Aerosol-generating system with spectrometer for aerosol analysis

Abstract: The invention relates to a handheld aerosol-generating device. The handheld aerosol-generating device comprises an emitter, configured to emit light. Furthermore, the handheld aerosol-generating device comprises a sensor, configured to receive light, and an aerosol chamber, configured to receive aerosol. The emitter is further configured to emit light into the aerosol chamber. The sensor is further configured to receive light from the aerosol chamber and measure at least one wavelength of the spectrum of the received light.
AEROSOL-GENERATING SYSTEM WITH SPECTROMETER FOR AEROSOL ANALYSIS

The present invention relates to an aerosol-generating system comprising an emitter and a receiver for electromagnetic radiation, and an aerosol chamber holding an aerosol to be analysed.

Handheld electrically operated aerosol-generating systems are known that consist of a device portion comprising a battery and control electronics and a separate cartridge comprising a supply of liquid aerosol-forming substrate held in a liquid storage portion and an electrically operated vaporiser or heater element. The quality of the generated aerosol may differ from device to device. Also, the quality of the generated aerosol may depend upon the used liquid aerosol-forming substrate, since different liquid aerosol-forming substrates with for example different flavour constituents can be used. Furthermore, the performance of the aerosol-generating system may change over time. The quality of the generated aerosol may also depend upon puff intensity, puff duration, if it is the first, second, etc. puff, or if the system is clean or dirty. In conventional aerosol-generating systems, such as disclosed in EP 2 493 342, the only feedback the system obtains is the impedance of the heater element. However, the quality of the generated aerosol is not directly measured. Also, the amount of liquid aerosol-forming substrate left in the liquid storage portion is not directly measured.

It is desirable to provide an aerosol-generating system which directly measures the quality of the generated aerosol. Also, it is desirable to provide an aerosol-generating system which directly measures the amount of liquid aerosol-forming substrate held in a liquid storage portion.

According to a first aspect of the present invention there is provided an aerosol-generating system comprising an emitter. The emitter is configured to emit light. The aerosol-generating system further comprises a sensor, which is configured to receive light. Also, the aerosol-generating system comprises an aerosol chamber, configured to comprise an aerosol. The emitter is configured to emit light into the aerosol chamber. The sensor is configured to receive light from the aerosol chamber and measure at least one wavelength of the spectrum of the received light.

The aerosol generating system may comprise a handheld aerosol-generating device. The handheld aerosol-generating device may be configured to generate an aerosol for user inhalation. The handheld aerosol-generating device may comprise a mouthpiece on which a user may suck to draw aerosol generated by the device out of the device. The aerosol-generating system may be a battery operated device. The aerosol-generating system may comprise a housing holding a battery and the emitter and the sensor. The device is preferably a portable device that is comfortable to hold between the fingers of a single hand. The device may be substantially cylindrical in shape and have a length of between 70 and 200mm. The
maximum diameter of the device is preferably between 10 and 30 mm.

The inventive aerosol-generating system allows that parameters, preferably the presence, of the aerosol in the aerosol chamber can be directly measured. This direct measurement of parameters of the aerosol in the aerosol chamber enables that the aerosol-generating system can be optimally operated. The aerosol chamber may be a passage or path within the aerosol-generating system, through which aerosol-forming substrate in vaporized form flows. The aerosol chamber may also be a generating chamber, in which the liquid aerosol-forming substrate is vaporized and an aerosol is formed. Generally, the aerosol chamber may be an open or closed chamber in which vaporized aerosol-forming substrate or an aerosol is present.

The aerosol in the aerosol chamber may be a vaporized aerosol-forming substrate. The vaporized aerosol-forming substrate may comprise multiple vapour components. The vaporized aerosol-forming substrate is provided to form an aerosol which is subsequently inhaled by a user. During vaporization of a liquid aerosol-forming substrate, unwanted products may form. The formation of unwanted products should be prevented by the heating regime which results in the vaporized aerosol-forming substrate. However, as outlined above - the vaporization of a liquid aerosol-forming substrate depends on multiple factors such as the type of the liquid aerosol-forming substrate, the number of heating processes, etc.. The inventive aerosol-generating system now provides a possibility to measure the type and the amount of at least one of the components of the vaporized aerosol-forming substrate directly.

The measurement may comprise the determination of at least one component of the vaporized aerosol-forming substrate. In this regard, the spectrum of the vaporized aerosol-forming substrate is analysed. The spectrum or electromagnetic spectrum of the vaporized aerosol-forming substrate characterizes the components of the vaporized aerosol-forming substrate by a characteristic distribution of electromagnetic radiation absorbed by the vaporized aerosol-forming substrate.

In more detail, every component of the vaporized aerosol-forming substrate is able to absorb electromagnetic waves with certain frequencies or wavelengths. In the present invention, preferably Infrared- or IR-spectroscopy is used. If light is directed on these components, they will absorb certain wavelengths of the light. Thus, every component of the vaporized aerosol-forming substrate has a characteristic spectroscopic distribution or spectrum which can be observed. In the observed spectrum, certain peaks can be observed which correspond to absorbed light with certain frequencies. Typically, every component absorbs light with different wavelength, thus every component shows multiple absorption peaks in the spectrum. The wavelength and the amplitude of these absorption peaks are indicative of the component. Thus, the reliability of the measurement may be enhanced by measuring multiple absorption peaks and/or the amplitude of the peaks. The observation
requires an emitter, configured to emit electromagnetic waves and a sensor, configured to receive electromagnetic waves. In the following, the general term "electromagnetic waves" is denoted by the more specific term "light". It should, however, be noted that no wavelengths are excluded by the term "light". The emitter may be configured to emit light with wavelengths between 200 nanometer and 30 micrometer and the receiver may be configured to receive light with wavelengths between 200 nanometer and 30 micrometer. Within this wavelength spectrum, unwanted products may be determined in aerosol-forming substrate such as e-liquid for e-cigarettes.

The emitter emits light in the direction of the aerosol, for example the vaporized aerosol-forming substrate, and the vaporized aerosol-forming substrate absorbs certain wavelengths of the light according to the components present in the vaporized aerosol-forming substrate. In other words, depending upon the components present in the vaporized aerosol-forming substrate, certain wavelengths of the light, which is emitted by the emitter, is at least partially absorbed by the vaporized aerosol-forming substrate, while other wavelengths may pass through the vaporized aerosol-forming substrate. Thus, a characteristic distribution of electromagnetic radiation passes through the vaporized aerosol-forming substrate, characterizing the specific composition of the vaporized aerosol-forming substrate. This characteristic distribution contains the information about the specific components of the vaporized aerosol-forming substrate as well as the amount of these components in the vaporized aerosol-forming substrate.

The sensor is configured to receive this characteristic distribution, which passes through the vaporized aerosol-forming substrate. In this regard, the sensor may be configured to receive only a single wavelength of this spectrum. In this case, the sensor is provided to detect a single absorption band and thus a single component within the vaporized aerosol-forming substrate. In more detail, a specific component, which is to be detected by the sensor, may absorb a specific wavelength. The emitter may be configured to emit light with this wavelength and the sensor may be configured to receive light with this wavelength. When the sensor receives light with this specific wavelength, the sensor detects that the component is not present in the aerosol chamber. If the sensor receives no light or light with an intensity which is below a predetermined threshold, the sensor detects that the component is present in the aerosol chamber. This can be utilized to detect an unwanted product in the vaporized aerosol-forming substrate. Thus, the sensor detects that a specific unwanted product is present in the vaporized aerosol-forming substrate if the sensor does not detect the wavelength, which is emitted by the emitter or detects only a low amount of the light, which is emitted by the emitter.

The emitter may be configured to emit light with multiple wavelengths and the sensor may be configured to receive this light. The emitter/sensor may be configured as a wide
bandgap emitter/sensor such as a wide bandgap microelectromechanical system emitter/sensor. Thus, the electromagnetic spectrum of the aerosol-generating substrate can be observed with the wide bandgap emitter and sensor. In this way, the presence of different components within the vaporized aerosol-forming substrate can be determined at the same time. Also, the reliability of the detection of a single component may be enhanced, since multiple absorption bands related to a single component may be detected.

Also, multiple emitters and sensors which may emit/detect different light with a single wavelength each may be provided. This multitude of emitters and sensors may be provided to increase the reliability of the measurement. In more detail, two emitters may be provided which emit light with different wavelengths. Corresponding two sensors may be provided, wherein the first sensor is configured to detect the light which is emitted by the first emitter and the second sensor is configured to detect the light which is emitted by the second emitter. Since a specific component in the aerosol, which is to be detected, may absorb multiple different wavelengths, the detection of this component is increased if the two emitter/sensor-pairs are configured to emit/detect corresponding absorption bands. Alternatively or additionally, multiple emitter/sensor-pairs may be provided to detect multiple components. In more detail, a single emitter/sensor-pair may in this case be configured as a single narrow-band emitter/sensor. Thus, a specific component, i.e. the presence of specific molecules, of the aerosol-generating substrate may be observed with the single narrow-band emitter and sensor. Every single emitter/sensor-pair may be provided to detect a different component of the vaporized aerosol-generating substrate. Also, multiple emitter/sensor-pairs may be provided to reliably detect a specific component of the vaporized aerosol-generating substrate by measuring distinct absorption bands, and further emitter/sensor-pairs may be provided to detect further components of the vaporized aerosol-generating substrate.

The emitter may be configured as a tunable single narrow-band emitter. This type of emitter is configured adjustable to emit light with different wavelengths. The sensor may be accordingly configured as a tunable single narrow-band sensor, configured to receive light with different wavelengths. By providing a tunable single narrow-band emitter and sensor, different components within the vaporized aerosol-forming substrate can be determined one after another.

Also, a multiple narrow-band emitter and sensor may be provided. The multiple narrow-band emitter is configured to emit light with different essentially distinct wavelengths. The sensor is accordingly configured to receive light with different essentially distinct wavelengths. Thus, the presence of different components within the vaporized aerosol-forming substrate can be determined at the same time with high accuracy.

By directly determining the components of the vaporized aerosol-forming substrate, the operation of the aerosol-generating system may be optimized. For example, if an unwanted
product is detected in the vaporized aerosol-forming substrate, the temperature of a heater element may be lowered or the heater element may be deactivated. In this regard, the sensor as well as the emitter may be connected with control circuitry, wherein the control circuitry is further configured to control the flow of electric energy from a power supply to the heater element. Additionally or alternatively, a warning signal may be generated by the control circuitry upon the detection of unwanted products in the vaporized aerosol-forming substrate.

The emitter and the sensor may be arranged isolated from the aerosol. In more detail, the emitter as well as the sensor may be arranged outside of the aerosol chamber or the liquid storage portion, respectively. By arranging the emitter and the sensor isolated from the aerosol, a contamination of the sensor and the emitter may be prevented. Thus, the quality of the measurement is constantly high even if multiple measurements are obtained and even if multiple replaceable aerosol chambers are used.

When the aerosol chamber is provided as part of a liquid storage portion, the liquid storage portion may be provided replaceable. If the liquid aerosol-forming substrate in the liquid storage portion is depleted, the liquid storage portion is detached from the aerosol-generating system and a new liquid storage portion is attached to the aerosol-generating system. The emitter as well as the sensor may be provided as part of the aerosol-generating system, such that no new emitter or sensor must be provided when a new liquid storage portion is provided.

To facilitate that the emitter and the sensor may be provided isolated from the aerosol chamber, the aerosol chamber may have an at least partially transparent housing. By providing an at least partially transparent housing of the aerosol chamber, light, which is emitted by the emitter, may pass into the aerosol chamber and exit the aerosol chamber in the direction of the sensor. The partially transparent housing is arranged between the inner of the aerosol chamber and the emitter and sensor.

The sensor as well as the emitter may be provided as a microelectromechanical system (MEMS) or opto-semiconductor or compound semiconductor or hybrid electronic device. MEMS are very small devices with a typical size between 20 micrometers to a millimeter. Recent developments have led to middle and far infra-red MEMS emitters, coupled with the appropriate detectors. See for example "a MEMS based thermal infra-red emitter for an integrated NDIR spectrometer", published in Microsyst Technol (2012) 18: 1147-1154, which is incorporated herein in its entirety. Generally, any suitable emitter and corresponding sensor may be used as long as the sensor and the corresponding emitter are sufficiently small to be employed in the aerosol-generating system. Also, the emitter and the sensor must be able to emit (emitter) and receive (sensor) light with wavelength between 200 nanometer and 30 micrometer in order to examine the aerosol in the aerosol chamber. The emitter or the sensor may have a diameter of 0.5 to 5 millimeter or 1 to 3.5 millimeter or around
2 millimeter. The sensor may comprise at least two sensor-layers, which are each configured to receive light with a certain wavelength. Further, the sensor-layers may be configured to be transparent with respect to light with a certain wavelength. In this way, a single sensor may detect multiple wavelengths and thus examine multiple components of the vaporized aerosol-forming substrate.

The emitter may be configured to emit light with a wavelength of between 2.8 micrometer and 3.2 micrometer, preferably around 3.0 micrometer and/or of between 6.0 micrometer and 6.6 micrometer, preferably around 6.3 micrometer. By detecting these wavelengths, the presence of water may be determined in the vaporized aerosol-forming substrate. Alternatively or additionally, the emitter may be configured to emit light with a wavelength of between 5.9 micrometer and 6.1 micrometer or preferably around 5.9 micrometer and/or of between 3.3 micrometer and 4.0 micrometer, preferably around 3.7 micrometer. By detecting these wavelengths, the presence of carboxylic acid may be determined in the vaporized aerosol-forming substrate. Carboxylic acid is an undesired product and may be generated, when the heater gets too hot. The sensor may be configured to receive the respective wavelengths. Similar spectrums, which are well-known by the person skilled in the art, may be detected and determined with respect to different components in the vaporized aerosol-forming substrate. For example, 1.3-butadiene may be detected. This component is, like carboxylic acid, a representative component which is an undesirable product within the vaporized aerosol-forming substrate. Other components which can be detected in the above described way are benzene, formaldehyde and nicotine. The respective wavelengths for benzene are around 2.5 micrometer, 3.3 micrometer and 5.7 micrometer. By determining the presence of these components, the quality of the aerosol in the aerosol chamber may be determined. Preferably, multiple wavelengths are measured for each component to increase the reliability of the detection.

Multiple emitters may be provided and arranged in a matrix. The matrix of emitters may be arranged around the aerosol chamber such that essentially half of the surface of the aerosol chamber is covered with the matrix of emitters. The other half of the surface of the aerosol chamber may be covered with a matrix of respective sensors. Thus, 3D-spectroscopy can be conducted in the aerosol chamber in the sense that essentially the whole volume of the aerosol chamber may be subject to the measurement as described above. Consequently, the quality of the measurement, i.e. the accuracy of the measurement, may be improved. In more detail, the whole volume or essentially the whole volume of the aerosol chamber is irradiated with light from the emitters. This light travels through the whole volume of the aerosol chamber and is subsequently received by the matrix of sensors. Thus, the vaporized aerosol-forming substrate in the aerosol chamber may be subject to measurement regardless of the orientation of the aerosol chamber. Exemplarily, it may be detected if undesired components are present
in specific areas of the aerosol chamber. The sensors may detect that an undesired component is present in the aerosol chamber, if the concentration of this undesired component exceeds a predefined threshold in a specific area of the aerosol chamber.

Also, the matrix of emitters and the corresponding sensors may be arranged such that a first row of emitters of the matrix of emitters are configured to emit light with a specific wavelength and a corresponding first row of sensors in the matrix of sensors is configured to receive light with this specific wavelength. In this regard, the first row of emitters may be comprised of narrow-band emitters. A further second row of emitters, preferably likewise narrow-band emitters, may similarly emit light of a different specific wavelength. A corresponding second row of sensors are, similarly, configured to receive this light with a different specific wavelength. In this regard, the rows of sensors may each be comprised of narrow-band sensors. Thus, multiple components of the aerosol may be measured at the same time by providing multiple emitters and multiple sensors, adapted to emit and receive light with different specific wavelengths. Also, the reliability of the measurement may be enhanced by observing different wavelengths of the spectrum of a single component. Advantageously, however, the used emitters and sensors may be cheap emitters and sensors only adapted to emit (emitters) and receive (sensors) light with specific singular wavelengths.

Multiple emitters and multiple sensors may be arranged around the aerosol chamber, wherein the emitters and the sensors are not arranged in a matrix, but emitter-sensor-pairs are formed able to emit and detect light of a specific wavelength. In this way, multiple components within the aerosol may be detected or the reliability of the measurement may be enhanced.

According to a second aspect of the present invention, a process for manufacturing an aerosol-generating system is provided, wherein the process comprises the following steps:

i) providing a housing, enclosing a power supply and electric circuitry for controlling the power supply,

ii) providing an emitter, configured to emit light,

iii) providing a sensor, configured to receive light, and

iv) providing an aerosol chamber, configured to comprise an aerosol,

wherein the emitter is further configured to emit light into the aerosol chamber, and wherein the sensor is further configured to receive light from the aerosol chamber and measure at least one wavelength of the spectrum of the received light. The aerosol-generating system may be a handheld aerosol-generating device.

Features described in relation to one aspect may equally be applied to other aspects of the invention.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is an illustrative view of an schematic emitter and a schematic sensor
according to the present invention;

Figure 2 is an illustrative view of a matrix of emitters and sensors according to an embodiment of the present invention;

Figure 3 is an illustrative view of a matrix of emitters and sensors surrounding an aerosol chamber of an aerosol-generating system according to an embodiment of the present invention;

Figure 4 is an illustrative view of a sensor according to a further embodiment of the present invention;

Figure 5 shows an illustrative view of a further embodiment of the present invention, in which the emitters are provided as a layer around the aerosol chamber;

Figure 6 shows an illustrative view of an embodiment of a sensor according to the present invention, which comprises multiple sensor-layers; and

Figure 7 is an exemplarily IR spectroscopy from the Wikipedia Article "Infrared spectroscopy".

Figure 1 shows an emitter 2 and a sensor 4. The emitter emits light 6 in the direction of the sensor 4. The emitted light 6 is directed towards an aerosol chamber 8.

In the aerosol chamber 8, a component 10 of an aerosol-forming substrate is comprised. The component 10 is in Figure 1 depicted as a vaporized component with multiple small particles. The left part of Figure 1, denoted as Figure 1.1, shows the aerosol chamber 8 with a low amount of the component 10 in the aerosol chamber 8. The light, which is emitted by the emitter 2 and directed towards the aerosol chamber 8 is thus only partly absorbed by the component 10.

In more detail, the component 10 is able to at least partly absorb the light which is emitted by the emitter 2. In this regard, the emitter 2 emits light with a specific wavelength or specific wavelengths and the component absorbs this light at least partly. Thus, depending on the amount of the component present in the aerosol chamber 8, more or less light passes through the aerosol chamber 8. In Figure 1.1, a relatively low amount of the component 10 is present in the aerosol chamber 8. Thus, a large amount of the light reaches the sensor 4. The sensor 4 therefore detects that a low amount of the component 10, or no component 10, is present in the aerosol chamber 8. To increase the reliability of the measurement, multiple wavelengths are emitted by the emitter 2 and received by the sensor 4 such that the absorption spectrum of the component 10, and thus the component 10 itself, can be unambiguously detected.

Thus, an IR-absorption spectrum is measured by the sensor 4. An exemplary IR-absorption spectrum is depicted in Fig. 7, which shows a sample of an IR spectrum for bromomethane (CH3Br) taken from the Wikipedia Article "Infrared spectroscopy". Fig. 7 clearly shows absorption peaks around 3000, 1300, and 1000 centimeter⁻¹ (on the horizontal axis).
with different amplitudes. Similar IR-spectrums are created for each component in the aerosol, wherein these spectrums superimpose to form a single spectrum for the aerosol. Multiple peaks and peak-amplitudes are measured by the sensor 4 in this spectrum for the at least one component to be detected to reliably detect the presence and the amount of this component.

In the right part of Figure 1, denoted as Figure 1.2, a relatively high amount of the component 10 is present in the aerosol chamber 8. Thus, a low amount of the light reaches the sensor 4. The sensor 4 therefore detects that a high amount of the component 10, or that the component 10, is present in the aerosol chamber 8.

The amount of the component 10 present in the aerosol chamber 8 is indicative of the amount of an undesired products in the vaporized aerosol-forming substrate.

Figure 2 shows a second embodiment of the present application, in which multiple emitters 2 and multiple sensors 4 are provided. The emitters 2 as well as the emitters 2 are provided in a matrix. The emitters 2 are arranged around the aerosol chamber 8 as shown in Figure 4. Thus, the emitters 2 are provided to emit light into the aerosol chamber 8. To enable that, the aerosol chamber 8 is at least partly transparent. By providing multiple emitters 2 and arranging the emitters in a matrix around the aerosol chamber 8, the whole interior of the aerosol chamber 8 can be irradiated with the light of the emitters 2.

Consequently, a matrix of sensors 4 is provided in this embodiment such as shown in Figure 2. The sensors 4 are also arranged around the aerosol chamber 8 such as shown in Figure 4. The sensors 4 are arranged opposite the emitters 2 so that the light emitted by the emitters 2 is radiated into the aerosol chamber 8 and subsequently received by the sensors 4. If a high amount of a certain absorbing component is present in the aerosol chamber 8, only a low amount of or even no light passes through the aerosol chamber 8 to be detected by the sensors 4. Then, the sensors 4 detect that a high amount of the absorbing component is present in the aerosol chamber 8. Thus, the quality and amount of aerosol in the aerosol chamber 8 can be determined with high accuracy. In the embodiment as shown in Figure 2, the emitters 2 are configured to emit light with a specific wavelength and the sensors 4 are configured to receive and detect light with the same specific wavelength.

Figure 3 shows a further embodiment of the present invention, in which multiple emitters 2 and multiple sensors 4 are provided in respective matrixes. In contrast to the embodiment as shown in Figure 2, the emitters 2 are not configured to emit light of the same specific wavelength. Rather, the emitters 2 as shown in Figure 3 are arranged in rows 2.1 to 2.6, wherein each row of emitters 2 consists of emitters 2 which are configured to emit light of the same specific wavelength. A different row of emitters 2 consists of emitters 2 which are configured to emit light of a different specific wavelength. Opposite of the emitters 2 are arranged sensors 4 which are configured symmetrical in rows 4.1 to 4.6. That is, if a first row 2.1 of emitters 2 is configured to emit light with a specific first wavelength, the first row 4.1 of
sensors 4 is configured to receive and detect light with this first wavelength. The second row 2.2 of emitters 2 and the second row 4.2 of sensors 4 are configured to emit/receive light with a specific second wavelength. Different absorption bands are determined by the different rows of emitters 2/sensors 4.

Figure 4 shows the distribution of the emitters 2 and the sensors 4 around the aerosol chamber 8. The emitters 2 as well as the sensors 4 are arranged in the shape of a semicircle along the length of the aerosol chamber 8. The emitters 2 are arranged such that they irradiate light 6 into the inner of the aerosol chamber 8. The aerosol chamber 8 is provided transparent such that the light 6 can enter the inner of the aerosol chamber 8. The emitters 2 are provided as wide bandgap MEMS emitters with a diameter of around 2 millimeter such that multiple emitters can be placed around the aerosol chamber 8. The sensors 4 provided as wide bandgap MEMS sensors arranged around the aerosol chamber 8 opposite of the emitters 2 in the shape of a semicircle. The sensors 4 are configured and arranged such that light 6 from the inner of the aerosol chamber 8 can be received by the sensors 4.

Figure 5 shows a further embodiment, in which the emitters 2 are provided as a layer around the aerosol chamber 8. In this embodiment, the layer comprises multiple emitters 2, which radiate light 6 into the inner of the aerosol chamber 8 as described above. The sensors 4 or only the sensors 4 can be provided in a layer instead of distinct separated sensors 4 as depicted in Figure 4.

Figure 6 shows an embodiment of a sensor 4 which comprises multiple sensor-layers 4.10, 4.12 and 4.14. The different sensor-layers 4.10, 4.12, 4.14 are configured to receive light with a certain wavelength. Further, the sensor-layers 4.10, 4.12, 4.14 are configured to be transparent with respect to light with a certain wavelength. In more detail, a first sensor-layer 4.10 is configured to receive light with a first wavelength 6.1 while being transparent to light with a second wavelength 6.2 and a third wavelength 6.3. Behind the first sensor-layer 4.10, a second sensor-layer 4.12 is arranged. The second sensor-layer 4.12 is configured to receive light with the second wavelength 6.2 while being transparent to light with the third wavelength 6.3. Behind the second sensor-layer 4.12, a third sensor-layer 4.14 is arranged. The third sensor-layer 4.14 is configured to receive light with the third wavelength 6.3. In this way, the single sensor 2 can detect multiple wavelengths and thus examine multiple absorption spectra. In this embodiment, the sensor 4 comprises at least two sensor-layers.

The exemplary embodiments described above illustrate but are not limiting. In view of the above discussed exemplary embodiments, other embodiments consistent with the above exemplary embodiments will now be apparent to one of ordinary skill in the art.
CLAIMS

1. A handheld aerosol-generating device, comprising:
   an emitter, configured to emit light;
   a sensor, configured to receive light; and
   an aerosol chamber, configured to comprise an aerosol,
   wherein the emitter is further configured to emit light into the aerosol chamber, and
   wherein the sensor is further configured to receive light from the aerosol chamber and measure
   at least one wavelength of the spectrum of the received light.

2. The handheld aerosol-generating device of claim 1, wherein the emitter is
   configured to emit light with wavelengths between 200 nanometer and 30 micrometer, and
   wherein the sensor is configured to receive light with wavelengths between 200 nanometer
   and 30 micrometer.

3. The handheld aerosol-generating device of claim 1 or 2, wherein the handheld
   aerosol-generating device comprises at least two emitters and two sensors, wherein the first
   sensor is provided to emit light with a first wavelength, and the second emitter is provided to
   emit light with a second wavelength, wherein the first wavelength is different from the second
   wavelength.

4. The handheld aerosol-generating device of claim 3, wherein the first sensor is
   configured to receive light with the first wavelength and the second sensor is configured to
   receive light with the second wavelength.

5. The handheld aerosol-generating device of any one of the preceding claims,
   wherein at least one of the emitter and the sensor is further configured isolated from the
   aerosol.

6. The handheld aerosol-generating device of any one of the preceding claims,
   wherein the aerosol chamber has an at least partially transparent housing.

7. The handheld aerosol-generating device of any one of the preceding claims,
   wherein at least one of the emitter and the sensor is configured as one of a
   microelectromechanical system, a opto-semiconductor, a compound semiconductor and a
   hybrid electronic device.
8. The handheld aerosol-generating device of any one of the preceding claims, wherein the handheld aerosol-generating device comprises more than two emitters and more than two sensors.

9. The handheld aerosol-generating device of claim 8, wherein the emitters and sensors are each arranged in a matrix, preferably each constituted essentially in a semicircle.

10. The handheld aerosol-generating device of claim 9, wherein each row of the matrix of emitters comprises emitters configured to emit light with a wavelength different from the wavelength of light emitted by emitters of different rows of the matrix, and each row of the matrix of sensors comprises sensors configured to receive light of a wavelength corresponding to the wavelength emitted by the emitters.

11. The handheld aerosol-generating device of any one of the preceding claims, wherein the emitter, preferably the first emitter according to claim 3, is configured to emit light with a wavelength of between 2,8 micrometer and 3,2 micrometer, preferably around 3,0 micrometer.

12. The handheld aerosol-generating device of any one of the preceding claims, wherein the emitter, preferably the second emitter according to claim 3, is configured to emit light with a wavelength of between 6,0 micrometer and 6,6 micrometer, preferably around 6,3 micrometer.

13. The handheld aerosol-generating device of any one of the preceding claims, wherein at least one of the emitter is configured as a multiple narrow-band emitter and the sensor is configured as a multiple narrow-band sensor.

14. The handheld aerosol-generating device of any one of the preceding claims, wherein the sensor is configured to detect at least one of C02, Water, benzene, 1,3-butadiene, formaldehyde, nicotine and carboxylic acid.

15. Process for manufacturing a handheld aerosol-generating device, the process comprising the following steps:
   i) providing a housing, enclosing a power supply and electric circuitry for controlling the power supply,
   ii) providing an emitter, configured to emit light,
iii) providing a sensor, configured to receive light, and
iv) providing an aerosol chamber, configured to comprise an aerosol,

wherein the emitter is further configured to emit light into the aerosol chamber, and
wherein the sensor is further configured to receive light from the aerosol chamber and measure
at least one wavelength of the spectrum of the received light.
Figure 3

Diagram showing a series of grid-like structures labeled with numbers 2.1, 2.2, 2.3, 2.4, 2.5, 2.6 on the left and 4.1, 4.2, 4.3, 4.4, 4.5, 4.6 on the right, connected by a line labeled 8.
Figure 6
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. A24F47/00 A61M15/06 B05B12/08 G01N21/3504
G01N21/31

ADD.

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 B05B G01N G01J

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 , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category* Citation of document, with indication, where appropriate, of the relevant passages Relevant to claim No.

X US 2012/080611 A1 (JONES ROBERT [GB] ET AL) 5 April 2012 (2012-04-05) figures 1,2,7 1-15

X GB 2 524 779 A (CIGTRONICA LTD [GB]) 7 October 2015 (2015-10-07) figures 1-3 1,2,5,6, 14, 15

Y 7,11,12, 14

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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

'A' document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search: 9 October 2017

Date of mailing of the international search report: 20/10/2017

Name and mailing address of the ISA:

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer: Strohmayer, Bernhard
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>X</td>
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