Claims

1. A method for manufacturing an embossed sheet of material configured to be folded and obtain a filtering element configured for an inhalable drug delivery device, and for filtering a mainstream gas flow passing through the filtering element, comprising steps of:

providing the sheet of material; and

embossing the sheet of material with a plurality of stripes, by means of a patrix-matrix embossing rollers system, and by feeding the sheet of material to a nip between the patrix-matrix embossing rollers, each stripe comprising corresponding embossing features on each of a patrix embossing roller and a matrix embossing roller of the embossing rollers system, and each embossed stripe being oriented longitudinally on the sheet of material with respect to a feed direction of the sheet of material fed to the nip,

the embossing features comprising:

profile embossing features configured for embossing at least an aerodynamic profile on the sheet of material, the profile embossing features being arranged according to a radial direction of the stripe on the embossing rollers, the embossed aerodynamic profile being configured to modify in a determined manner flow properties for the mainstream gas flow passing through the filtering element by creating a gas flow turbulence occurrence in the filtering element,

whereby

the profile embossing features in the stripe form at least an alternance of a minimum constriction section area and a maximum expansion section area in the radial direction of the stripe on the embossing roller, with a cross-section area ratio between the maximum expansion section area and the minimum constriction section area in a range from 15:1 to 2:1; and

the embossing features further comprising:

radial embossing features configured to delimitate each stripe on opposite radial sides of the stripe, on the patrix-matrix embossing rollers, and further configured to form longitudinal

delimitation embossed features that delimitate the embossed stripe on the sheet of material, on opposite longitudinal sides of the embossed stripe.

2. The method for manufacturing the embossed sheet of material according to claim 1, wherein the radial embossing features are further configured to emboss a folding line into the sheet of material.

3. The method for manufacturing of claim 1 or 2, further wherein
the radial embossing features are further configured
to form
a plurality of enclosing walls on the patrix-matrix embossing rollers describing at least an enclosure around one or a plurality of the profile embossing features,
and, for each enclosure,
an enclosure opening in the enclosure connecting the enclosure to a successive enclosure in radial direction of the stripe,
the enclosure having a corresponding maximum enclosure expansion section area in axial direction of the stripe and the enclosure opening having a corresponding enclosure opening constriction section area in the axial direction of the stripe which is smaller than the corresponding maximum enclosure expansion section area, and
to define at least one alternance of the enclosure opening constriction section area and the maximum enclosure expansion section area in the longitudinal direction of the stripe, formed by the enclosure opening and the enclosure respectively, with a cross-section area ratio between the maximum enclosure expansion section area and the enclosure opening constriction section area of the profile in a range from 15:1 to 2:1.

4. The method for manufacturing of any one of claims 1 to 3, wherein a first set of the profile embossing features in a first one of the stripes is designed for a determined gas flow turbulence in a first longitudinal direction of a corresponding embossed first one

of the stripes, and a second set of the profile embossing features in a second one of the stripes adjacent to the first one is designed for the determined gas flow turbulence in a second longitudinal direction of a corresponding embossed second one of the stripes, opposite to the first longitudinal direction.

5. The method for manufacturing of any one of claims 1 to 4, wherein the profile embossing features comprise at least one from a list comprising a recess profile embossing feature configured to emboss a corresponding recessed shape in the sheet of material and a protrusion profile embossing feature configured to emboss a corresponding protrusion in the sheet of material.

6. The method for manufacturing of any one of claims 1 to 5, wherein the sheet of material comprises any material from a list comprising paper, a cellulose-based material, wool, plant- or animal-based fibrous material.

7. The method for manufacturing of any one of the claims 1 to 6, whereby the profile embossing features are further configured to produce a height of the aerodynamic profile that is in a range of 1 to 15 times of a thickness of the sheet of material.

8. The method for manufacturing according to any one of the claims 1 to 7, further wherein the embossing of the sheet of material is configured to be a wallpaper-like embossing producing an uninterrupted and repeating pattern of embossed aerodynamic features and longitudinal delimitation embossed features.

9. The method for manufacturing of claim 1, whereby the cross-section area ratio between the maximum expansion section area and the minimum constriction section area is in a range of 8:1 to 3:1.

10. The method for manufacturing of claim 1, whereby each one of the profile embossing features as a height in a range between 0,1 mm and 2,5 mm.

11. The method for manufacturing according to any one of the preceding claims, wherein the sheet of material has a grammage in a range between 10 gsm and 100 gsm and a thickness in a range between 0,02 mm and 1,5 mm.

12. An embossing set-up for manufacturing an embossed sheet of material configured to be folded and obtain a filtering element configured for an inhalable drug delivery device, and for filtering a mainstream gas flow passing through the filtering element, comprising features of:

a patrix-matrix roller embossing system configured to emboss the sheet of material with a plurality of stripes, in a nip between the patrix-matrix embossing rollers, each stripe comprising corresponding embossing features on each of a patrix embossing roller and a matrix embossing roller of the embossing rollers system, and each embossed stripe being oriented longitudinally on the sheet of material with respect to a feed direction of the sheet of material fed to the nip, the embossing features comprising:

profile embossing features configured for embossing at least an aerodynamic profile on the sheet of material, the profile embossing features being arranged according to a radial direction of the stripe on the embossing rollers, the embossed aerodynamic profile being configured to modify in a determined manner flow properties for the mainstream gas flow passing through the filtering element by creating a gas flow turbulence occurrence in the filtering element;

whereby

the profile embossing features in the stripe form at least an alternance of a minimum constriction section area and a maximum expansion section area in the radial direction of the stripe on the embossing roller, with a cross-section area ratio between the maximum expansion section area and the minimum constriction section area in a range from 15:1 to 2:1; and

the embossing features further comprising:

radial embossing features configured to delimitate each stripe on opposite radial sides of the stripe, on the patrix-matrix embossing rollers, and further configured to form longitudinal delimitation embossed features that delimitate the embossed stripe on the sheet of material, on opposite longitudinal sides of the embossed stripe.

13. The embossing set-up of claim 12, wherein the radial embossing features are further configured to emboss a folding line into the sheet of material.

14. The embossing set-up of claim 12, further wherein:
the radial embossing features are further configured
to form
a plurality of enclosing walls on the patrix-matrix embossing rollers describing at least an enclosure around one or a plurality of the profile embossing features,
and, for each enclosure,
an enclosure opening in the enclosure connecting the enclosure to a successive enclosure in radial direction of the stripe,
the enclosure having a corresponding maximum enclosure expansion section area in axial direction of the stripe and the enclosure opening having a corresponding enclosure opening constriction section area in the axial direction of the stripe which is smaller than the corresponding maximum enclosure expansion section area, and
to define at least one alternance of the enclosure opening constriction section area and the maximum enclosure expansion section area in the longitudinal direction of the stripe, formed by the enclosure opening and the enclosure respectively, with a cross-section area ratio between the maximum enclosure expansion section area and the enclosure opening constriction section area of the profile in a range from 15:1 to 2:1.

15. The embossing set-up of any one of claims 12 to 14, wherein a first set of the profile embossing features in a first one of the stripes is designed for a determined gas flow turbulence in a first longitudinal direction of a corresponding embossed first one of the stripes, and a second set of the profile embossing features in a second one of the stripes adjacent to the first one is designed for the determined gas flow turbulence in a second longitudinal direction of a corresponding embossed second one of the stripes opposite to the first longitudinal direction.

16. The embossing set-up of any one of claims 12 to14, wherein the profile embossing features comprise at least one from a list comprising a recess profile embossing feature configured to emboss a corresponding recessed shape in the sheet of material and a protrusion profile embossing feature configured to emboss a corresponding protrusion in the sheet of material.

17. The embossing set-up of any one of claims 12 to 16, wherein the sheet of material comprises any material from a list comprising paper, a cellulose-based material, wool, plant- or animal-based fibrous material.

18. The embossing set-up of any one of the claims 12 to 17, whereby the profile embossing features are further configured to produce a height of the aerodynamic profile that is in a range of 1 to 15 times of a thickness of the sheet of material.

19. The embossing set-up of any one of the claims 12 to 18, further wherein the patrix-matrix rollers and the embossing features are configured for embossing of the sheet of material to be a wallpaper-like embossing producing an uninterrupted and repeating pattern of embossed aerodynamic features and longitudinal delimitation embossed features.

20. The embossing set-up of claim 12, whereby the cross-section area ratio between the maximum expansion section area and the minimum constriction section of the profile is in a range of 8:1 to 3:1.

21. A method for manufacturing an embossed sheet of material configured to be folded and obtain a filtering element configured for an inhalable drug delivery device, and for filtering a mainstream gas flow passing through the filtering element, comprising steps of:

providing the sheet of material; and

embossing the sheet of material with a plurality of stripes, by means of a patrix-matrix embossing rollers system, and by feeding the sheet of material to a nip between the patrix-matrix embossing rollers, each stripe comprising corresponding embossing features on each of a patrix embossing roller and a matrix embossing roller of the embossing rollers system, and each embossed

stripe being oriented longitudinally on the sheet of material with respect to a feed direction of the sheet of material fed to the nip,

the embossing features comprising:

profile embossing features configured for embossing at least an aerodynamic profile on the sheet of material, the profile embossing features being arranged according to a radial direction of the stripe on the embossing rollers, the embossed aerodynamic profile being configured to modify in a determined manner flow properties for the mainstream gas flow passing through the filtering element by creating a gas flow turbulence occurrence in the filtering element;

and

the embossing features further comprising:

radial embossing features configured to delimitate each stripe on opposite radial sides of the stripe, on the patrix-matrix embossing rollers, and further configured to form longitudinal delimitation embossed features that delimitate the embossed stripe on the sheet of material, on opposite longitudinal sides of the embossed stripe,

wherein:

the radial embossing features are further configured

to form

a plurality of enclosing walls on the patrix-matrix embossing rollers describing at least an enclosure around one or a plurality of the profile embossing features,

and, for each enclosure,

an enclosure opening in the enclosure connecting the enclosure to a successive enclosure in radial direction of the stripe,

the enclosure having a corresponding maximum enclosure expansion section area in axial direction of the stripe and the enclosure opening having a corresponding enclosure opening constriction section area in the axial direction of the stripe which is smaller than the

corresponding maximum enclosure expansion section area, and

to define at least one alternance of the enclosure opening constriction section area and the maximum enclosure expansion section area in the longitudinal direction of the stripe, formed by the enclosure opening and the enclosure respectively, with a cross-section area ratio between the maximum enclosure expansion section area and the enclosure opening constriction section area of the profile in a range from 15:1 to 2:1.

22. An embossing set-up for manufacturing an embossed sheet of material configured to be folded and obtain a a filtering element configured for an inhalable drug delivery device, and for filtering a mainstream gas flow passing through the filtering element, comprising features of:

a patrix-matrix roller embossing system configured to emboss the sheet of material with a plurality of stripes, in a nip between the patrix-matrix embossing rollers, each stripe comprising corresponding embossing features on each of a patrix embossing roller and a matrix embossing roller of the embossing rollers system, and each embossed stripe being oriented longitudinally on the sheet of material with respect to a feed direction of the sheet of material fed to the nip, the embossing features comprising:

profile embossing features configured for embossing at least an aerodynamic profile on the sheet of material, the profile embossing features being arranged according to a radial direction of the stripe on the embossing rollers, the embossed aerodynamic profile being configured to modify in a determined manner flow properties for the mainstream gas flow passing through the filter element by creating a gas flow turbulence occurrence in the filtering element;

and

the embossing features further comprising:

radial embossing features configured to delimitate each stripe on opposite radial sides of the stripe, on the patrix-matrix embossing rollers, and

further configured to form longitudinal delimitation embossed features that delimitate the embossed stripe on the sheet of material, on opposite longitudinal sides of the embossed stripe,

wherein:

the radial embossing features are further configured

to form

a plurality of enclosing walls on the patrix-matrix embossing rollers describing at least an enclosure around one or a plurality of the profile embossing features,

and, for each enclosure,

an enclosure opening in the enclosure connecting the enclosure to a successive enclosure in radial direction of the stripe,

the enclosure having a corresponding maximum enclosure expansion section area in axial direction of the stripe and the enclosure opening having a corresponding enclosure opening constriction section area in the axial direction of the stripe which is smaller than the corresponding maximum enclosure expansion section area, and

to define at least one alternance of the enclosure opening constriction section area and the maximum enclosure expansion section area in the longitudinal direction of the stripe, formed by the enclosure opening and the enclosure respectively, with a cross-section area ratio between the maximum enclosure expansion section area and the enclosure opening constriction section area of the profile in a range from 8:1 to 2:1.

23. The embossing set-up of of claim 22, wherein the sheet of material comprises any material from a list comprising paper, a cellulose-based material, wool, plant- or animal-based fibrous material.

24. The embossing set-up of any one of the claims 22 to 23, whereby the profile embossing features are further configured to produce a height of the aerodynamic profile that is in a range of 1 to 15 times of a thickness of the sheet of material.

25. The embossing set-up of any one of the claims 22 to 24, further wherein the patrix-matrix rollers and the embossing features are configured for embossing of the sheet of material to be a wallpaper-like embossing producing an uninterrupted and repeating pattern of embossed aerodynamic features and longitudinal delimitation embossed features.