prior to pausing it, in particular the greater the number of puffs during operation in the heating mode prior to operation in the pause mode and/or the longer the time period of operation in the heating mode prior to operation in the pause mode, the greater the time shift forward in the heating mode temperature profile preferably is. Therefore, the controller may be configured to determine the time offset such as to have an increasing value associated with a time shift forward in the heating mode temperature profile with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode.

Likewise, the longer the duration of operation in the pause mode, the greater the time shift forward in the heating mode temperature profile preferably is. Accordingly, the controller may be configured to determine the time offset such as to have an increasing value associated with a time shift forward in the heating mode temperature profile with an increasing duration of operation in the pause mode.

However, it was found that it can be more advantageous in favor a proper first puff after resumption of a user experience that the time offset is constant irrespective of a duration of operation in the pause mode, if the number of puffs during operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold number and/or if the time period of operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold time. Accordingly, the controller may be configured to determine the time offset such as to be constant irrespective of a duration of operation in the pause mode, if the number of puffs during operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold number and/or if the time period of operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold time. The pre-defined threshold number of puffs may be in a range between 4 and 8, for instance 6. The pre-defined threshold time of operation in the heating mode prior to operation in the pause mode may be in a range between 2 minutes and 8 minutes, in particular 3 minutes and 4 minutes, for instance 3.5 minutes.

The time offset may be in a range between 0 seconds (no shift) and 180 seconds or between 1 second and 180 seconds, in particular between 1 second and 100 seconds, more particularly in a range between 1 second and 7 seconds or between 10 seconds and 80 seconds or between 20 seconds and 70 seconds or between 30 seconds and 70 seconds backwards and/or forward

in the heating mode temperature profile. These values have been proven particularly beneficial for a proper resumption of a user experience.

With increasing progress of the user experience, the aerosol-forming substrate is more and more depleted. In particular if the substrate is a solid aerosol-forming substrate, depletion of the substrate propagates from areas of the substrate around the heater to areas of the substrate further away from the heater. In order to sufficiently heat areas of the substrate further away from the heater, the heating mode temperature profile may include changes (increase/decrease) of the operation temperature of the heater as the user experience progresses. In particular, the heating mode temperature profile may include a plurality of consecutive profile sections, each associated with a change in temperature of the heater as compared to the previous profile section. With respect to such a heating mode temperature profile, resumption of the user experience after its pausing may be such that operation in the heating mode is resumed over a remaining time according to the profile section of the heating mode temperature profile being effective at the time of pausing operation in the heating mode, before proceeding operation according to the corresponding subsequent profile section. Accordingly, in response to termination of operation in the pause mode, the controller may be configured to determine the time offset such that operation in the heating mode is resumed over a remaining time according to the profile section of the heating mode temperature profile being effective at the time of pausing operation in the heating mode, before subsequently proceeding operation according to the corresponding subsequent profile section. The remaining time basically corresponds to the realization of the offset time, as will be described in more detail further below. In particular, the controller may be configured to determine the remaining time depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode, in particular depending on a number of puffs during operation in the heating mode prior to operation in the pause mode and/or a time period of operation in the heating mode prior to operation in the pause mode.

The remaining time may be in a range between 0% and 100% percent, in particular 0% and 80%, more particularly between 25% and 75% or between 30% and 50% of predefined total interval time of the respective profile section of the heating mode temperature profile being effective at the time of pausing operation in the heating mode. A value of 0% means that the remaining time for operation according to the profile section of the heating mode temperature profile being effective at the time of initiating the pause is zero and thus, that after termination of the pause operation in the heating mode immediately proceeds with the subsequent profile section. Likewise, a value of 100% means that after termination of the pause operation in the heating mode is resumed by repeating again operation according to the entire profile section that

was effective at the time of initiating the pause, that is, over the total interval time of that profile section.

Alternatively, the remaining time may be in a range between 0% and 100 % percent, in particular 0% and 80%, more particularly between 25% and 75% or between 30% and 50% of a calculative remaining time that is given by a predefined total interval time of the respective profile section of the heating mode temperature profile being effective at the time of pausing operation in the heating mode minus a portion of the predefined total interval time of that profile section already elapsed until pausing operation in the heating mode. For example, if two thirds of the predefined total interval time of a profile section of the heating mode temperature profile already elapsed until pausing operation in the heating mode, the calculative remaining time is one third. Accordingly, for this example, the remaining time may be in a range between 0% and 100 % percent, in particular 0% and 80%, more particularly between 25% and 75% or between 30% and 50% of that one third of the predefined total interval time of the profile section that was effective at the time of initiating the pause.

As mentioned above, operation in the heating mode may be resumed by starting with a temperature boost phase. Further details and aspects of the temperature boost phase have been described further above and equally apply to the presently discussed aspect of the invention, that is, the time offset.

In general, the duration of the temperature boost phase and the time offset are independent from each other. In particular, the temperature boost phase and the operation phase starting at the shifted position in the heating mode temperature profile may be consecutive operation phases. Accordingly, the controller may be configured to control the heater to resume operation in the heating mode by starting with a temperature boost phase before resuming operation at the shifted position in the heating mode temperature profile, in particular before resuming operation over the variable remaining time according to the profile section of the heating mode temperature profile being effective at the time of pausing operation in the heating mode.

The aerosol-generating device may comprise a heating arrangement operatively coupled to the controller. The heating arrangement is used to heat aerosol-forming substrate in order to generate an aerosol. In principle, the heating arrangement may be of any type suitable to heat the aerosol-forming substrate.

The heating arrangement may be a resistive heating arrangement. As such, the resistive heating arrangement may comprise a resistive heating element as the heater. That is, in this configuration, the resistive heating element corresponds to the heater that is controlled by the controller of the device. The resistive heating element may be, for example, a resistive heating wire or a resistive heating coil or a resistive heating track (in particular a resistive heating track provided on a heating blade), a resistive heating grid or a resistive heating mesh. In use of the

device, the resistive heating element may be in thermal contact with or thermal proximity to the aerosol-forming substrate to be heated.

It is also possible that the heating arrangement is an induction heating arrangement. As such, the induction heating arrangement may comprise an induction source including an induction coil for generating a varying magnetic field. The varying magnetic field preferably is generated at the place of the aerosol-forming substrate in use of the device. The varying magnetic field may be high-frequency varying magnetic field. The varying magnetic field may be in the range between 500 kHz (kilo-Hertz) to 30 MHz (Mega-Hertz), in particular between 5 MHz to 15 MHz, preferably between 5 MHz and 10 MHz. The varying magnetic field is used to inductively heat a susceptor due to at least one of eddy currents or hysteresis losses, depending on the electrical and magnetic properties of the susceptor material. In use, the susceptor is in thermal contact with or thermal proximity to the aerosol-forming substrate to be heated.

In general, the susceptor may be either part of the aerosol-generating device or part of an aerosol-generating article comprising the aerosol-forming substrate to be heated. According to the first alternative, the induction heating arrangement of the aerosol-generating device may further comprise a susceptor (as the heater) which is inductively heatable by the varying magnetic field. That is, in this configuration, the susceptor corresponds to the heater that is controlled by the controller of the device.

The at least one induction coil may be a helical coil or flat planar coil, in particular a pancake coil or a curved planar coil. The at least one induction coil may be held within one of a main body or a housing of the aerosol-generating device.

The induction source may comprise an alternating current (AC) generator. The AC generator may be powered by a power supply of the aerosol-generating device. The AC generator is operatively coupled to the at least one induction coil. In particular, the at least one induction coil may be integral part of the AC generator. The AC generator is configured to generate a high frequency oscillating current to be passed through the at least one induction coil for generating the varying magnetic field. The AC current may be supplied to the at least one induction coil continuously following activation of the system or may be supplied intermittently, such as on a puff by puff basis.

Preferably, the induction source comprises a DC/AC converter connected to the DC power supply including an LC network, wherein the LC network comprises a series connection of a capacitor and the inductor. In addition, the induction source may comprise a matching network for impedance matching. In particular, the induction source comprise may comprise a power amplifier, for example a Class-C power amplifier or a Class-D power amplifier or Class-E power amplifier.

In case of an inductive heating arrangement, the aerosol-generating device may further comprise a flux concentrator arranged and configured to distort the varying magnetic field of the at least one inductive source towards the location the susceptor is arranged at in use. Preferably, the flux concentrator comprises a flux concentrator foil, in particular a multi-layer flux concentrator foil.

The aerosol-generating device may comprise a power supply, in particular a DC power supply for providing power to operate the device, in particular for providing power to the heater. Preferably, the power supply is a battery such as a lithium iron phosphate battery. As an alternative, the power supply may be another form of charge storage device such as a capacitor. The power supply may require recharging, that is, the power supply may be rechargeable. The power supply may have a capacity that allows for the storage of enough energy for one or more user experiences. In another example, the power supply may have sufficient capacity to allow for a predetermined number of puffs or discrete activations of the heater.

Preferably, the aerosol-generating device is a puffing device for generating an aerosol that is directly inhalable by a user thorough the user's mouth. In particular, the aerosol-generating device is a hand-held aerosol-generating device.

The present disclosure further relates to an aerosol-generating system which comprises an aerosol-generating device according to the present invention and as described herein and an aerosol-generating article an aerosol-generating article including an aerosol-forming substrate for use with the device.

As used herein, the term "aerosol-generating system" refers to the combination of an aerosol-generating article as further described herein and an aerosol-generating device according to the invention and as described herein. In the system, the article and the device may cooperate to generate an inhalable aerosol. As used herein, the term "aerosol-generating article" refers to an article comprising at least one aerosol-forming substrate that, when heated, releases volatile compounds that can form an aerosol. Preferably, the aerosol-generating article comprises an aerosol-forming substrate that is intended to be heated rather than combusted in order to release volatile compounds that can form an aerosol. The aerosol-generating article may be a consumable, in particular a consumable to be discarded after a single use. The article be a rod-shaped article resembling conventional cigarettes. For example, the article may be a cartridge including a liquid aerosol-forming substrate to be heated. As another example, the article may be an article including a solid aerosol-forming substrate, in particular a tobacco containing aerosol-forming substrate.

As used herein, the term "aerosol-forming substrate" relates to a substrate capable of releasing volatile compounds that can form an aerosol when heated. The aerosol-forming substrate may be a solid aerosol-forming substrate or a gel-like aerosol-forming substrate or a

liquid aerosol-forming substrate or a combination thereof.

The aerosol-forming substrate may be tobacco-containing aerosol-forming substrate. That is, the aerosol-forming substrate may comprise a tobacco-containing material containing volatile tobacco flavor compounds, which are released from the substrate upon heating. The aerosol-forming substrate may comprise tobacco particles, in particular tobacco powder. The aerosol-forming substrate may have a total tobacco content of at least 70 percent by weight, in particular at least 75 percent by weight.

Alternatively or additionally, the aerosol-forming substrate may comprise a non-tobacco material. In particular, the aerosol-forming substrate may comprise substantially no tobacco material, such as less than 1% by weight tobacco material. Preferably, the aerosol-forming substrate may be a non-tobacco aerosol-forming substrate, i.e., the aerosol-forming substrate may comprise no tobacco material or may contain no detectable amount of added tobacco particulate material.

The aerosol-forming substrate may be a cellulose based aerosol-forming substrate as described in WO2020/207733 and/or WO2022/074157. For example, the aerosol-forming substrate may comprise one or more cellulose based agents. The one or more cellulose based agents may include one or more cellulose based film forming agents, cellulose based strengthening agents, cellulose based binders, and combinations thereof. Suitable cellulose based film forming agents include those selected from the group consisting of hydroxypropyl methylcellulose (HPMC), methylcellulose (MC), ethylcellulose (EC), hydroxyethyl methyl cellulose (HEMC), hydroxyethyl cellulose (HEC), hydroxypropyl cellulose (HPC) and combinations thereof. Preferably, the cellulose based film forming agent is hydroxypropyl methylcellulose (HPMC). Suitable cellulose based strengthening agents include those selected from the group consisting of cellulose powder, microcrystalline cellulose (MCC), cellulose fibres, and combinations thereof. Preferably, the cellulose based strengthening agent is cellulose fibres. Suitable cellulose based binders include carboxymethyl cellulose and salts thereof. Preferable, the cellulose based binder is sodium carboxymethyl cellulose (sodium CMC). The aerosol-generating substrate may also comprise one or more non-cellulose based thickening agents, such as those selected from the group consisting of agar, xanthan gum, gum Arabic, guar gum, locust bean gum, pectin, carrageenan, starch, alginate, and combinations thereof. The one or more cellulose based agents may account for at least about 35% by weight of the substrate. That is, the aerosol-forming substrate may have a total cellulose based agent content of at least 35 percent by weight.

The aerosol-forming substrate may further comprise one or more aerosol formers. Examples of suitable aerosol formers are 1,3-butanediol, glycerin, 1,3-propanediol, propylene glycol, triethylene glycol, glycerol monoacetate, glycerol diacetate, glycerol triacetate, dimethyl dodecanedioate and dimethyl tetradecanedioate. Preferably, the aerosol former is glycerine. The

aerosol-forming substrate may comprise a total aerosol-former content that is greater than 10 percent by weight, in particular greater than 20 percent by weight. The aerosol-forming substrate may comprise a total aerosol-former content that is lower than 30 percent by weight, in particular lower than 25 percent by weight, preferably lower than 20 percent by weight. These values are particularly applicable for aerosol-forming substrates containing tobacco material, i.e. tobacco containing aerosol-forming substrates. Vice versa, the aerosol-forming substrate may comprise a total aerosol-former content that is greater than or equal 30 percent by weight, in particular greater than 35 percent by weight, more particularly greater than 40 percent by weight or greater than 45 percent by weight. The latter values are particularly advantageous for aerosol-forming substrates comprising no tobacco material, i.e. for non-tobacco aerosol-forming substrates.

The aerosol-forming substrate may also comprise other additives and ingredients, such as nicotine and/or flavoring substances. In particular, the aerosol-forming substrate may include solvents, ethanol, plant extracts, natural flavors and/or artificial flavors. The aerosol-forming substrate may comprise water. The aerosol-forming substrate may have a water content of between 5 percent by weight and 35 percent by weight.

As mentioned, the aerosol-forming substrate may further comprise nicotine, or a salt thereof. The nicotine may comprise one or more nicotine salts. The one or more nicotine salts may be selected from the group consisting of nicotine lactate, nicotine citrate, nicotine pyruvate, nicotine bitartrate, nicotine benzoate, nicotine pectate, nicotine alginate, and nicotine salicylate. The nicotine may comprise an extract of tobacco. The aerosol-forming substrate may have a nicotine content of greater than about 0.5 percent by weight of the substrate.

The aerosol-forming substrate may further comprise one or more carboxylic acids. The one or more carboxylic acids may be selected from the group consisting of lactic acid, levulinic acid, fumaric acid, maleic acid, malic acid, and combinations thereof. The aerosol-forming substrate may have a total carboxylic acid content of at least about 0.5 percent by weight of the substrate.

As an example (in particular as an example of an aerosol-forming substrate of a first type), the aerosol-forming substrate may be a non-tobacco aerosol-forming substrate comprising one or more cellulose based agents, preferably with a total cellulose based agent content of at least 35 percent by weight. The substrate may further comprise one or more aerosol formers, preferably with a total aerosol-former content that is greater than or equal to 30 percent by weight. In addition, the substrate may comprise nicotine. In order to stabilize the nicotine, the substrate may further comprise one or more carboxylic acids selected from fumaric acid, maleic acid and malic acid, preferably a total carboxylic acid content of at least 0.5 percent by weight. The substrate according to this example may be a substrate having a higher thermal mass.

As another example (in particular as an example of an aerosol-forming substrate of a second type), the aerosol-forming substrate may be tobacco-containing aerosol-forming substrate

comprising tobacco material, such as tobacco particles, in particular tobacco powder, preferably with a total tobacco content of at least 70 percent by weight, in particular at least 75 percent by weight. In addition, the substrate may comprise one or more cellulose based agents, such as cellulose fibers, preferably with a total cellulose based agent content of at most 10 percent by weight, in particular at most 5 percent by weight. The substrate may further comprise one or more aerosol formers, preferably with a total aerosol-former content that is lower than 30 percent by weight, more particularly lower than 20 percent by weight. The substrate according to this example may be a substrate having a lower thermal mass.

The aerosol-forming substrate may also be a paste-like material, a sachet of porous material comprising aerosol-forming substrate, or, for example, loose tobacco mixed with a gelling agent or sticky agent, which could include a common aerosol former such as glycerin, and then is compressed or molded into a plug.

In case the aerosol-generating device comprises an inductive heating arrangement, the aerosol-generating system may comprise at least one susceptor as the heater (controlled by the controller of the device) for heating the aerosol-forming substrate. The susceptor may be integral part of the aerosol-generating article. That is, the aerosol-generating article may comprise a susceptor as the heater. Accordingly, the aerosol-generating article may comprise at least one susceptor as the heater (controlled by the controller of the device). The susceptor may be positioned in thermal proximity to or thermal contact with the aerosol-forming substrate such that in use the susceptor is inductively heatable by the inductive heating arrangement when the article is engaged with the device. It is also possible that the susceptor is part of the aerosol-generating device (forming the heater controlled by the controller of the device). In this configuration, the susceptor may be arranged in the device such that it is in thermal proximity to or thermal contact with the aerosol-forming substrate, when the article is engaged with the device.

Further features and advantages of the aerosol-generating system according to the invention have been described with regard to the aerosol-generating device and equally apply.

The present disclosure further relates to a method of operating an aerosol-generating system, in particular an aerosol-generating system according to the present invention, capable of generating an aerosol by heating an aerosol-forming substrate. The method comprises selectively operating the system in a heating mode in which the temperature of a heater used for heating the substrate is controlled according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the temperature of the heater is controlled according to a pause mode temperature profile for pausing operation in the heating mode, wherein the pause mode temperature profile is adapted depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode.

The present disclosure further relates to a method of operating an aerosol-generating system, in particular an aerosol-generating system according to the present invention, capable of generating an aerosol by heating an aerosol-forming substrate. The method comprises selectively operating the system in a heating mode in which the temperature of a heater used for heating the substrate is controlled according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the temperature of the heater is controlled according to a pause mode temperature profile for pausing operation in the heating mode, wherein in response to termination of operation in the pause mode, operation in the heating mode is resumed by starting with a temperature boost phase, wherein a temperature of the heater during operation in the temperature boost phase is higher than an initial temperature level at the beginning of the heating mode temperature profile and/or higher than a temperature level in the heating mode before activation of the pause mode.

The present disclosure further relates to a method of operating an aerosol-generating system, in particular an aerosol-generating system according to the present invention, capable of generating an aerosol by heating an aerosol-forming substrate. The method comprises selectively operating the system in a heating mode in which the temperature of a heater used for heating the substrate is controlled according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the temperature of the heater is controlled according to a pause mode temperature profile for pausing operation in the heating mode, wherein in response to termination of operation in the pause mode, operation in the heating mode is resumed by activating the heater to reheat the substrate for aerosol generation over a variable reheating time, wherein the reheating time is determined depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or a duration of operation in the pause mode.

The present disclosure further relates to a method of operating an aerosol-generating system, in particular an aerosol-generating system according to the present invention, capable of generating an aerosol by heating an aerosol-forming substrate. The method comprises selectively operating the system in a heating mode in which the temperature of a heater used for heating the substrate is controlled according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the temperature of the heater is controlled according to a pause mode temperature profile for pausing operation in the heating mode, wherein in response to termination of operation in the pause mode, operation in the heating mode is resumed by resuming operation at a shifted position in the heating mode temperature profile which corresponds to a position in the heating mode temperature profile at the time of pausing operation in the heating mode shifted by a variable time offset, and wherein the time offset is determined

depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode.

The present disclosure further relates to a method of operating an aerosol-generating system, in particular an aerosol-generating system according to the present invention, capable of generating an aerosol by heating an aerosol-forming substrate. The method comprises selectively operating the system in a heating mode in which the temperature of a heater used for heating the substrate is controlled according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the temperature of the heater is controlled according to a pause mode temperature profile for pausing operation in the heating mode, wherein the heating mode temperature profile and the pause mode temperature profile are chosen such that a temperature of the heater during operation in the pause mode is lower than during operation in the heating mode, and wherein a temperature level, in particular an initial temperature level of the pause mode temperature profile to which the temperature of the heater is lowered, in particular initially lowered in response to initiating operation in the pause mode is in a range between 240 °C and 280 °C, in particular between 250 °C and 270 °C, more particularly 260 °C.

The present disclosure further relates to a method of operating an aerosol-generating system capable of generating an aerosol by heating an aerosol-forming substrate. The method comprises selectively operating the system in a heating mode in which the temperature of a heater used for heating the substrate is controlled according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the temperature of the heater is controlled according to a pause mode temperature profile for pausing operation in the heating mode, wherein the heating mode temperature profile and the pause mode temperature profile are chosen such that a temperature of the heater during operation in the pause mode is lower than during operation in the heating mode, and wherein a temperature level, in particular an initial temperature level of the pause mode temperature profile to which the temperature of the heater is lowered, in particular initially lowered in response to initiating operation in the pause mode is less than 150 °C or at most 145 °C. For example, a temperature level of the pause mode temperature profile to which the temperature of the heater is lowered in response to initiating operation in the pause mode may be in a range between 100 °C and 145 °C, in particular between 110 °C and 145 °C or between 110 °C and 14 °C or between 120 °C and 145 °C or between 125 °C and 145 °C or between 125 °C and 140 °C or between 125 °C and 135 °C, preferably around 130 °C. Yet, the temperature level of the pause mode temperature profile may be also higher. Accordingly, it is also possible that the temperature level of the pause mode temperature profile to which the temperature of the heater is lowered in response to initiating operation in the pause is in a range between 100 °C and 250 °C, in particular between 110 °C and 225 °C or

between 110 °C and 170 °C or between 120 °C and 170 °C or between 125 °C and 170 °C or between 130 °C and 150 °C, in particular 130 °C.

Further features and advantages of the method(s) according to the invention have been described with regard to the aerosol-generating device and the aerosol-generating system, and
5 equally apply.

The invention is defined in the claims. However, below there is provided a non-exhaustive list of non-limiting examples. Any one or more of the features of these examples may be combined with any one or more features of another example, embodiment, or aspect described herein.

Example Ex1: An aerosol-generating device comprising a controller configured to control
10 a heater for heating an aerosol-forming substrate in order to generate an aerosol, wherein the controller is configured to selectively operate:

in a heating mode in which the controller controls the heater according to a heating mode temperature profile for generating an aerosol, and

in a pause mode in which the controller controls the heater according to a pause mode
15 temperature profile for pausing operation in the heating mode,
wherein the controller is further configured to adapt the pause mode temperature profile depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode.

Example Ex2: The aerosol-generating device according to example Ex1, wherein the
20 controller is configured to determine and record the operation history during operation in the heating mode prior to operation in the pause mode.

Example Ex3: The aerosol-generating device according to any one of the preceding examples, wherein the operation history includes at least one of the following parameters:

a number of puffs during operation in the heating mode prior to operation in the pause
25 mode; and

a time period of operation in the heating mode prior to operation in the pause mode.

Example Ex4: The aerosol-generating device according to any one of the preceding examples, wherein the controller is configured to adapt the pause mode temperature profile such that an operation temperature of the heater is progressively decreased as the duration of
30 operation in the pause mode progresses.

Example Ex5: The aerosol-generating device according to any one of the preceding examples, wherein the controller is configured to adapt the pause mode temperature profile such that a progression of a decrease of the operation temperature of the heater is adapted depending on the operation history during operation in the heating mode prior to operation in the pause
35 mode.

Example Ex6: The aerosol-generating device according to any one of the preceding examples, wherein the controller is configured to adapt the pause mode temperature profile such that a decrease of the operation temperature of the heater is less progressive with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode.

Example Ex7: The aerosol-generating device according to any one of the preceding examples, wherein the controller is configured to adapt the pause mode temperature profile such that an operation temperature of the heater is decreased in successive temperature steps as the duration of operation in the pause mode progresses.

Example Ex8: The aerosol-generating device according to example Ex7, wherein during the decrease a decrement of the operation temperature of the heater between successive temperature steps is in a range between 2 °C and 25 °C, in particular between 5 °C and 20 °C, more particularly between 7 °C and 15 °C, for example 10 °C.

Example Ex9: The aerosol-generating device according to any one of examples Ex7 to Ex8, wherein during the decrease a respective time period of the successive temperature steps is in a range between 1 minute and 6 minutes.

Example Ex10: The aerosol-generating device according to any one of examples Ex7 to Ex9, wherein during the decrease a respective time period of the successive temperature steps increases from temperature step to temperature step.

Example Ex11: The aerosol-generating device according to any one of examples Ex7 to Ex10, wherein the controller is configured to adapt a respective time period of the successive temperature steps depending on the operation history during operation in the heating mode prior to operation in the pause mode.

Example Ex12: The aerosol-generating device according to any one of examples Ex7 to Ex11, wherein the controller is configured to adapt a respective time period of the successive temperature steps such that a respective time period of the successive temperature steps increases with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode.

Example Ex13: The aerosol-generating device according any one of the preceding examples, wherein the controller is configured to adapt the pause mode temperature profile such that after decreasing the operation temperature over a pre-defined decrease time period an operation temperature of the heater is progressively increased as the duration of operation in the pause mode further progresses.

Example Ex14: The aerosol-generating device according to example Ex13, wherein the controller is configured to adapt the decrease time period depending on the operation history during operation in the heating mode prior to operation in the pause mode.

5 Example Ex15: The aerosol-generating device according to any one of examples Ex13 to Ex14, wherein the decrease time period is in a range between range between 15 seconds and 6 minutes, in particular 3 minute and 6 minutes, more particularly between 3.5 minutes and 4 minutes.

10 Example Ex16: The aerosol-generating device according to any one of examples Ex13 to Ex15, wherein the controller is configured to adapt the pause mode temperature profile such that a progression of an increase of the operation temperature of the heater is adapted depending on the operation history during operation in the heating mode prior to operation in the pause mode.

15 Example Ex17: The aerosol-generating device according to any one of examples Ex13 to Ex16, wherein the controller is configured to adapt the pause mode temperature profile such that an increase of the operation temperature of the heater is less progressive with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode.

20 Example Ex18: The aerosol-generating device according to any one of examples Ex13 to Ex17, wherein the controller is configured to adapt the pause mode temperature profile such that after decreasing the operation temperature over a pre-defined decrease time period an operation temperature of the heater is increased in successive temperature steps as the duration of operation in the pause mode progresses.

25 Example Ex19: The aerosol-generating device according to example Ex18, wherein during the increase an increment of the operation temperature of the heater between successive temperature steps is in a range between 2 °C and 25 °C, in particular between 5 °C and 20 °C, more particularly between 7 °C and 15 °C, for example 10 °C.

Example Ex20: The aerosol-generating device according to any one of examples Ex18 to Ex19, wherein during the increase a respective time period of the successive temperature steps is in a range between 15 seconds and 6 minutes, in particular 1 minute and 6 minutes.

30 Example Ex21: The aerosol-generating device according to any one of examples Ex18 to Ex20, wherein during the increase a respective time period of the successive temperature steps increases from temperature step to temperature step.

35 Example Ex22: The aerosol-generating device according to any one of examples Ex18 to Ex21, wherein the controller is configured to adapt a respective time period of the successive temperature steps during the increase depending on the operation history during operation in the heating mode prior to operation in the pause mode.

Example Ex23: The aerosol-generating device according to any one of the preceding examples, wherein the controller is configured to adapt the pause mode temperature profile such that an operation temperature of the heater is kept constant depending on the operation history, for instance, if the number of puffs during operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold number and/or if the time period of operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold time.

Example Ex24: The aerosol-generating device according to example Ex23, wherein the pre-defined threshold number of puffs is in a range between 6 and 10, in particular between 7 and 9, for instance 8; and/or wherein the pre-defined threshold time of operation in the heating mode prior to operation in the pause mode is in a range between 2 minutes and 8 minutes, in particular 4 minutes and 7 minutes, for instance 5 minutes.

Example Ex25: The aerosol-generating device according to any one of the preceding examples, wherein the heating mode temperature profile and the pause mode temperature profile are chosen such that an operation temperature of the heater during operation in the pause mode is lower than during operation in the heating mode.

Example Ex26: The aerosol-generating device according to any one of the preceding examples, wherein operation in the pause mode is user-terminable.

Example Ex27: The aerosol-generating device according to any one of the preceding examples, wherein the device comprises a user interface operatively coupled with the controller enabling a user to initiate and/or resume and/or terminate operation in the pause mode.

Example Ex28: The aerosol-generating device according to any one of the preceding examples, wherein operation in the pause mode has a defined total duration, in particular for a single user experience and/or for a single pause of operation in the heating mode.

Example Ex29: The aerosol-generating device according to example Ex28, wherein the defined total duration of operation in the pause mode is in a range between 1 minute and 15 minutes, in particular between 2 minutes and 10 minutes, preferably between 6 minutes and 9 minutes, for example 8 minutes.

Example Ex30: The aerosol-generating device according to any one of examples Ex28 to Ex29, wherein the defined total duration of operation in the pause mode is predefined before the start of operation in the heating mode and/or depends on the operation history during operation in the heating mode prior to operation in the pause mode.

Example Ex31: The aerosol-generating device according to any one of examples Ex28 to Ex30, wherein the controller is configured to adapt the total duration of operation in the pause mode depending on the operation history during operation in the heating mode prior to operation in the pause mode.

Example Ex32: The aerosol-generating device according to any one of the preceding examples, wherein the controller is configured to resume operation in the heating mode after operation in the pause mode is ended, for instance after the defined total duration has elapsed.

5 Example Ex33: The aerosol-generating device according to any one of the preceding examples, wherein the controller is configured to cease providing power to the heater after operation in the pause mode is ended, for instance after the defined total duration of operation in the pause mode has elapsed.

10 Example Ex34: The aerosol-generating device according to any one of the preceding examples, further comprising an indicator, wherein the controller is configured to indicate to a user, via the indicator, a remaining time before operation in the pause mode is ended.

Example Ex35: The aerosol-generating device according to example Ex34, wherein the indicator comprises at least one of a visual indicator, for example a display or a light signal, such as, one or more LEDs, a haptic indicator (haptic output unit), an audio indicator (audio output unit), and an audiovisual indicator.

15 Example Ex36: The aerosol-generating device according to any one of the preceding examples, wherein the device comprises a heating arrangement operatively coupled to the controller.

Example Ex37: The aerosol-generating device according to example Ex36, wherein the heating arrangement is a resistive heating arrangement.

20 Example Ex38: The aerosol-generating device according to example Ex37, wherein the resistive heating arrangement comprises a resistive heating element as heater.

Example Ex39: The aerosol-generating device according to example Ex36, wherein the heating arrangement is an induction heating arrangement.

25 Example Ex40: The aerosol-generating device according to example Ex39, wherein the induction heating arrangement comprises an induction source including an induction coil for generating a varying magnetic field.

Example Ex41: The aerosol-generating device according to example Ex39 or Ex40, wherein the induction heating arrangement further comprises a susceptor as the heater which is inductively heatable by the varying magnetic field.

30 Example Ex42: An aerosol-generating system comprising an aerosol-generating device according to any one of the preceding examples, and an aerosol-generating article including an aerosol-forming substrate for use with the device.

35 Example Ex43: The aerosol-generating system according to example Ex42, wherein the aerosol-forming substrate is a solid aerosol-forming substrate, in particular a tobacco containing aerosol-forming substrate.

Example Ex44: An aerosol-generating system according to any one of examples Ex42 to Ex43, comprising an aerosol-generating device according to any one of examples Ex39 to Ex40, wherein the aerosol-generating article comprises a susceptor as the heater.

Example Ex45: A method of operating an aerosol-generating system capable of generating an aerosol by heating an aerosol-forming substrate, in particular an aerosol-generating system according to any one of examples Ex42 to Ex44, the method comprises selectively operating the system in a heating mode in which the temperature of a heater used for heating the substrate is controlled according to a heating mode temperature profile for generating an aerosol, and in a pause mode in which the temperature of the heater is controlled according to a pause mode temperature profile for pausing operation in the heating mode, wherein the pause mode temperature profile is adapted depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode.

Examples will now be further described with reference to the figures in which:

Fig. 1 schematically illustrates an aerosol-generating system according to an exemplary embodiment of the present invention, including an aerosol-generating device and an aerosol-generating article for use with the device;

Fig. 2 shows an exemplary embodiment of a method for operating the aerosol-generating device according to Fig. 1;

Figs. 3-8 include various diagrams showing the evolution of the operation temperature versus time during the sequence of operation in different modes for usage with an aerosol-forming substrate of a first type; and

Figs. 9-12 include various diagrams showing the evolution of the operation temperature versus time during the sequence of operation in different modes for usage with an aerosol-forming substrate of a second type.

Fig. 1 schematically illustrates an exemplary embodiment of an aerosol-generating system 1 according to the present invention that is capable to generate an inhalable aerosol by heating an aerosol-forming substrate. The system 1 comprises an aerosol-generating article 10 which includes the aerosol-forming substrate 21 to be heated, and an aerosol-generating device 100 for inductively heating the substrate upon engaging the article 10 with the device 100.

The aerosol-generating article 10 has a substantially rod-like shape resembling the shape of a conventional cigarette. In the present embodiment, the article 10 comprises five elements sequentially arranged in coaxial alignment: a distal front plug element 80, a substrate element 20, a first tube element 40, a second tube element 50, and a filter element 60. The distal front plug element 80 is arranged at a distal end of the article 10 to cover and protect the distal front end of the substrate element 20. The filter element 60 is arranged at a proximal end of the article 10 and serves as a mouthpiece together with the second tube element 50. Both, the distal front plug

element 80 and the filter element 60 may be made of the same filter material. The substrate element 20 comprises the aerosol-forming substrate 21 to be heated and – as heater 30 – a susceptor 31 which is in direct physical contact with substrate 21 and used to inductively heat the substrate 21. This will be described in more detail below. Each one of the first and the second tube element 40, 50 is a hollow cellulose acetate tube having a central air passage, wherein a cross-section of the central air passage of the second tube element 50 is larger than a cross-section of the central air passage of the first tube element 40. The aforementioned five elements have a substantially cylindrical shape with substantially the same diameter. In addition, the five elements are circumscribed by one or more outer wrappers such as to keep the elements together and to maintain the desired circular cross-sectional shape of the article 10. In the present embodiment, the distal front plug element 80, the substrate element 20 and the first tube element 40 are circumscribed by a first wrapper, whereas the second tube element 50 and the filter element 60 are circumscribed by a second wrapper. The second wrapper also circumscribes at least a portion of the first tube element 40 (after being wrapped by the first wrapper) to connect the distal front plug element 80, the substrate element 20 and the first tube element 40 being circumscribed by the first wrapper to the second tube element 50 and the filter element 60. Preferably, the first and the second wrapper are made of paper. In addition, the second wrapper may comprise perforations around its circumference (not shown). The wrappers may further comprise adhesive that adheres the overlapped free ends of the wrappers to each other.

As also illustrated in Fig. 1, the aerosol-generating device 100 comprises two portions: a proximal portion 102 and a distal portion 101. In the proximal portion 102, the device 100 comprises a cavity 103 for removably receiving at least a portion of the aerosol-generating article 10. In the distal portion 101, the device 100 comprises a DC power supply 150, such as a rechargeable battery, for powering operation of the device, as well as a controller 160 for controlling operation of the device 100, in particular for controlling the operation temperature of the heater 30, i.e. the susceptor 31, that is used to heat the substrate 21 in the article 10. For this, the device 100 comprises an inductive heating arrangement 110 operatively coupled to the controller 160. The heating arrangement 110 includes an induction source 115 and an induction coil 118 for generating an alternating, in particular high-frequency magnetic field within the cavity 103. As can be seen in Fig. 1, the induction coil 118 is a helical coil which is arranged in the proximal portion 102 of the device such as to circumferentially surround the cylindrical receiving cavity 103. Hence, upon engaging the aerosol-generating article 10 with the device 100 (as shown in Fig. 1) and activating the heating arrangement 110, the susceptor 31 in the article 10 experiences the alternating magnetic field which in turn induces eddy currents and/or hysteresis losses in the susceptor 31, depending on the magnetic and electric properties of the susceptor material. As a consequence, the susceptor 31 heats up until reaching a temperature sufficient to

vaporize the aerosol-forming substrate 21 surrounding the susceptor 31 within the article 10. Instead of induction heating, the aerosol-generating device may alternatively comprise a resistive heating arrangement including - as the heater - a resistive heating element. The resistive heating element may be, for example, a resistive heating track provided on a heating blade), which in use is arranged in thermal contact with or thermal proximity to the aerosol-forming substrate to be heated.

In use of the system, when a user takes a puff, that is, when a negative pressure is applied at the filter element 60 of the article 10, air is drawn into the cavity 103 at the rim of the article insertion opening 105. The air flow further extends towards the distal end of the cavity 103 through a passage which is formed between the inner surface of the cylindrical cavity 103 and the outer surface of the article 10. At the distal end of the cavity 103, the air flow enters the aerosol-generating article 10 through the distal front plug element 80 into the substrate element 20. From there, the airflow further passes through the first and second tube elements 40, 50 and the filter element 60, where it finally exits the article 10. During heating, vaporized material from the aerosol-forming substrate 21 is entrained into the air flow through the substrate element 20. When further passing through the second support element 40, the cooling element 50 and the filter element 60 the air flow including the vaporized material cools down such as to form an aerosol escaping the article 10 through the filter element 60.

Normally, once started, a user experience is continued without ceasing until the aerosol-forming substrate 21 in the article 10 is depleted or until predetermined operational conditions are entered. That is, a user typically takes a plurality of consecutive puffs until sensing depletion of the substrate 21 or until a predetermined number of puffs or a predetermined maximum operation time is reached. However, a user may also want to interrupt a user experience and to resume the experience at a later stage using the same article 10 with still acceptable quality of the aerosol. To this end, the aerosol-generation device 100 according to the present invention is configured to pause a user experience by changing operation of the controller 160 from an operation in a heating mode to an operation in a pause mode. As used herein, the "heating mode" refers to the normal operation of the device for aerosol generation in which the controller controls the heater 30 according to a heating mode temperature profile in order to heat the aerosol-forming substrate 21 at a temperature at or above the volatilization temperature of aerosol-forming material included in the substrate 21. Vice versa, the "pause mode" refers to an operational mode of the controller 160 for pausing operation in the heating mode, in which the controller 160 controls the heater 30 according to a pause mode temperature profile that is associated with temperatures at which aerosol generation does not take place, or at least is reduced to a lower or minimum level. This may be achieved by choosing the heating mode temperature profile and the pause mode temperature profile such that an operation temperature of the heater 30 during operation in the

pause mode is lower than during operation in the heating mode in order to minimize depletion of the substrate 21, but still high enough to avoid condensation of vapor in the cavity 103 which otherwise might adversely affect the substrate 21. During both, operation in the heating mode and operation in the pause mode, the heating arrangement 110 is in active operation in order to heat the heater 30, yet at different temperature regimes according the temperature profiles of the respective modes. While the temperatures of the heating mode temperature profile are generally chosen to be sufficiently high in order to generate an aerosol, and the temperatures of the pause mode temperature profile level are chosen to be sufficiently low in order to minimize depletion of the substrate, whilst avoiding degradation.

In addition to the heating mode and the pause mode, the controller 160 may be also configured to operate in a preparation mode in which the controller 160 controls the heater 30 according to a preparation mode temperature profile. The preparation mode temperature profile may comprise a pre-heating phase and/or a calibration phase. In the pre-heating phase, the controller may control the heater to heat up, thus enabling heat to spread within the substrate 21. In the calibration phase, the controller 160 may control the heater 30 such that an operation temperature of the heater 30 passes through one or more reference points at which the controller measures one or more calibration values of a parameter that is indicative of an operation temperature of the heater. Based on the one or more calibration values, the controller 160 may adjust the temperature of the heater 30. Further details of the preparation phase and the calibration phase are described, for example, in WO 2022/136661 A1.

An exemplary embodiment of the different operational modes described above is illustrated in **Fig. 2**, which shows the evolution of the operation temperature T of the heater 30 over time t across the different modes. Starting at the left hand side of Fig. 2, a user experience is initiated at time t_0 . For example, the user experience can be initiated by a user input via a user interface, for instance by pressing a user button 165 (see Fig. 1), or by detecting the insertion of the aerosol-generating article 10 into the device 100. Once initiated, the controller 160 starts to operate in a preparation mode PCM in which it controls the heater 30 according to a preparation mode temperature profile including a pre-heating phase followed by a calibration phase. In the preparation mode PCM, the aerosol-forming substrate 21 in the article 10 is heated from room temperature T_3 until reaching a first temperature level T_1 at time t_1 . At time t_1 , operation of the controller 160 changes from operation in the preparation mode PCM into operation in the heating mode HM in which the temperature T of the heater 30 is controlled according to the heating mode temperature profile. At this point, the system is ready for the user experience to be started with the fresh article 10, and a user can take the first puff.

Depending on the substrate and article type, the heating mode temperature profile can have different patterns. In the present embodiment, the heating mode temperature profile includes a

plurality of consecutive profile sections, each associated with a change, in particular an increase of the temperature of the heater 30 as compared to the previous profile section. The step-wise increase of the temperature is chosen such that to provide more and more heat to non-depleted areas of the substrate 21 further away from the heater 30, as with increasing progress of the user experience, depletion of the substrate 21 propagates from areas of the substrate 21 closer to the heater 30 to areas of the substrate 21 further away from the heater 30. Further details of that heating mode temperature profile with the step-wise increase of the temperature of the heater 30 are described, for example, in WO 2022/136661 A1. In the present embodiment, the first temperature level T1 reached after operation in the preparation mode PCM corresponds to the initial temperature level of the heater 30 at the beginning of the heating mode temperature profile. The initial temperature level is chosen sufficient to vaporize the aerosol-forming substrate 21 in order to form an aerosol. Depending on the substrate type, the initial temperature level may be in a range between 325 °C and 385 °C, particularly between 340 °C and 370 °C, more particularly between 350 °C and 360 °C. These values and ranges are particularly applicable for aerosol-forming substrates containing tobacco material or a combination of tobacco material and other botanical material(s), and/or for aerosol-forming substrates comprising a total aerosol-former content that is lower than 30 percent by weight, in particular lower than 25 percent by weight, preferably lower than 20 percent by weight, and/or for aerosol-forming substrates having a lower thermal mass.

Once the system is ready for the user experience to be started, a user may take a certain number of puffs at his or her discretion until he or she may decide to interrupt the user experience. In the example according to Fig. 2, the user takes two puffs (indicated by the dotted curved lines) and subsequently decides at time t_2 to interrupt the user experience temporarily. This pause may be initiated, for example, by a user input via a user interface, for instance by pressing again the user button 165. Alternatively or in addition, as shown in Fig. 1, the aerosol-generating device 100 may comprise a motion sensor 166 for detecting a movement of the device 100. The motion sensor 166 may, for example, detect that the aerosol-generating device 100 is not moved for certain time which might be indicative of the device 100 being unused, for example, since the device 100 is lying idle on a table. As a consequence, the motion sensor 166 may output a sensor signal indicative of the user experience to be paused.

In response to initiation of the user experience pause at time t_2 , the controller 160 changes from operating in the heating mode HM to operation in the pause mode PM according to the pause mode temperature profile. In general, the pause mode temperature profile is associated with temperatures at which aerosol generation does not take place, or at least is reduced to a lower or minimum level. Again, depending – inter alia – on the specific substrate type and composition, the temperatures of the heater 30 during operation in the pause mode PM may be

in a range between 160 °C and 280 °C. In the present example, the initial temperature level T2 is about 260 °C (measured the center of main surface of the strip-shaped susceptor 31 as indicated by cross 34). This temperature is sufficiently low to minimize depletion of the substrate 21, but still high enough to prevent vaporized substances in the cavity 103 from condensation.

While the pause mode temperature profile in general may be pre-defined and thus fixed, it was found advantageous that the temperature profile used during operation in the pause mode PM is not fixed, but adaptable in order to be able, on the one hand, to minimize the substrate depletion during the user experience pause and, on the other hand, to return to temperatures at or above the volatilization temperature of the aerosol forming substrate within a reasonable time.

To achieve this, the pause mode temperature profile advantageously is adaptable depending on the operation history during operation in the heating mode prior to operation in the pause mode and/or on the duration PD of operation in the pause mode. That is, the pause mode temperature profile preferably is dynamically adjusted depending on the stage of the user experience at which the pause mode PM was launched and/or the duration PD of operation in the pause mode PM.

Primarily, the operation history may include the number of puffs during operation in the heating mode prior to operation in the pause mode, and/or a time period of operation in the heating mode prior to operation in the pause mode. In the example shown in Fig. 2, the number of puffs during operation in the heating mode HM prior to operation in the pause mode is two, and the time period t_{hpp} of operation in the heating mode HM prior to operation in the pause mode PM corresponds to the time span between time t_1 (end of operation in preparation mode PCM/initial start of operation in the heating mode HM) and time t_2 (initiation of operation in the pause mode PM). Both, the parameters belonging to the operation history, in particular the number of puffs during operation in the heating mode prior to operation in the pause mode, and the time period t_{hpp} of operation in the heating mode prior to operation in the pause mode, as well as the duration PD of operation in the pause mode may be determined and/or recorded by the controller 160, as described further above.

In order to minimize the substrate depletion during the user experience pause, the controller 160 of the aerosol-generating device 100 according to the present embodiment is configured to adapt the pause mode temperature profile such that an operation temperature of the heater 30 is progressively decreased as the duration PD of operation in the pause mode progresses. Advantageously, progressively lowering the operation temperature of the heater 30 during operation in the pause mode PM also helps to reduce the overall energy consumption of the system. Advantageously, the progression of the decrease of the operation temperature is not fixed, but also adaptable depending on the operation history during operation in the heating mode prior to operation in the pause mode. Accordingly, the controller 160 according to the present embodiment is further configured to adapt the pause mode temperature profile such that a

decrease of the operation temperature of the heater 30 is less progressive with an increasing number of puffs during operation in the heating mode HM prior to operation in the pause mode or with an increasing time period t_{hpp} of operation in the heating mode prior to operation in the pause mode, respectively.

Exemplary embodiments of the dynamic adaptability of the pause mode temperature profile depending on the stage of the user experience at which the pause mode was launched and/or the duration of operation in the pause mode is shown in **Fig. 3 - Fig. 6**. Similar to Fig. 2, each of the diagrams in Fig. 3 - Fig. 6 shows the evolution of the operation temperature T of the heater 30 versus time t (upper curve in each diagram) during the sequence of operation in the different modes: Starting with operation in the heating mode HM (first section of step-wise increasing profile), the user experience is interrupted after a certain number of puffs by changing to operation in the pause mode PM. Subsequently, after a certain duration PD of operation in the pause mode PM (profile at lower temperature – partially descending), the user experience is resumed by resuming operation in the heating mode HM (boost followed by continuation of step-wise increasing profile). In each of the diagrams in Fig. 3 - Fig. 6, upper curve shows the temperature T of the susceptor 31 versus time t as measured on one of the main surfaces of the stripe-shaped susceptor 31 at the center of the distal end edge of the main surface (position marked by cross 33 in Fig. 1), i.e. a temperature profile following the heating mode temperature profile and the pause mode temperature profile. Note: The temperature values given further above with respect to the operation temperature of the heater refer to the temperature as measured at a geometrical center point of a main surface of the heater, marked by cross 34 in Fig. 1, or as averaged along a geometrical center line on a main surface of the heater. In general, these temperature values are slightly higher than the one measured at an edge of the same main surface. The lower curve in each diagram of Fig. 3 - Fig. 6 represents the temperature of the aerosol-forming substrate 21 versus time as measured at half of the radius of the circular cylindrical substrate element 20 of the article 10 shown in Fig. 1 (position marked by cross 23 in Fig. 1).

The diagrams of Fig. 3 show the time evolution of the operation temperature T during sequential operation in the different modes for a user experience that is paused after 2 puffs in each diagram, but resumed after different durations PD of operation in the pause mode, as indicated at the top of each diagram. Likewise, the diagrams in each of Fig. 4, Fig. 5 and Fig. 6 show the time evolution of the operation temperature T for different durations PD of operation in the pause mode, wherein the diagrams of Fig. 4 refer to a user experience that is paused after 4 puffs, the diagrams of Fig. 5 refer to a user experience that is paused after 6 puffs, and the diagrams of Fig. 6 refer to a user experience that is paused after 7 puffs. As can be seen by comparison of the diagrams within each of the respective figures (Fig. 3 - Fig. 6), the pause mode temperature profile is adapted such that with increasing duration PD of operation in the pause

mode PM the operation temperature of the heater 30 is progressively decreased, in particular in successive temperature steps. Advantageously, successive temperature steps are technically easy to implement. The decrement of the operation temperature of the heater between successive temperature steps may be in a range between 2 °C and 25 °C, in particular between 5 °C and 20 °C, more particularly between 7 °C and 15 °C, for example 10 °C.

The respective time period of the successive temperature steps may depend – inter alia – on the number of sequence of a respective temperature step. In general, the longer the pause mode has been active, the longer the respective time period of a temperature step can be. Increasing the respective time period of the successive temperature steps from temperature step to temperature step effectively makes the decrease of the operation temperature of the heater less progressive which facilitates resumption of the user experience within a reasonable time.

The respective time period of the successive temperature steps may also depend on the operation history during operation in the heating mode HM prior to operation in the pause mode PM. Accordingly, the controller 160 according to the present embodiment is also configured to adapt a respective time period of the successive temperature steps depending on the operation history during operation in the heating mode prior to operation in the pause mode. In particular, the controller 160 is configured to adapt a respective time period of the successive temperature steps such that the time period gets longer with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode. This can be seen from a comparison of the different diagrams in Fig. 3 - Fig. 6 for equal duration PD of operation in the pause mode PM. In other words, the temperature decrease can be made less progressive in favor of a faster resumption of the user experience, the further the user experience has progressed prior to pausing it. As a result, the further the user experience has progressed prior to pausing it, the fewer temperature steps the pause mode temperature profile may have. Accordingly, with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode, the number of temperature steps decreases. For instance, if the number of puffs before the pause is greater than 4, or 5 or 6, the pause mode temperature profile may only comprise two or even a single temperature step (see Fig. 5 and Fig. 6).

As can be further deduced from Fig. 3 - Fig. 6, the adaptable pause mode temperature profile according to the present embodiment is in general such that the decrease of the operation temperature of the heater 30 is continued until the end of operation in the pause mode PM (unless - due to the operation history - the progression of the decrease is not retarded to such an extent that hardly or no decrease of the operation temperature of the heater takes place during operation in the heating mode, as in Fig. 5 and Fig. 6). Alternatively, the pause mode temperature profile may be such that the decrease of the operation temperature of the heater stops after a pre-defined time of operation in the pause mode, in particular a pre-defined decrease time period, and/or a

predefined number of temperature steps, and that subsequently the operation temperature of the heater is kept constant until the end of operation in the pause mode.

Fig. 7 - Fig. 8 show alternative pause mode temperature profiles, where the diagrams for different pause durations PD in Fig. 7 refer to a user experience that is paused after 4 puffs, and the diagrams for different pause durations PD in Fig. 8 refer to a user experience that is paused after 6 puffs. In contrast to the descending pause mode temperature profiles in Fig. 3 - Fig. 6, the pause mode temperature profiles in Fig. 7 and Fig. 8 are such that after decreasing the operation temperature over a pre-defined decrease time period DT an operation temperature T of the heater 30 is progressively increased in successive temperature steps as the duration of operation in the pause mode PM further progresses. Accordingly, the pause mode temperature profiles in Fig. 7 and Fig. 8 may be denoted as descending-ascending profiles. Advantageously, increasing the operation temperature again after a certain time period DT of decrease facilitates to prepare the aerosol-forming substrate in advance such as to be ready again for aerosol generation in suitable time. During the increase, the increment of the operation temperature between successive temperature steps may be similar or identical to the decrement of the operation temperature during the decrease. For instance, the decrement and the increment may be in a range between 2 °C and 25 °C, in particular between 5 °C and 20 °C, more particularly between 7 °C and 15 °C, for example 10 °C.

The decrease time period DT may be fixed. Alternatively, as follows from a comparison of the diagrams in Fig. 7 - Fig. 8, the controller 160 may be configured to adapt the decrease time period DT depending on the operation history during operation in the heating mode prior to operation in the pause mode. In this regard, it was found that further the user experience has progressed prior to pausing it, the less attention needs to be paid to avoiding or minimizing depletion of the non-depleted substrate, and the more focus can be placed on getting the substrate ready to resume the user experience more quickly. Accordingly, the greater the number of puffs during operation in the heating mode prior to operation in the pause mode, the shorter the decrease time period DT can be. Advantageously, the decrease time period DT may be adaptable in a range between range between 15 seconds and 6 minutes, in particular 3 minutes and 5 minutes, more particularly between 3.5 minutes and 4.5 minutes.

Similar to the descending temperature steps, a respective time period of the successive ascending temperature steps may be either fixed or adaptable, especially adaptable depending on the operation history during operation in the heating mode prior to operation in the pause mode. For instance, a progression of the (re-)increase of the operation temperature T of the heater 30 may depend on the operation history during operation in the heating mode prior to operation in the pause mode. Accordingly, the controller 160 may be configured to adapt the pause mode temperature profile such that an increase of the operation temperature of the heater

is less progressive with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode and/or with an increasing time period t_{hpp} of operation in the heating mode prior to operation in the pause mode. In particular, the respective time period of the successive ascending temperature steps may be adapted such that it gets longer with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode as can be seen from a comparison of the different diagrams in Fig. 7 and Fig. 8 for equal duration PD of operation in the pause mode PM.

If the pause mode is initiated at an advanced stage of the user experience, when the aerosol-forming substrate has already been at least partially or mostly depleted, it may be more advantageous in favor a proper first puff after resumption of a user experience that the operation temperature T during operation in the pause mode PM is not changed, but kept constant. Hence, the controller 160 may be configured to adapt the pause mode temperature profile such that an operation temperature of the heater is kept constant depending on the operation history, for instance, if the number of puffs during operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold number. This is shown in Fig. 6, where the temperature of the heater 30 is kept constant when pausing the user experience after 7 puffs, while in Fig. 6, the operation temperature T during operation in the pause mode PM is still reduced in one temperature step, when pausing the user experience after 6 puffs.

Once a user has decided to resume the user experience, a change from operation in the pause mode PM back into the heating mode may be initiated, for example, by a user input, preferably via the user button 165. In addition or alternatively, the motion sensor 166 may be used to re-initiate operation in the heating mode, for instance by detecting a movement of the device 100 which might indicate that the user is (again) holding the device 100 and therefore probably about to resume the user experience. Accordingly, the motion sensor 166 may output a sensor signal indicative of the device 100 being or being intended to be in operation again. In response to such as a sensor signal or in response to a signal generated by pressing the user button 165, the controller 160 may be switch from operation in the pause mode PM back into the heating mode HM. It is also possible that the controller 160 resumes operation in the heating mode HM after elapse of defined total duration of operation in the pause mode. In particular, this may happen irrespective of whether a user has actively initiated the resumption of the user experience. Advantageously, this avoids keeping the device 100 excessively long in the pause mode PM which in turn prevents the aerosol-forming substrate 21 from eventually becoming depleted without being used. In addition, having a predetermined maximum pause time may help preventing the device 100 from running out of electrical power. In principle, the total duration of operation in the pause mode may be either pre-defined, i.e. fixed, or adaptable depending on the operation history during operation in the heating mode prior to operation in the pause mode.

In order to resume a paused user experience with acceptable quality of the aerosol, it may be essential to suitably prepare the aerosol-forming substrate 21 for optimizing the deliveries with respect to the first puff after the pause. Preferably, aerosol delivery of the first puff after resuming the paused user experience should be as high as the first puff at the beginning of the user experience. This is an important aspect in order to satisfy the user who wants to promptly experience a proper. For this, it was found advantageous to provide an energy boost to the heater 30 when resuming the paused user experience. Accordingly, as shown in each diagram of Fig. 2 - Fig. 8, operation in the heating mode HM is resumed by starting with a temperature boost phase BP. The boost phase is designed such that a temperature of the heater 30 during operation in the temperature boost BP phase is higher, for instance by at least 30 °C, than an initial temperature level at the beginning of the heating mode temperature profile subsequent to operation in the preparation mode PCM, as described further above. Preferably, a temperature of the heater 30 during operation in the temperature boost phase BP preferably is also higher than the temperature of the heater 30 immediately before initiating operation in the pause mode PM as can be seen from the diagrams in of Fig. 2 - Fig. 8.

As can be further seen from Fig. 2, the temperature boost phase BP can be followed by an operation at lower temperatures in order to reduce energy consumption and to avoid excessive depletion of the substrate 21. However, for long durations of operation in the pause mode (see e.g. lower diagrams in Fig. 5) and/or for user experiences being paused at a late stage in the heating mode temperature profile, where the temperature level immediately before the pause may already be increased as compared to the initial temperature level at the beginning of the heating mode temperature profile (see e.g. diagrams in Fig. 6), the temperature during operation in the temperature boost phase BP may be equal to the temperature during subsequent operation in the heating mode immediately after the temperature boost phase BP.

Furthermore, the duration of the temperature boost phase BP may advantageously be adaptable by the controller, in particular depending on the operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration PD of operation in the pause mode. Preferably, the duration of the temperature boost phase BP is increased with an increasing number of puffs during operation in the heating mode HM prior to operation in the pause mode PM and/or with an increasing time period t_{hpp} of operation in the heating mode HM prior to operation in the pause mode and/or with an increasing duration PD of operation in the pause mode PM. For example, the duration of the temperature boost BP phase may be adaptable in a range between 1 second and 90 seconds, in particular between 5 seconds and 90 seconds, more particularly between 15 seconds and 60 seconds, even more particularly in a range between 15 seconds and 50 seconds, preferably between 20 seconds and 50 seconds or between 20 seconds and 30 seconds.

Although the temperature of the heater during operation in the temperature boost phase BP may in principle be adaptable as well, it was found advantageous to have it at a fixed temperature level, denoted as boost temperature level BTL (see Fig. 2). Preferably, the boost temperature level BTL is as high as possible, that is, at a maximum temperature reachable by the heater. Advantageously, this simplifies the control effort. In absolute terms, the temperature level of the heater during operation in the temperature boost phase BP may be in a range between 300 °C and 500 °C, in particular between 375 °C and 400 °C, preferably around 390 °C.

After termination of operation in the pause mode PM, the heater 30 may generally need some time to thermally prepare the aerosol-forming substrate 21 for a proper first user puff of the resumed user experience. The time for preparation may strongly depend on the operation history during operation in the heating mode prior to operation in the pause mode and/or on the duration of operation in the pause mode. Accordingly, it is preferred that operation in the heating mode HM is resumed by activating the heater 30 to reheat the substrate 21 for aerosol generation over a variable reheating time RHT (as indicated in Fig. 2), after which the substrate 21 is ready for the first puff of the resumed user experience to be taken. Although the reheating time RHT generally defines the time after which a user experience should be resumed at the earliest, it does not preclude that a user experience can be resumed before the reheating time has ended, in particular that a user takes a puff before the reheating time RHT has ended.

As mentioned the reheating time RHT is variable, and as such preferably determined by the controller 160 depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or a duration of operation in the pause mode PM. In general, the further the user experience has progressed prior to pausing it, in particular the greater the number of puffs during operation in the heating mode HM prior to operation in the pause mode PM, the longer the reheating time RHT should be made. Likewise, the reheating time RHT is increased the longer the duration PD of operation in the pause mode has been. The reheating time may be or may be adaptable in a range between 1 second and 90 seconds, in particular between 5 seconds and 60 seconds, more particular in a range between 5 seconds and 50 seconds. These values of the reheating time have proven advantageous to provide a satisfying first user puff.

The controller 160 is further configured to generate a signal indicating that the variable reheating time RHT has ended and/or that a user is permitted to resume puffing to generate aerosol from the device. This may be indicated to the user of the device 100 via an indicator, for instance via a visual indicator, such as a display or a light signal, e.g. a LEDs 169 as shown in Fig. 1, via a haptic indicator (haptic output unit), via an audio indicator (audio output unit), or via an audiovisual indicator.

In general, the duration of the temperature boost phase BP and the reheating time RHT are independent from each other. Accordingly, the duration of the temperature boost phase BP may be shorter than the reheating time RHT. Hence, upon termination of operation in the pause mode a user would take a first puff after the temperature boost phase BP has ended. This indicated in Fig. 2, where the temperature boost phase BP lasts from time t_3 to time t_5 , whereas the reheating time RHT is longer corresponding to the time span between time t_3 and time t_5 . Vice versa, the reheating time RHT may be shorter than a duration of the temperature boost phase BP, in which case the user would take a first puff after termination of operation in the pause mode PM during the temperature boost phase BP.

Furthermore, it was found that the position in the heating mode temperature profile to which the temperature of the heater 30 re-connects after termination of operation in the pause mode PM may have a significant impact on the quality of the first puff after resumption of the user experience. To this extent, it was found that the temperature of the heater 30 after operation in the pause mode PM should ideally re-connect to about the same temperature level as at the time of pausing operation in the heating mode HM, yet possibly shifted in the heating mode temperature profile by a variable time offset t_{offset} that depends on the operation history during operation in the heating mode prior to operation in the pause mode and/or on the duration PD of operation in the pause mode. As a result, operation in the heating mode is resumed at a shifted position in the heating mode temperature profile.

The time offset is illustrated in Fig. 2: There, operation in the heating mode is paused at time t_2 , when the first one of the consecutive step-like profile sections of the heating mode profile was effective for a duration t_A corresponding to the time span between time t_1 time t_2 , i.e. $t_A = t_2 - t_1$. Without having been paused, the predefined total interval time of the first profile sections would have been equal to $t_A + t_B = (t_2 - t_1) + (t_7 - t_4)$. That is, if operation of the pause would be re-connected to that time position in the heating mode temperature profile at which operation in the heating mode was paused, the temperature-versus-time curve after resumption of the heating mode would look like as indicated by the dashed-double dotted profile in Fig. 2. However, at hand, operation in the heating mode is resumed at a shifted position in the heating mode temperature profile which corresponds to a position in the heating mode temperature profile at the time of pausing operation in the heating mode shifted by a variable time offset t_{offset} . That is, the time offset t_{offset} amounts to the time shift by which the effective remaining time $t_B' = t_6 - t_4$ of operation in the first profile section is effectively shortened (or prolonged) as compared to the calculative remaining time t_B that is given by the predefined total interval time $t_A + t_B$ of the first profile section, i.e. the profile section of the heating mode temperature profile being effective at the time t_2 of pausing operation in the heating mode, minus that portion t_A of the predefined total interval time $t_A + t_B$ of the first profile section already elapsed until pausing operation in the heating mode HM.

As at hand the effective remaining time $t_{B'} = t_6 - t_4$ of operation in the first profile section is shortened as compared to the calculative remaining time t_B , the offset time t_{offset} is associated with a time shift forward in the heating mode temperature profile.

In general, the further the user experience has progressed prior to pausing it, in particular the greater the number of puffs during operation in the heating mode HM prior to operation in the pause mode, the greater the time shift forward in the heating mode temperature profile preferably is. Likewise, the longer the duration PD of operation in the pause mode, the greater the time shift forward in the heating mode temperature profile preferably is. Accordingly, as can be seen from a comparison of the various diagrams in Fig. 3 - Fig. 6, the controller 160 determines the time offset t_{offset} such as to have an increasing value associated with a time shift forward in the heating mode temperature profile with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode and/or with an increasing duration PD of operation in the pause mode.

In absolute terms, the time offset t_{offset} may be in a range between 0 seconds and 180 seconds or between 1 second and 180 seconds, in particular between 1 second and 100 seconds, more particularly in a range between 1 second and 70 seconds or between 10 seconds and 80 seconds or between 20 seconds and 70 seconds or between 30 seconds and 70 seconds backwards and/or forward in the heating mode temperature profile. These values have been proven particularly beneficial for a proper resumption of a user experience.

In relative terms, the effective remaining time $t_{B'}$ may be in a range between 0% and 100 % percent, in particular 0% and 80%, more particularly between 25% and 75% or between 30% and 50% of a calculative remaining time t_B . Likewise, the effective remaining time $t_{B'}$ may be in a range between 0% and 100% percent, in particular 0% and 80%, more particularly between 25% and 75% or between 30% and 50% of predefined total interval time $t_A + t_B$ of the profile section of the heating mode temperature profile being effective at the time t_2 of pausing operation in the heating mode HM.

As mentioned further above, the heating and pause mode temperature profiles may not only depend on operational parameters, such as the operation history, but in general also on the substrate type, in particular on its constituents, the thermal stability of the substrate, the total aerosol-former content, and/or the grammage of the substrate. The substrate type may have an impact on both, the general temperature levels during the various modes and the course of the profiles. The substrate type may even have an influence on whether one or more parameters of the various profiles are adapted, e.g. depending on the operation history, or not. To this extent, the various heating and pause mode temperature profiles shown in Fig. 2 - Fig. 8 preferably refer to a user experience with an aerosol-forming substrate containing tobacco material or a

combination of tobacco material and other botanical material(s) and/or for aerosol-forming substrates comprising a total aerosol-former content that is lower than 30 percent by weight, in particular lower than 25 percent by weight, preferably lower than 20 percent by weight, and/or for aerosol-forming substrates having a lower thermal mass. As an example, the substrate may be tobacco-containing aerosol-forming substrate comprising tobacco material, such as tobacco particles, in particular tobacco powder, preferably with a total tobacco content of at least 70 percent by weight, in particular at least 75 percent by weight. In addition, the substrate may comprise one or more cellulose based agents, such as cellulose fibers, preferably with a total cellulose based agent content of at most 10 percent by weight, in particular at most 5 percent by weight. The substrate may further comprise one or more aerosol formers, preferably with a total aerosol-former content that is lower than 30 percent by weight, more particularly lower than 20 percent by weight.

In contrast to this, the lower diagrams in each of **Fig. 9 - Fig. 12** show various heating and pause mode temperature profiles which are preferably designed for a user experience with an aerosol-forming substrate containing no tobacco material, i.e. for a non-tobacco aerosol-forming substrate, and/or an aerosol-forming substrate having a higher thermal mass, and/or an aerosol-forming substrate comprising a total aerosol-former content that is greater than or equal 30 percent by weight, in particular greater than 35 percent by weight, more particularly greater than 40 percent by weight or greater than 45 percent by weight,. For example, the non-tobacco aerosol-forming substrate may comprise one or more cellulose based agents, preferably with a total cellulose based agent content of at least 35 percent by weight. The substrate may further comprise one or more aerosol formers, preferably with a total aerosol-former content that is greater than or equal to 30 percent by weight. In addition, the substrate may comprise nicotine. In order to stabilize the nicotine, the substrate may further comprise one or more carboxylic acids selected from fumaric acid, maleic acid and malic acid, preferably a total carboxylic acid content of at least 0.5 percent by weight.

Like the diagrams of in each one of Fig. 3 - Fig. 5 and Fig. 6 - Fig. 8, the lower diagrams in each one of Fig. 9 - Fig. 12 show the time evolution of the operation temperature T of the heater for different durations PD of operation in the pause mode, wherein the lower diagrams of Fig. 9 (Fig. 9-1 – Fig. 9-4) refer to a user experience that is paused after 2 puffs, the lower diagrams of Fig. 10 (Fig. 10-1 – Fig. 10-4) refer to a user experience that is paused after 4 puffs, the lower diagrams of Fig. 11 (Fig. 11-1 – Fig. 11-4) refer to a user experience that is paused after 6 puffs and the lower diagrams of Fig. 12 (Fig. 12-1 – Fig. 12-4) refer to a user experience that is paused after 7 puffs.

The profiles shown in the lower diagrams of Fig. 9 - Fig. 12 deviate from the profiles shown in Fig. 2 - Fig. 8 in the following aspects:

First, aerosol-forming substrates containing no tobacco material may typically have a higher total aerosol-former content than tobacco-containing substrates. In general, this requires lower temperatures during the heating mode and the pause mode. As can be seen from the lower diagrams in each one of Fig. 9 - Fig. 12, the temperature of the heater during operation in the "normal" heating mode, i. e. during any phase of the heating mode except for the temperature boost phase, is in a range around 255 °C. Vice versa, during operation in the pause mode, the temperature of the heater is in a range around 130 °C. The latter value is a compromise between – on the one hand – a temperature level that is sufficiently low to reduce depletion of the substrate during the pause mode but still sufficiently high to increase the deliveries of the first puff after resumption of the user experience, and – on the other hand – a temperature level that is within a technically feasible regulation range of the controller. At hand, the technically feasible regulation range is given by the inherent magnetic and electrical properties of the susceptor 31 which are associated with inherent calibration/reference values identical or similar to those described in WO 2023/285458 A1. More particularly, the temperature of the heater level during operation in the pause mode is chosen such that is slightly below, but not too close to the minimum (valley) in the conductance of the susceptor as described in WO 2023/285458 A1. Otherwise, calibration could be become an issue.

Second, as can be seen from a comparison of the lower diagrams in each one of Fig. 9 - Fig. 12, the temperature level to which the temperature of the heater is lowered upon initiating operation in the pause mode is always the same, regardless of the operation history prior to operation in the pause mode, i.e. independent from an operation history during operation in the heating mode prior to operation in the pause mode. Moreover, as follows from a comparison of the various lower diagrams within each one of Fig. 9 - Fig. 12, the temperature level during operation in the pause is constant over time, i.e. independent from a duration of operation in the pause mode.

Third, the profiles shown in the lower diagrams of Fig. 9 - Fig. 12 deviate from the profiles shown in Fig. 2 - Fig. 8 with respect to the heating mode temperature profile. While in Fig. 2 - Fig. 8, the heating mode temperature profiles include a plurality of profile sections at different temperature levels, the heating mode temperature profile in the lower diagrams of Fig. 9 - Fig. 12 is flat (except for the temperature boost), i.e. the substrate is heated at a constant temperature level over the entire user experience.

Fourth, similar to the profiles shown in Fig. 2 - Fig. 8, the profiles shown in the lower diagrams of Fig. 9 - Fig. 12 include a temperature boost phase BP, which marks the beginning of the resumed operation in the heating mode. However, in contrast to the profiles shown in Fig. 2 - Fig. 8, it has been found that aerosol-forming substrates containing no tobacco material but a higher total aerosol-former content do not require a temperature boost when resuming the user

experience after a short duration of operation in the pause mode, e.g. shorter than 30 seconds. That is, after the pause, the temperature of the heater is "only" increased to the temperature level of the "normal" heating mode prior to operation in the pause mode. Only for durations of operation in the pause mode longer than 30 seconds, a temperature boost phase at a temperature level high than during "normal" heating operation may prove beneficial to suitably prepare the substrate for the first puff after the pause. In the example given, the temperature of the heater during operation in the temperature boost phase, in particular the boost temperature level, may be in or may be adaptable in a range between 250 °C and 400 °C, in particular between 250 °C and 300 °C, more particularly between 260 °C and 275 °C, for example 270 °C. Again, these values may be a compromise between – on the one hand – a temperature level that is still sufficiently high to increase the deliveries of the first puff after resumption of the user experience, and – on the other hand – a temperature level that is within a technically feasible regulation range of the controller. At hand, the temperature of the heater during operation in the temperature boost phase is chosen such that is slightly below, but not too close to the maximum (hill) in the conductance of the susceptor as described in WO 2023/285458 A1. To this extend, this temperature corresponds to the maximum temperature reachable by the heater.

Further in contrast to the profiles shown in Fig. 2 - Fig. 8, the duration of the temperature boost phase BP always equals the reheating time RHT, i.e. the time required by the aerosol-generating device to prepare the aerosol-forming substrate for a proper first user puff after the pause. As a consequence, the temperature boost phase always ends at the same time the device is ready for the user to take the first puff after the pause. At this point in time, the controller may generate a signal, e.g. via the LEDs 169 as shown in Fig. 1, which indicates that the reheating time RHT has ended and that the user is permitted to resume puffing to generate aerosol from the device.

Like in Fig. 2 - Fig. 8, the reheating time RHT/the duration of the temperature boost phase BP may in general depend on the operation history during operation in the heating mode prior to operation in the pause mode and the duration of operation in the pause mode PM.

For very short pause durations, e.g. below 30 seconds, in particular for pause durations requiring no temperature boost, the reheating time RHT can be short, e.g. around 5 seconds. In particular, for short pause durations, the reheating time RHT may also be constant irrespective of the operation history during operation in the heating mode prior to operation in the pause mode, in particular irrespective of the number of puffs during operation in the heating mode HM prior to operation in the pause mode PM.

For longer pause durations, e.g. longer than 30 seconds, the reheating time RHT/the duration of the temperature boost phase BP is adaptable by the controller 160 such that the reheating time RHT/ the duration of the temperature boost phase BP increases with an increasing

number of puffs during operation in the heating mode HM prior to operation in the pause mode PM and/or with an increasing time period of operation in the heating mode HM prior to operation in the pause mode. In the present examples of Fig. 9 - Fig. 12, the reheating time RHT/the duration of the temperature boost phase BP may increase from 22 seconds (for zero or one puff being take before the pause) up to 30 seconds (for four or more puffs being taken before the pause). For longer pause durations, the operation history during operation in the heating mode prior to operation in the pause mode may be the dominant factor, in particular the only factor, in adapting of the reheating time RHT/the duration of the temperature boost phase BP, whilst the duration of operation in the pause mode PM may have less or even no influence thereon. In particular, for a given operation history, e.g. for a given number of puffs taken before the pause, the reheating time RHT/the duration of the temperature boost phase BP may be constant, i.e. always the same, for any duration of operation in the pause mode PM larger than, for example, 30 seconds.

The findings on the reheating time and the duration of the temperature boost phase BP as described herein have been tested and proven to provide acceptable aerosol deliveries. In this regard, the upper diagrams of each one of Fig. 9 - Fig. 12 show experimental evidence and simulation data reflecting the glycerin delivery (aerosol former delivery) – as indicator and measure for the aerosol deliveries – as the number of puffs progresses. While the upper curve in each diagram reflects the glycerin delivery for a user experience that is not pause, the two lower curves in each of the upper diagrams of Fig. 9 - Fig. 12 relate to user experiences that are paused after 2 puffs and resumed at puff number 3 (Fig. 9-1 – Fig. 9-4), after 4 puffs and resumed at puff number 5 Fig. 10 (Fig. 10-1 – Fig. 10-4), after 6 puffs and resumed at puff number 7 (Fig. 11 (Fig. 11-1 – Fig. 11-4), and after 7 puffs and resumed at puff number 8 (Fig. 12-1 – Fig. 12-4), respectively. In each diagram, the dashed one of the two lower curves refers to a reheating time/duration of the temperature boost phase BP of about 20 seconds, whereas the continuous (non-dashed) one of the two lower curves refers to a longer reheating time/duration of the temperature boost phase BP in a range between 25 seconds and 30 seconds. As can be seen from a comparison of the respective lower curves in each of the upper diagrams of Fig. 9 - Fig. 12, the glycerin delivery is higher for a longer reheating times/durations of the temperature boost phase BP, i.e. closer to the glycerin delivery of an unpaused user experience.

For the purpose of the present description and of the appended claims, except where otherwise indicated, all numbers expressing amounts, quantities, percentages, and so forth, are to be understood as being modified in all instances by the term "about". Also, all ranges include the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein. In this context, therefore, a number A is understood as $A \pm 5$ percent of A. Within this context, a number A may be considered to include numerical values that are within general standard error for the measurement of the property that

the number A modifies. The number A, in some instances as used in the appended claims, may deviate by the percentages enumerated above provided that the amount by which A deviates does not materially affect the basic and novel characteristic(s) of the claimed invention. Also, all ranges include the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein.

5

CLAIMS

1. An aerosol-generating device comprising a controller configured to control a heater for heating an aerosol-forming substrate in order to generate an aerosol,
wherein the controller is configured to selectively operate:
5 in a heating mode in which the controller controls the heater according to a heating mode temperature profile for generating an aerosol, and
 in a pause mode in which the controller controls the heater according to a pause mode temperature profile for pausing operation in the heating mode,
wherein the controller is further configured to adapt the pause mode temperature
10 profile depending on an operation history during operation in the heating mode prior to operation in the pause mode and/or on a duration of operation in the pause mode.
2. The aerosol-generating device according to claim 1, wherein the operation history includes at least one of the following parameters:
15 - a number of puffs during operation in the heating mode prior to operation in the pause mode;
 - a time period of operation in the heating mode prior to operation in the pause mode.
3. The aerosol-generating device according to any one of the preceding claims, wherein the
20 controller is configured to adapt the pause mode temperature profile such that an operation temperature of the heater is progressively decreased as the duration of operation in the pause mode progresses.
4. The aerosol-generating device according to claim 3, wherein the controller is configured to
25 adapt the pause mode temperature profile such that a progression of a decrease of the operation temperature of the heater is adapted depending on the operation history during operation in the heating mode prior to operation in the pause mode, in particular such that a decrease of the operation temperature of the heater is less progressive with an increasing number of puffs during operation in the heating mode prior to operation in the pause mode
30 and/or with an increasing time period of operation in the heating mode prior to operation in the pause mode.
5. The aerosol-generating device according to any one of the preceding claims, wherein the
35 controller is configured to adapt the pause mode temperature profile such that an operation temperature of the heater is decreased in successive temperature steps as the duration of operation in the pause mode progresses, wherein the controller preferably is configured to

adapt a respective time period of the successive temperature steps depending on the operation history during operation in the heating mode prior to operation in the pause mode.

- 5 6. The aerosol-generating device according to claim 5, wherein during the decrease a decrement of the operation temperature of the heater between successive temperature steps is in a range between 2 °C and 25 °C, in particular between 5 °C and 20 °C, more particularly between 7 °C and 15 °C, for example 10 °C.
- 10 7. The aerosol-generating device according to any one of the preceding claims, wherein the controller is configured to adapt the pause mode temperature profile such that after decreasing the operation temperature over a pre-defined decrease time period an operation temperature of the heater is progressively increased, in particular increased in successive temperature steps, as the duration of operation in the pause mode further progresses.
- 15 8. The aerosol-generating device according to claim 7, wherein the controller is configured to adapt the decrease time period depending on the operation history during operation in the heating mode prior to operation in the pause mode.
- 20 9. The aerosol-generating device according to claim 7 or claim 8, wherein the decrease time period is in a range between range between 15 seconds and 6 minutes, in particular 3 minute and 6 minutes, more particularly between 3.5 minutes and 4 minutes.
- 25 10. The aerosol-generating device according to any one of claims 7 to 9, wherein the controller is configured to adapt the pause mode temperature profile such that a progression of an increase of the operation temperature of the heater is adapted depending on the operation history during operation in the heating mode prior to operation in the pause mode.
- 30 11. The aerosol-generating device according to any one of claims 7 to 10, wherein during the increase a respective time period of the successive temperature steps is in a range between 15 seconds and 6 minutes, in particular 1 minute and 6 minutes.
- 35 12. The aerosol-generating device according to any one of the preceding claims, wherein the controller is configured to adapt the pause mode temperature profile such that an operation temperature of the heater is kept constant depending on the operation history, for instance, if the number of puffs during operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold number and/or if the time period of operation in the heating mode prior to operation in the pause mode is equal to or above a pre-defined threshold time.

13. The aerosol-generating device according to claim 12, wherein the pre-defined threshold number of puffs is in a range between 6 and 10, in particular between 7 and 9, for instance 8; and/or wherein the pre-defined threshold time of operation in the heating mode prior to operation in the pause mode is in a range between 2 minutes and 8 minutes, in particular 4 minutes and 7 minutes, for instance 5 minutes.
14. The aerosol-generating device according to any one of the preceding claims, wherein the heating mode temperature profile and the pause mode temperature profile are chosen such that an operation temperature of the heater during operation in the pause mode is lower than during operation in the heating mode.
15. An aerosol-generating system comprising an aerosol-generating device according to any one of the preceding claims, and an aerosol-generating article including an aerosol-forming substrate for use with the device.

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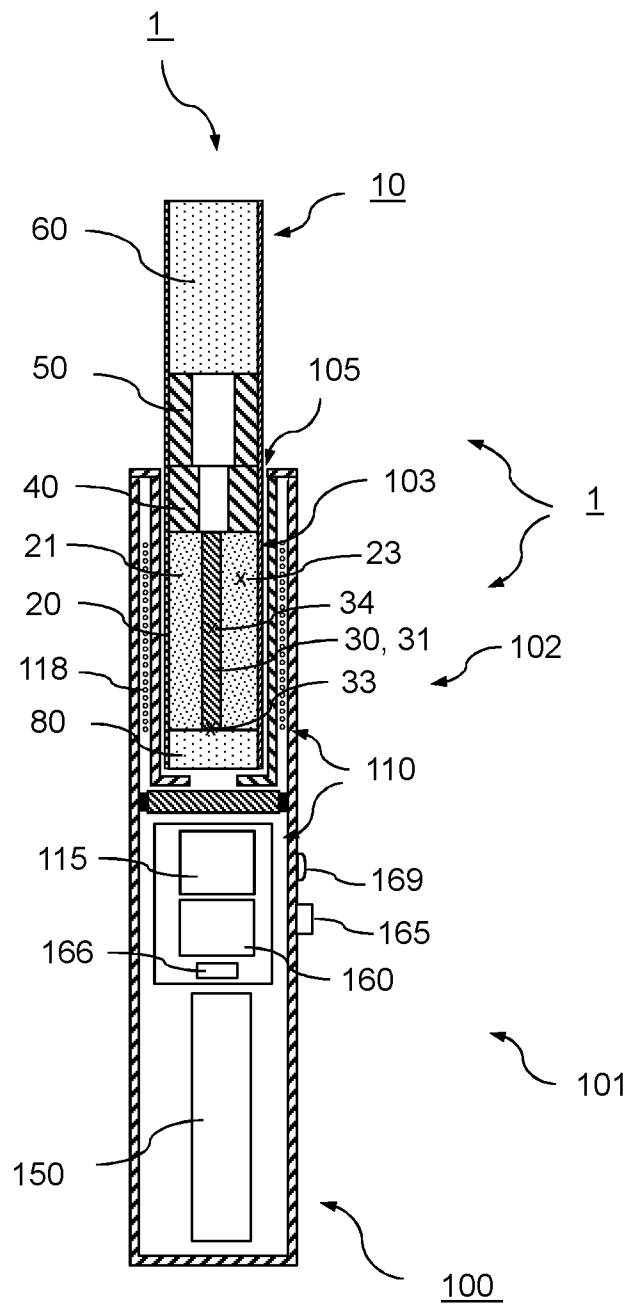


Fig. 1

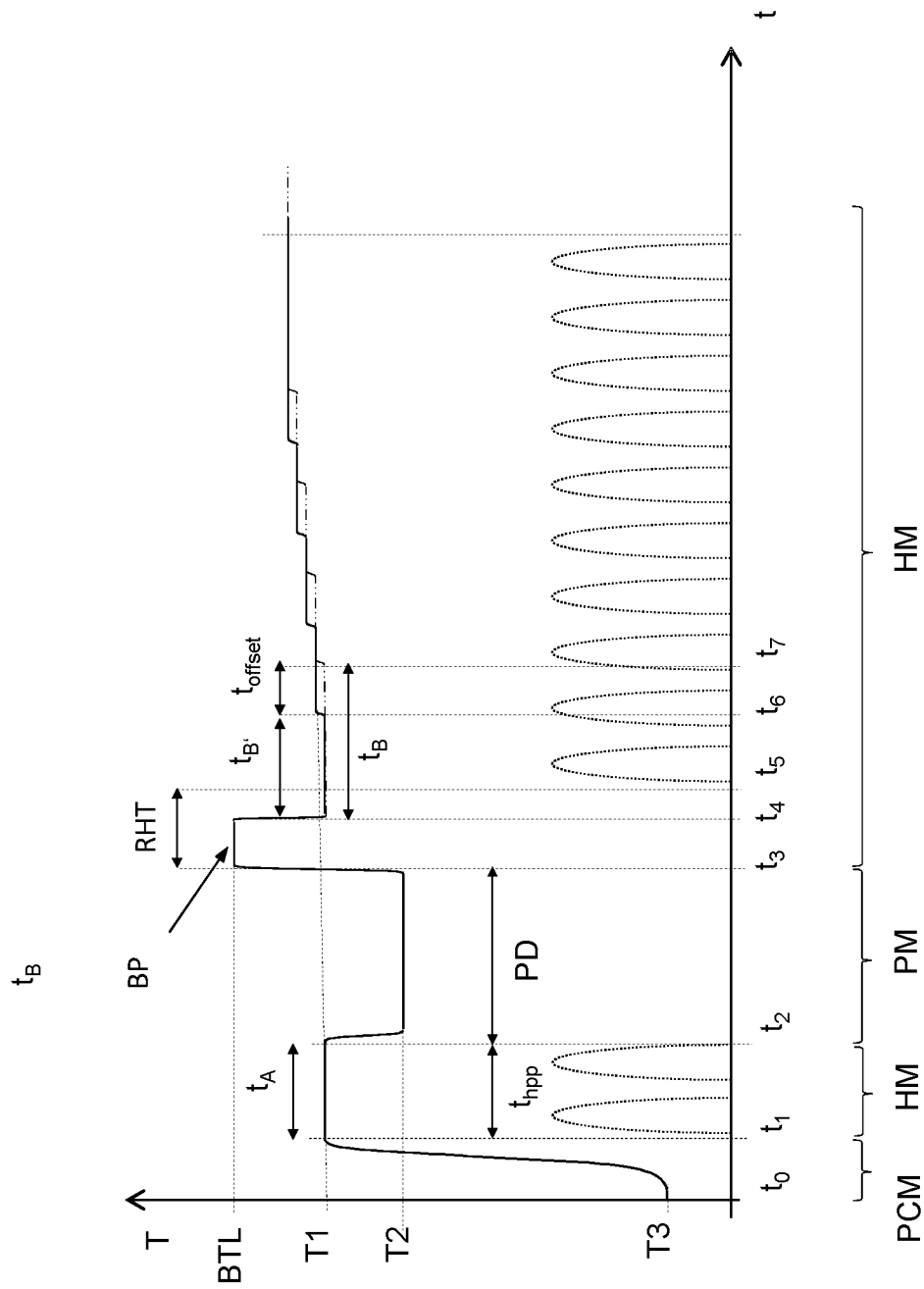


Fig. 2

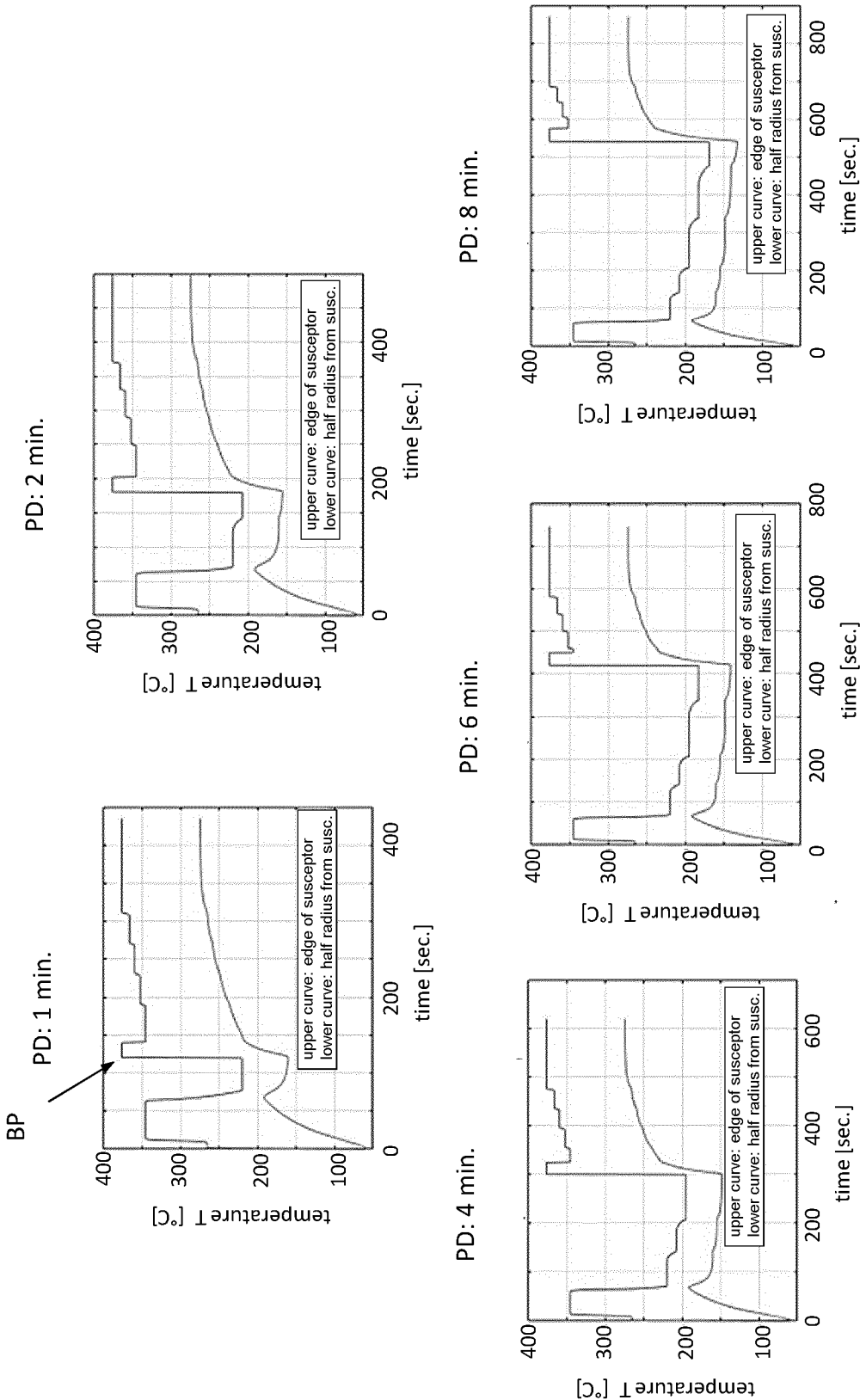


Fig. 3

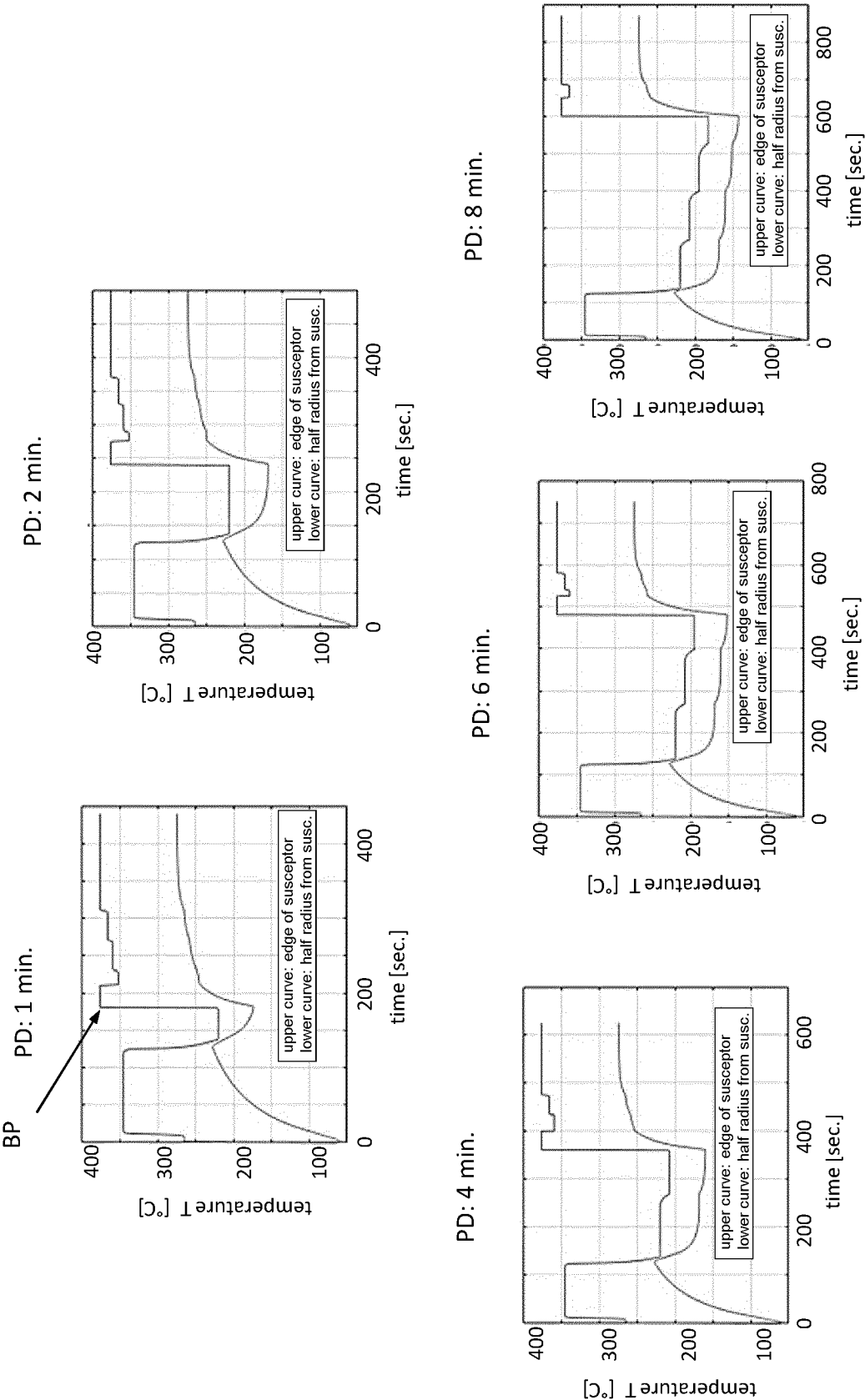


Fig. 4

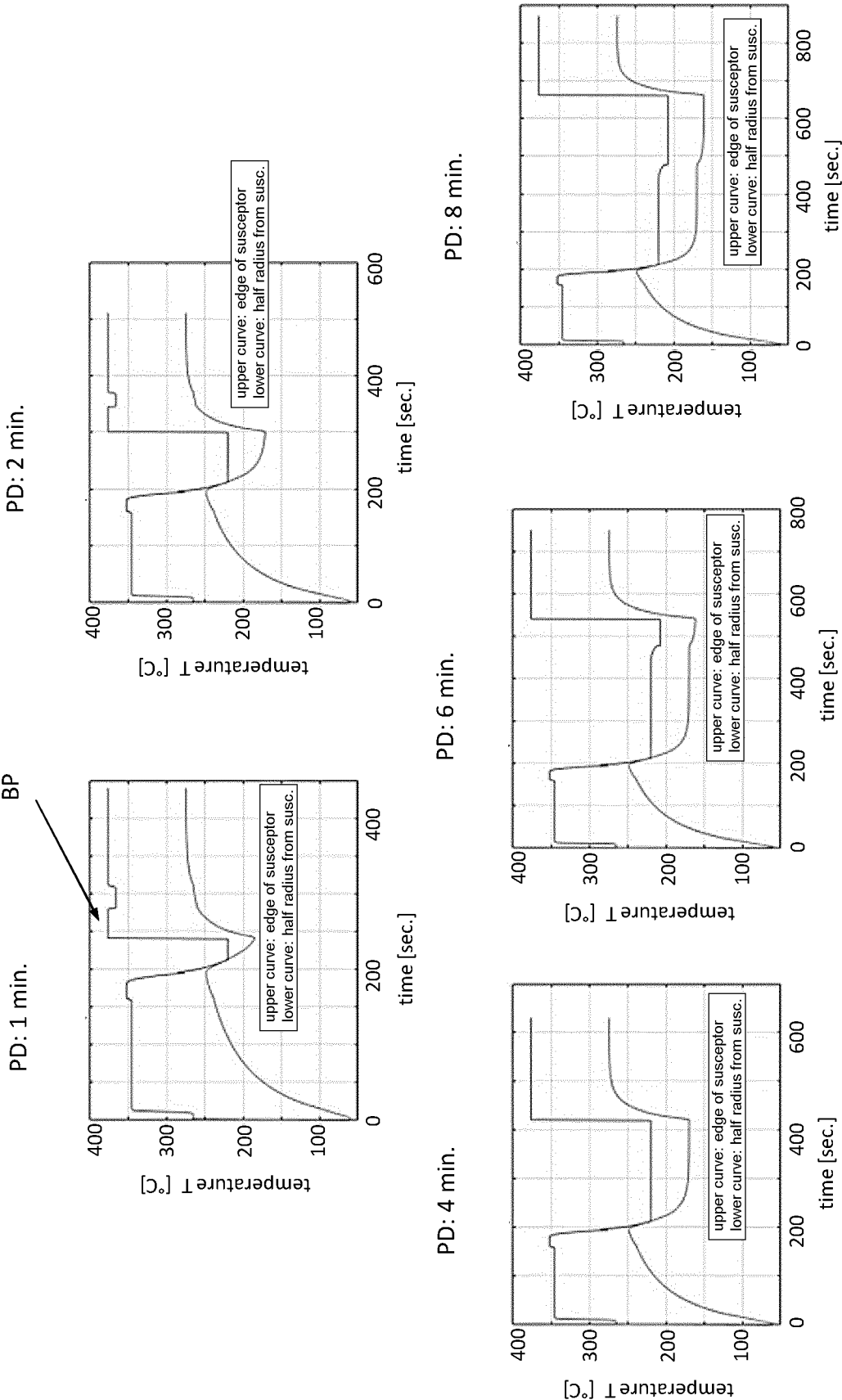


Fig. 5

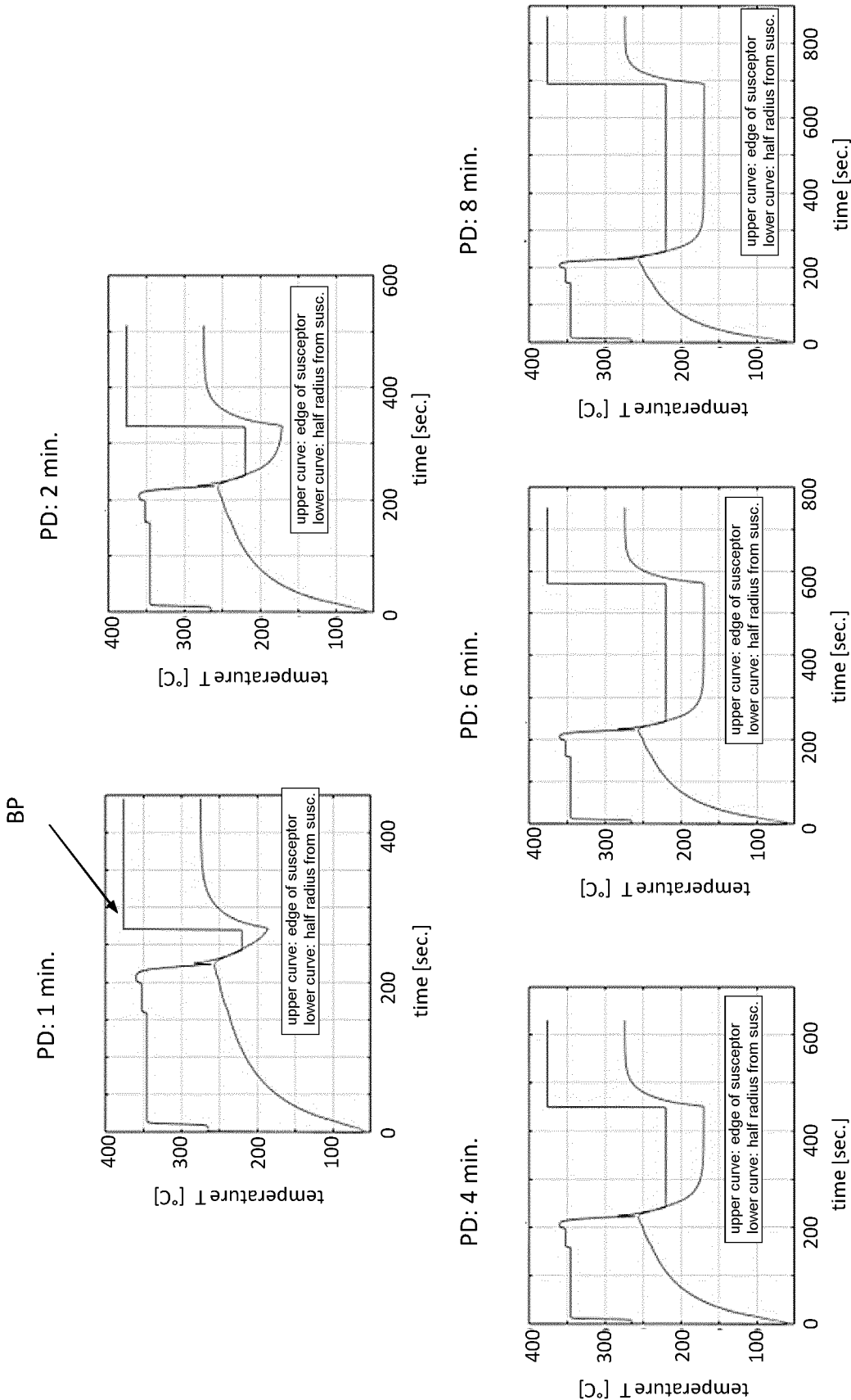


Fig. 6

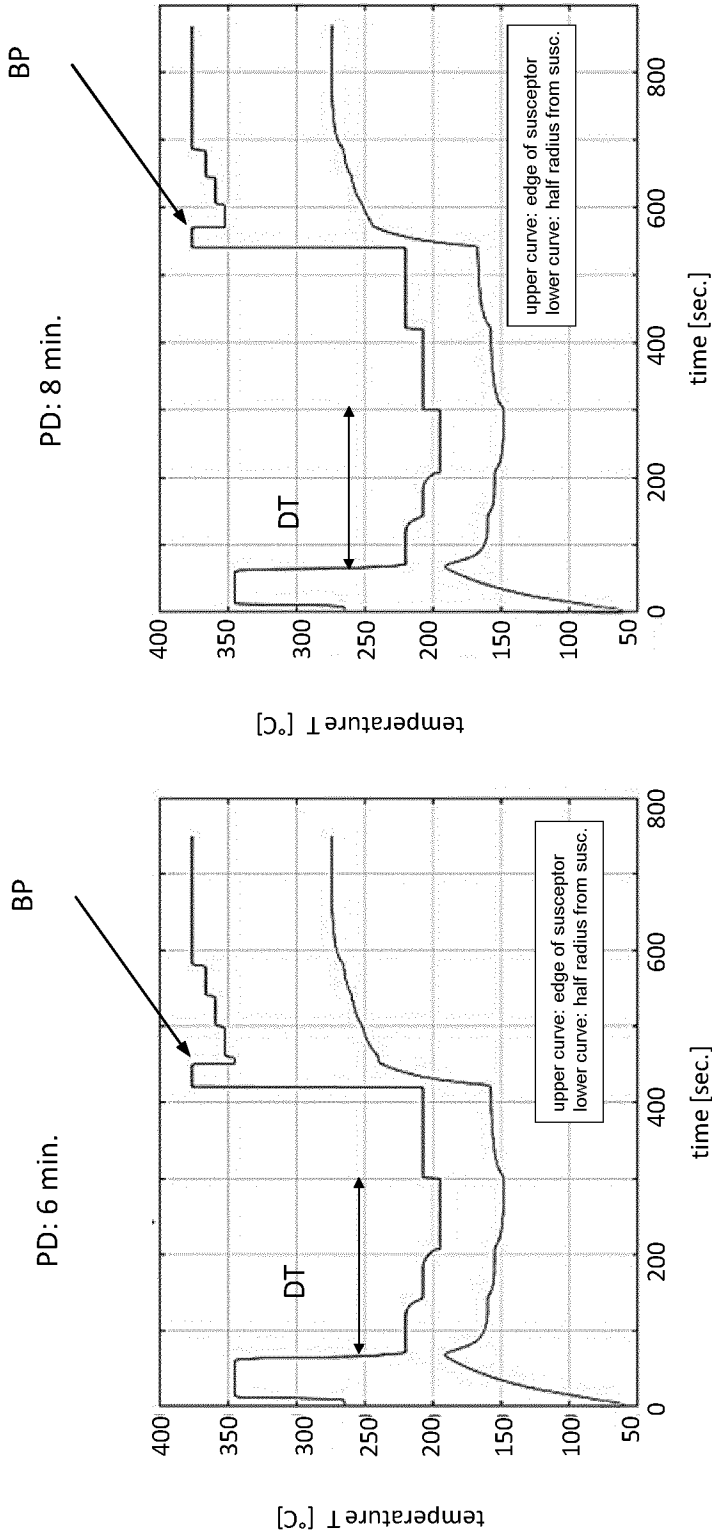


Fig. 7

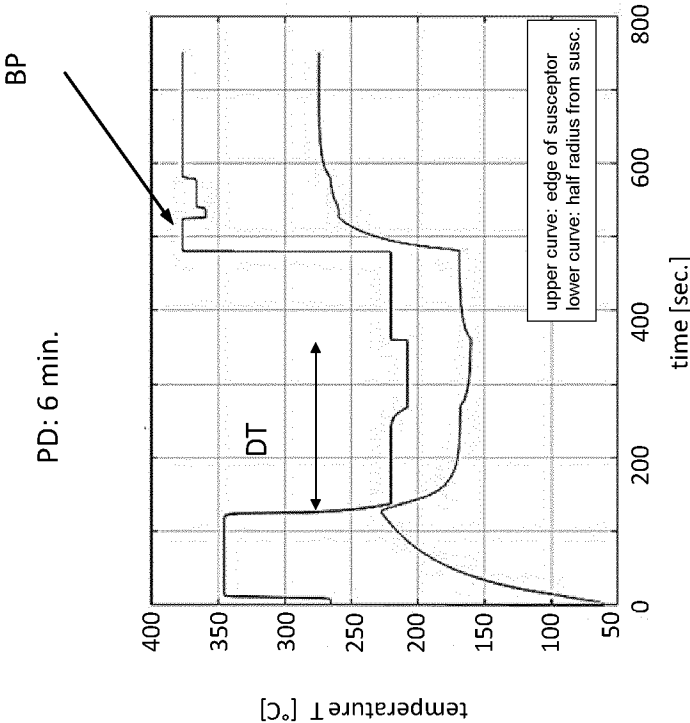
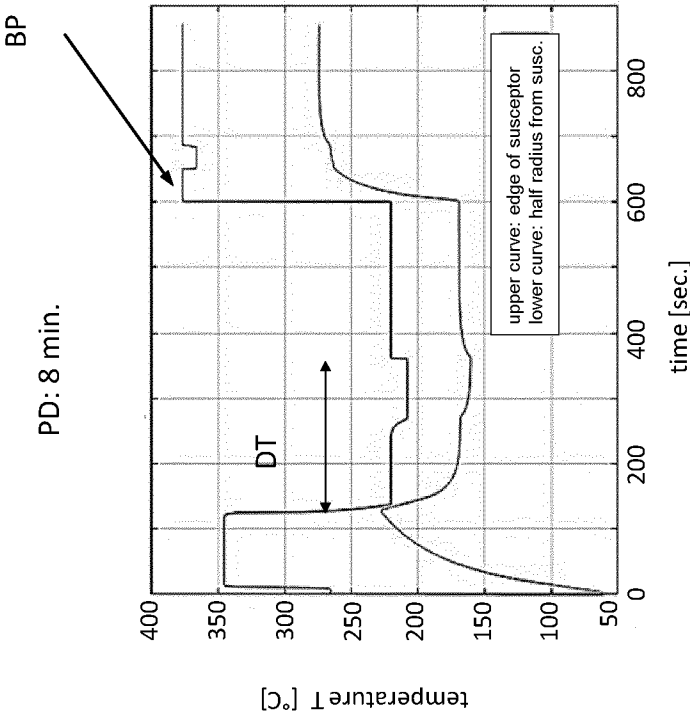


Fig. 8

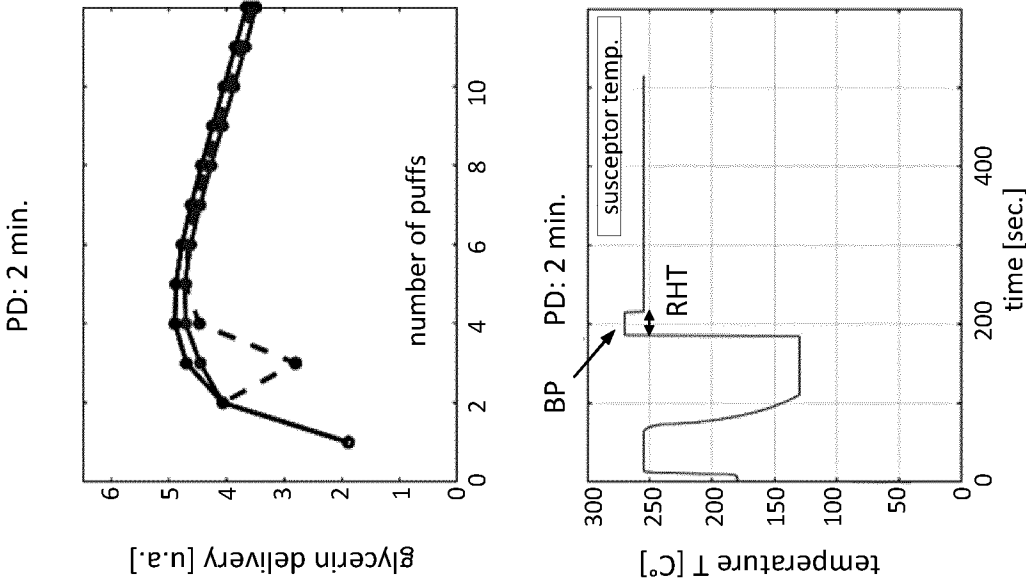


Fig. 9-2

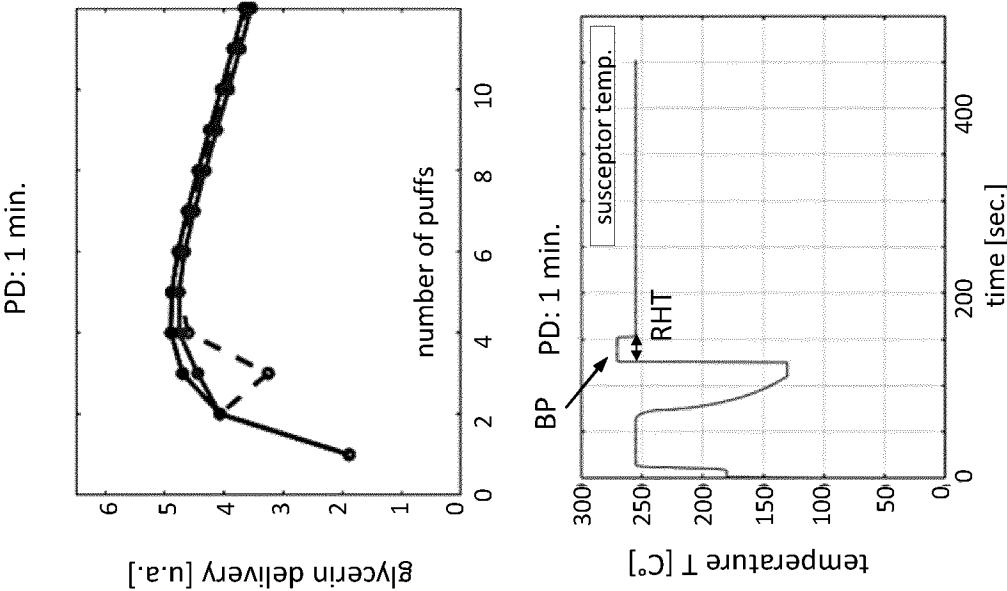


Fig. 9-1

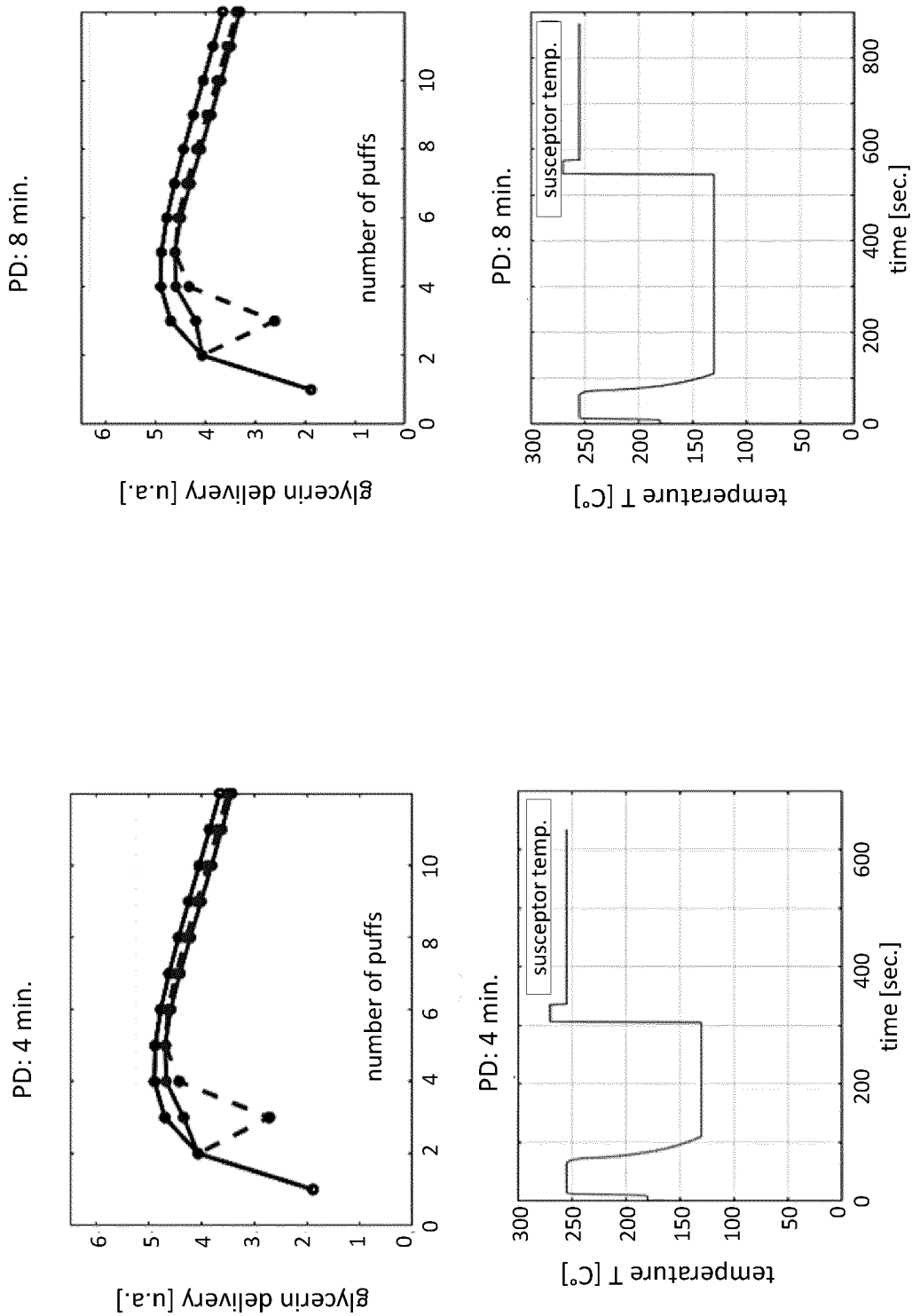


Fig. 9-4

Fig. 9-3

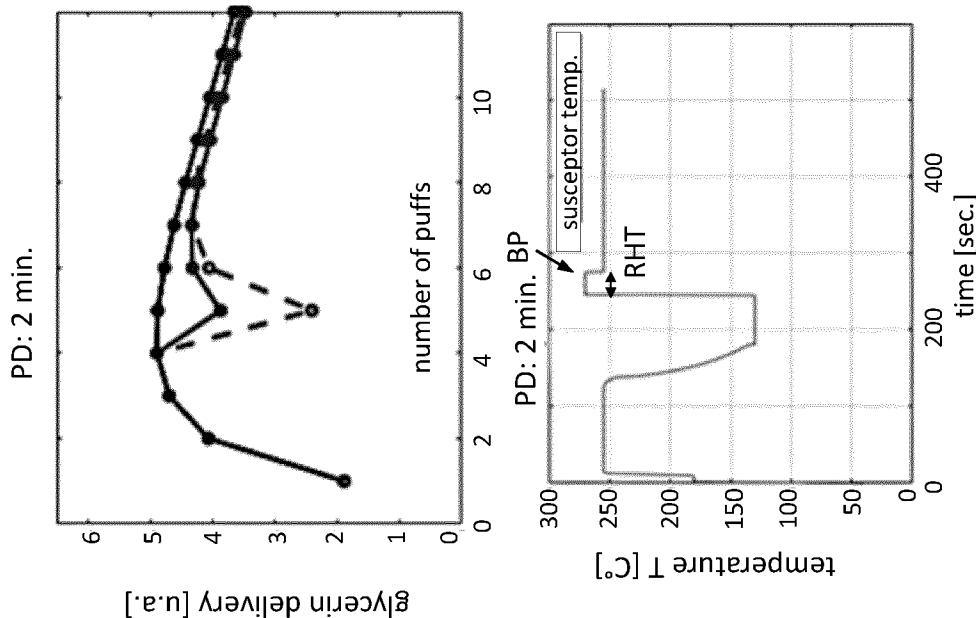


Fig. 10-2

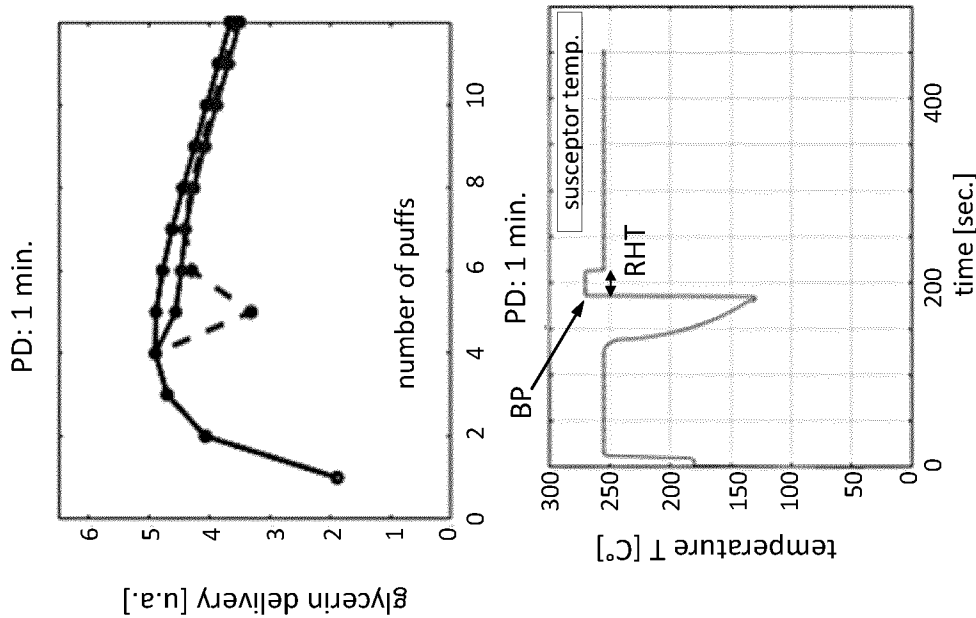


Fig. 10-1

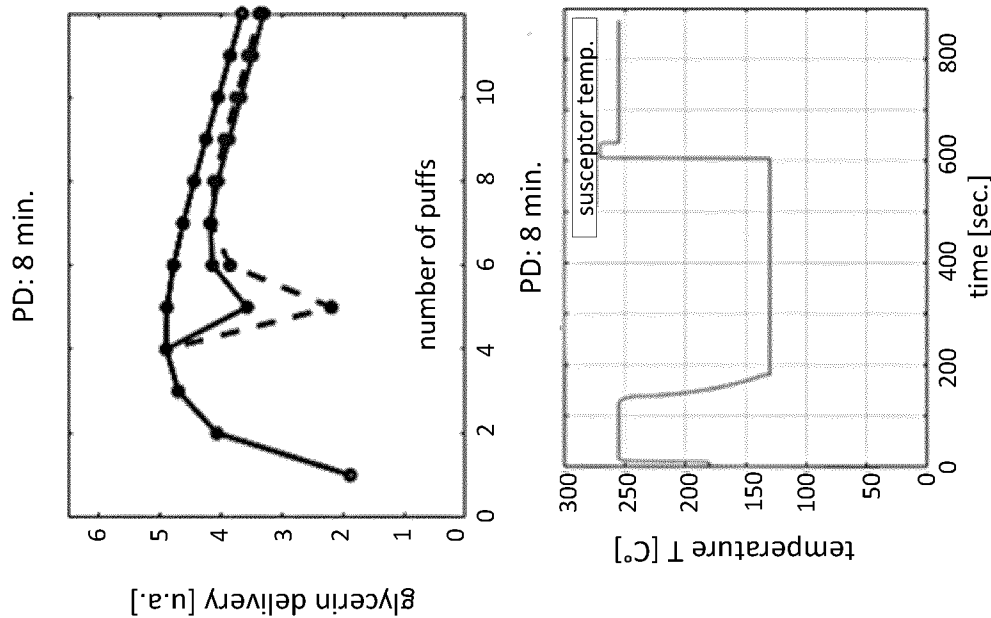


Fig. 10-4

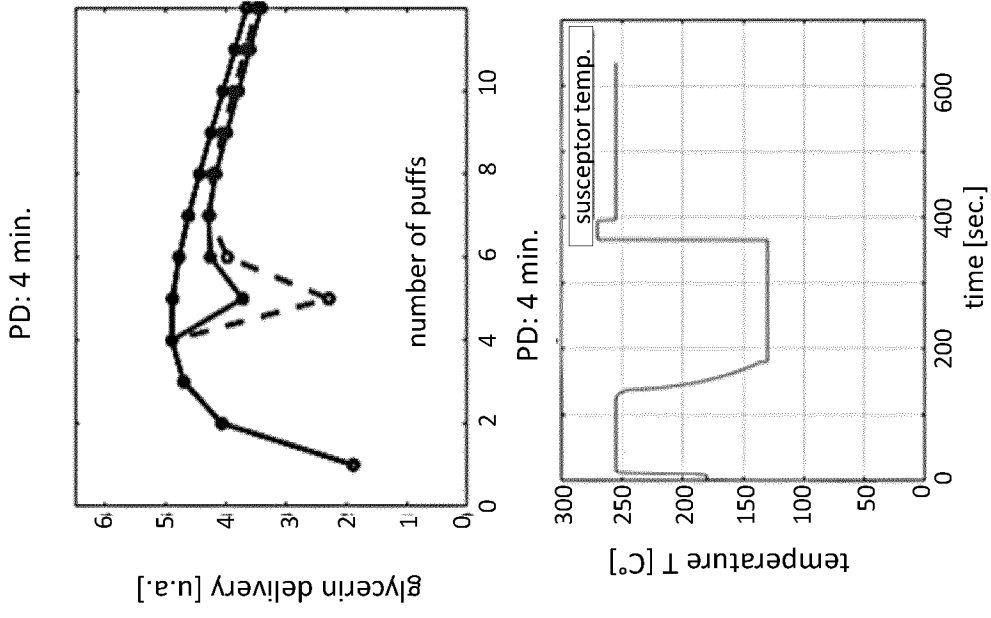


Fig. 10-3

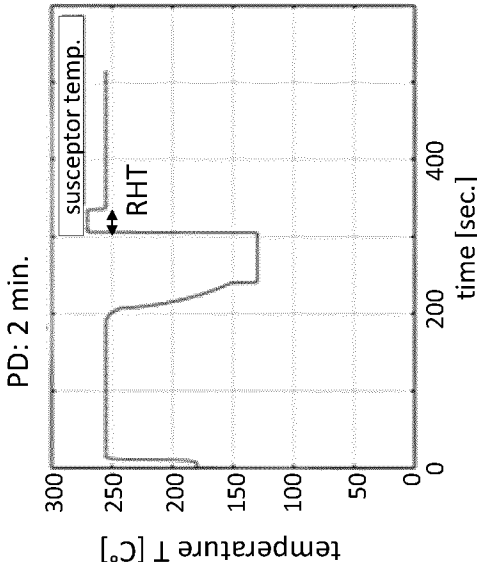
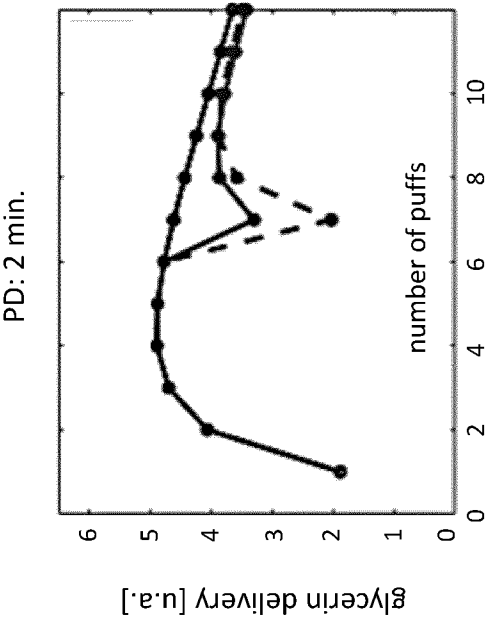


Fig. 11-2

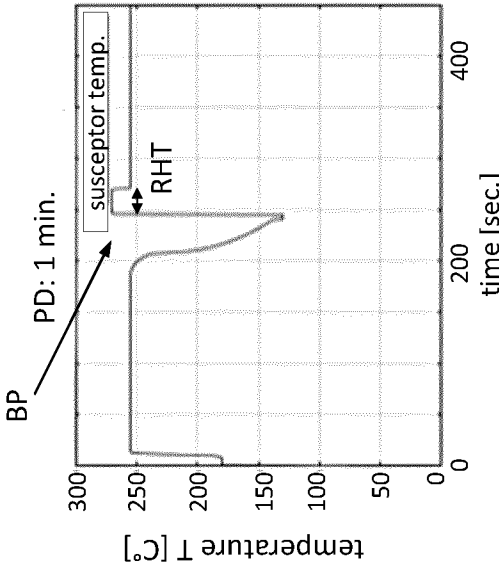
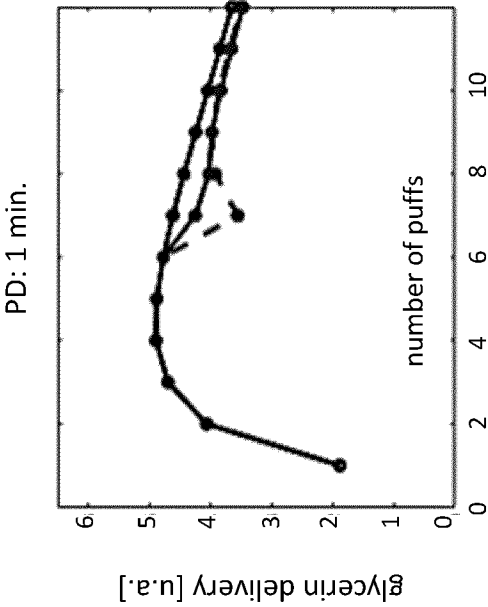


Fig. 11-1

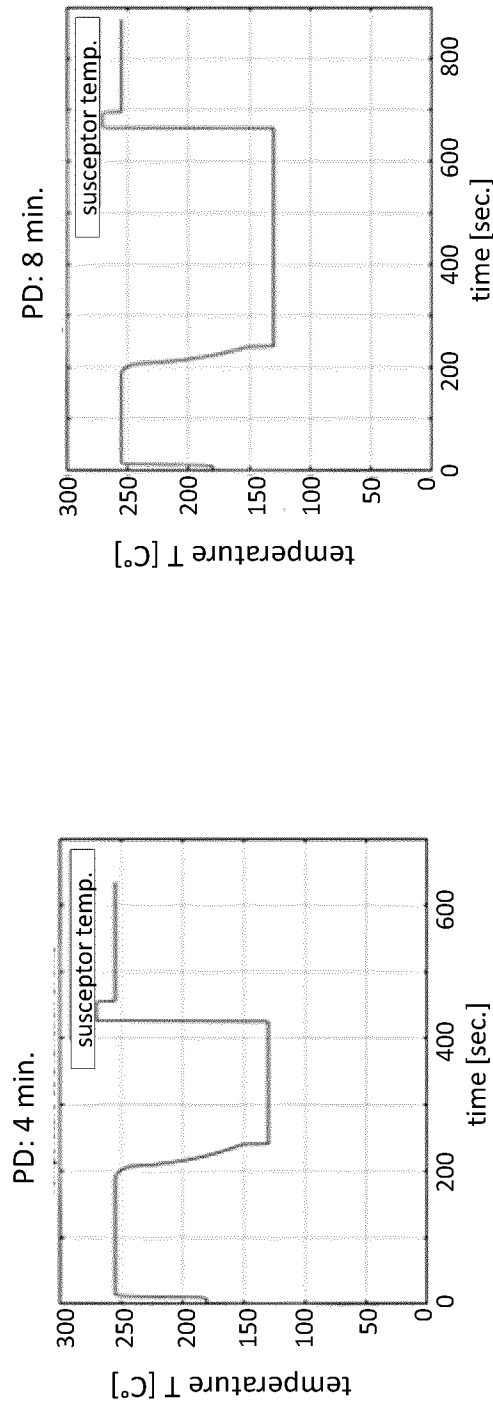
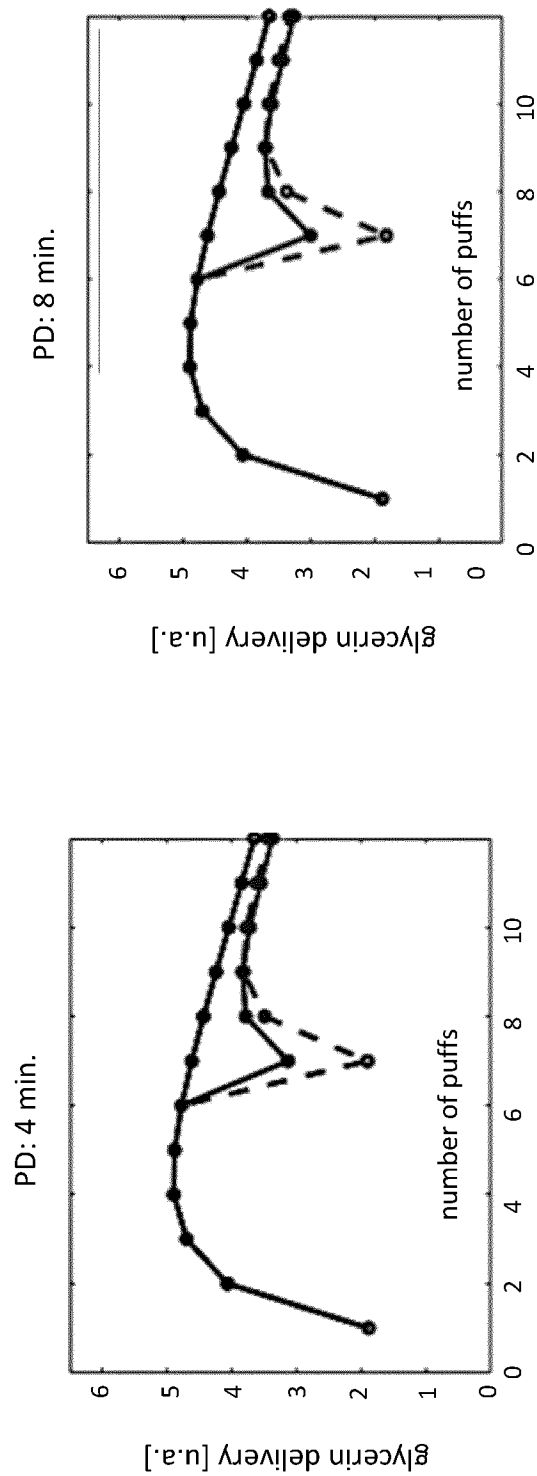


Fig. 11-3

Fig. 11-4

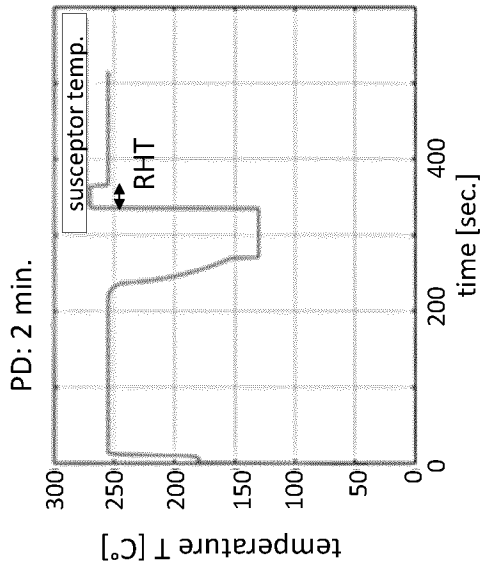
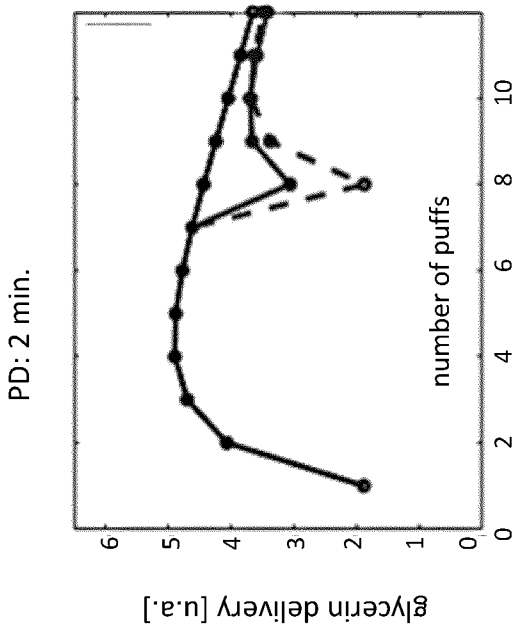


Fig. 12-2

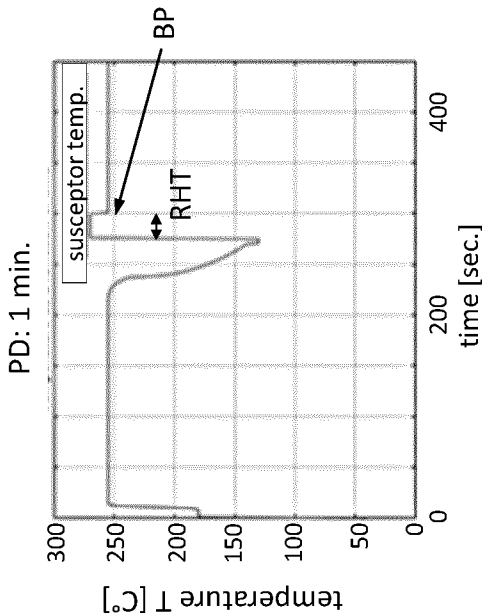
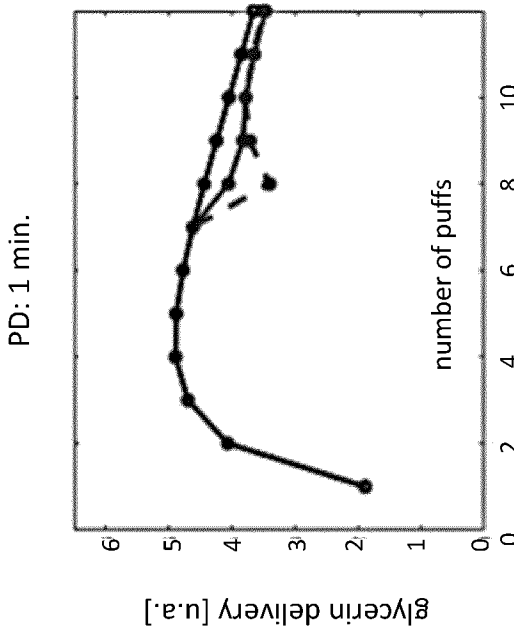


Fig. 12-1

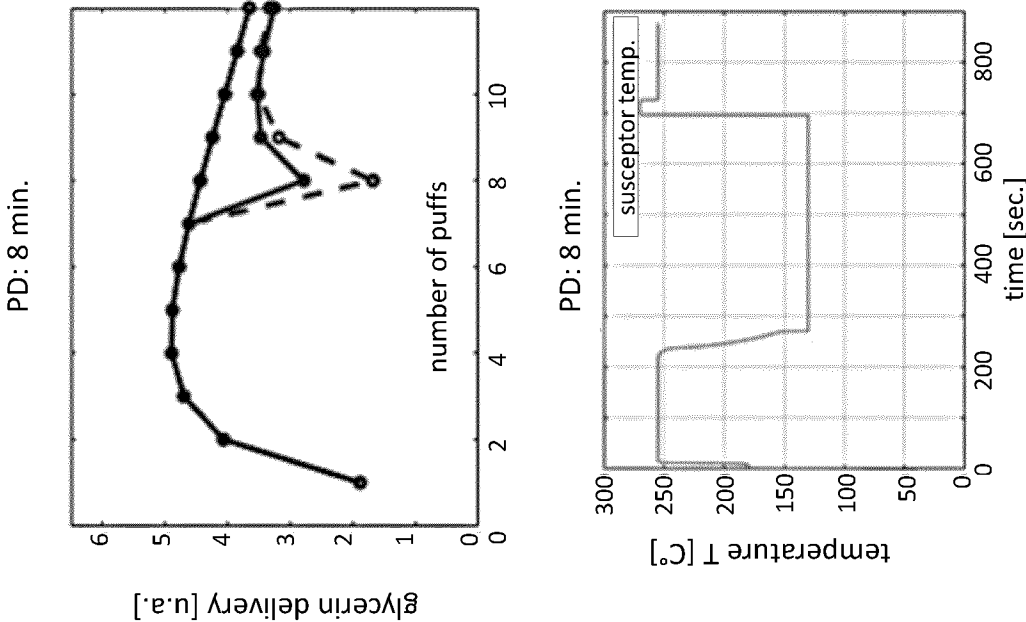


Fig. 12-4

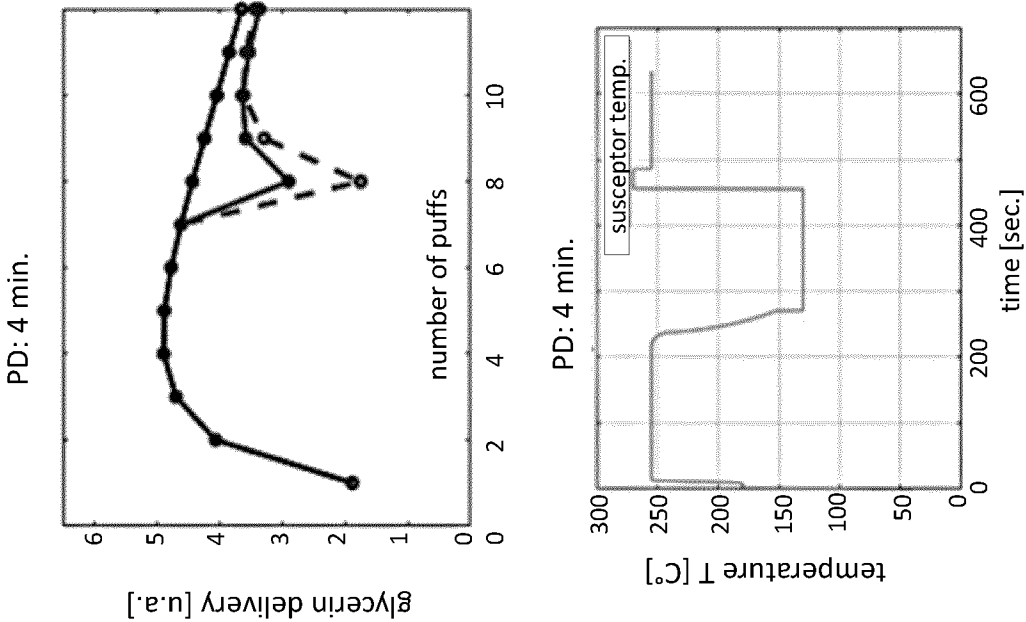


Fig. 12-3

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2024/077449

A. CLASSIFICATION OF SUBJECT MATTER

INV. A24F40/50 A24F40/57
ADD. A24F40/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A24F A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 2023 0118004 A (EM TECH CO LTD [KR])	1 - 3,
	10 August 2023 (2023-08-10)	12 - 15
A	the whole document	4 - 11

A	WO 2023/072680 A1 (NICOVENTURES TRADING LTD [GB]) 4 May 2023 (2023-05-04)	1 - 15
	page 1, line 1 - page 6, line 17	
	page 41, line 8 - page 48, line 33	

A	WO 2023/166150 A1 (PHILIP MORRIS PRODUCTS SA [CH]) 7 September 2023 (2023-09-07)	1 - 15
	page 1, line 1 - page 4, line 14	
	page 8, lines 9-34	
	page 22, line 28 - page 23, line 31	
	page 26, line 3 - page 31, line 21;	
	figures 8-14	

	- / - -	



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Date of the actual completion of the international search

23 December 2024

Date of mailing of the international search report

10/01/2025

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Authorized officer

Anticoli, Claud

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2024/077449

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2022/395028 A1 (LEE WON KYEONG [KR] ET AL) 15 December 2022 (2022-12-15) paragraph [0002] - paragraph [0004] paragraph [0124] - paragraph [0152] -----	1 - 15

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International application No
PCT/EP2024/077449

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