- movement of an embossing element along the structured stamp and embossing of the embossing material by applying the stamp face to the embossing material.

The embossing force must be correspondingly great with correspondingly large embodiments of the device according to the invention. The embossing force is preferably stated per metre. The following exemplary value ranges for an inventive embodiment of the invention are disclosed. The embossing force applied per metre lies in the value range between 0 N/m and 1000 N/m, preferably between 10 N/m and 500 N/m, more preferably between 25 N/m and 250 N/m, most preferably between 50 N/m and 100 N/m. The embossing force can be controlled, in particular by formulas which are stored in software and/or firmware and/or hardware. Furthermore, a dynamic change in the embossing force during the embossing process is conceivable.

A dynamic change is understood to mean that the control is adapted to unforeseeable circumstances. For example, it could be noted in a formula how the embossing force is to be applied as a function of the location. If, during the embossing process, a force is measured which differs from the setpoint force, for example due to unevenness present in the sample holder or substrate, the embossing force can be readjusted to the setpoint value.

According to a first aspect of the present invention, there is provided an apparatus for embossing micro- or nanostructures in an embossing material, including: a structured stamp, a mobile embossing element, and an embossing element suspension system for suspending the mobile embossing element, the embossing element suspension system is constituted such that a force acting on the structured stamp or a carrier of the structured stamp can be adjusted by a counterforce, wherein a removal of the structured stamp from the embossing material can be controlled in a targeted manner, and wherein a clamping bar for holding the structured stamp is provided, the clamping bar can be moved along a removal curve, wherein the removal curve is one of the following function selected from the group consisting of: polynomial, root function, logarithmic function, trigonometric function, and step function.

According to a second aspect of the present invention, there is provided a method for embossing micro- or nanostructures in an embossing material, wherein a mobile embossing element, by an action of a force on a structured stamp, embosses the micro- or nanostructures in the embossing material, wherein the action of the force on the structured stamp is provided by an embossing element suspension system for suspending the mobile embossing element, the embossing element suspension system is constituted such that the force acting on the structured stamp or a carrier of the structured stamp can be adjusted by a counterforce, wherein a removal of the structured stamp from the embossing material is controlled in a targeted manner, wherein a clamping bar can be moved along a removal curve, wherein the removal curve is one of the following function selected from the group consisting of: polynomial, root function, logarithmic function, trigonometric function, and step function.

According to a third aspect of the present invention, there is provided a stamp system, comprising: a structured stamp for embossing micro- or nanostructures, a carrier connected to the structured stamp, and an embossing element suspension system for suspending a mobile embossing element, the embossing element suspension system is constituted such that a force acting on the structured stamp or the carrier of the structured stamp can be adjusted by a counterforce, wherein the structured stamp and the carrier are constituted elastically, in such a way that they can be deformed by an embossing element, wherein a clamping bar can be moved along a removal curve, wherein the removal curve is one of the following function selected from the group consisting of: polynomial, root function, logarithmic function, trigonometric function, and step function.

According to a fourth aspect of the present invention, there is provided a removal means for separating a structured stamp from embossing material for an apparatus according to any one of the preceding claims, wherein the removal means are constituted for effecting a linear movement of a side of the structured stamp.

Claims

1. An apparatus (24, 24‘) for embossing micro- or nanostructures (31) in an embossing material (6, 6’), comprising:

a structured stamp (1),

a mobile embossing element (8), and

an embossing element suspension system (21, 21’, 21”, 21’’’) for suspending the mobile embossing element (8), the embossing element suspension system (21, 21’, 21”, 21’’’) is constituted such that a force (F, F’) acting on the structured stamp (1) or a carrier (17) of the structured stamp (1) can be adjusted by a counterforce (F_A, $F_{A'}$),

wherein a removal of the structured stamp (1) from the embossing material (6, 6’) can be controlled in a targeted manner, and

wherein a clamping bar (4, 4’) for holding the structured stamp (1) is provided, the clamping bar (4, 4’) can be moved along a removal curve, wherein the removal curve is one of the following function selected from the group consisting of:

- polynomial,
- root function,
- logarithmic function.
- trigonometric function, and
- step function.

2. The apparatus (24, 24‘) according to claim 1, wherein the polynomial is a straight line or parabola.

3. The apparatus (24, 24‘) according to claim 1 or 2, wherein the trigonometric function is a sine function.

4. The apparatus (24, 24‘) according to any one of the preceding claims, wherein the apparatus (24, 24‘) is designed for step-and-repeat operation.

5. The apparatus (24, 24‘) according to any one of the preceding claims, comprising removal means (19) for separating the structured stamp (1) from the embossing material (6, 6’).

6. The apparatus (24, 24‘) according to claim 5, wherein the removal means (19) are constituted for effecting a linear movement of a side of the structured stamp (1).

7. The apparatus (24, 24‘) according to claim 6, wherein the linear movement of the removal means (19) of the side of the structured stamp (1) is directed normal to an embossing surface (6o).

8. The apparatus (24, 24‘) according to any one of claims 5 to 7, wherein the removal means (19) comprise rods.

9. The apparatus (24, 24‘) according to claim 8, wherein the rods comprise mounted linear elements.

10. The apparatus (24, 24‘) according to any one of claims 5 to 9, wherein the removal means (19) are connected to the structured stamp (1), .

11. The apparatus (24, 24‘) according to claim 10, wherein the structured stamp (1) comprises a clamping bar (4, 4’).

12. The apparatus (24, 24‘) according to claim 11, wherein the clamping bar holds the structured stamp (1) or a carrier (17) with the structured stamp (1).

13. The apparatus (24, 24‘) according to any one of the preceding claims, wherein the embossing element suspension system (21, 21’, 21”, 21’’’) is constituted as a rotatably mounted rocker (21) or carrier (21’) or as a spiral (21”).

14. The apparatus (24, 24‘) according to any one of the preceding claims, wherein the structured stamp (1) is fixed by at least one clamping bar (4, 4’), wherein the at least one clamping bar (4, 4’) can be moved perpendicular to an embossing surface (6o) or in a Z-direction.

15. The apparatus (24, 24‘) according to claim 14, wherein the structured stamp (1) is laterally fixed by the at least one clamping bar (4, 4’).

16. The apparatus (24, 24‘) according to claim 14 or 15, wherein the at least one clamping bar (4, 4’) is moved by means of a lifting system (32).

17. The apparatus (24, 24‘) according to any one of the preceding claims, wherein the clamping bar (4, 4’) is mounted rotatably.

18. The apparatus (24, 24‘) according to claim 17, wherein the clamping bar (4, 4’) is rotatable about a rotation axis.

19. The apparatus (24, 24‘) according to claim 18, wherein the rotation axis is arranged parallel to the embossing surface (6o) or perpendicular to the Z-direction or perpendicular to the movement direction of the embossing element (8) or parallel to the Y-direction.

20. The apparatus (24, 24‘) according to claim 14, wherein the at least one clamping bar (4, 4’) can be moved in a second direction.

21. The apparatus (24, 24‘) according to claim 20, wherein the at least one clamping bar (4, 4’) is a lifting system (32).

22. The apparatus (24, 24‘) according to claim 20 or 21, wherein the at least one clamping bar (4, 4’) and the lifting system (32) can be moved simultaneously.

23. The apparatus (24, 24‘) according to claim 20, 21 or 22, wherein the at least one clamping bar (4, 4’) can be moved in the x-direction or parallel to the embossing surface (6o) or parallel to the movement direction of the embossing element (8).

24. The apparatus (24, 24‘) according to any one of the preceding claims, wherein the translational speed of the removal means (19) lies between 0.1 mm/s and 100 mm/s.

25. The apparatus (24, 24‘) according to claim 24, wherein the translational speed of the removal means (19) lies between 1 mm/s and 75 mm/s.

26. The apparatus (24, 24‘) according to claim 24, wherein the translational speed of the removal means (19) lies between 5 mm/s and 50 mm/s.

27. A method for embossing micro- or nanostructures (31) in an embossing material (6, 6’),

wherein a mobile embossing element (8), by an action of a force (F, F’) on a structured stamp (1), embosses the micro- or nanostructures (31) in the embossing material (6, 6’),

wherein the action of the force (F, F’) on the structured stamp (1) is provided by an embossing element suspension system (21, 21’, 21”, 21’’’) for suspending the mobile embossing element (8), the embossing element

suspension system (21, 21', 21", 21''') is constituted such that the force (F, F') acting on the structured stamp (1) or a carrier (17) of the structured stamp (1) can be adjusted by a counterforce (F_A, $F_{A'}$),

wherein a removal of the structured stamp (1) from the embossing material (6, 6') is controlled in a targeted manner, wherein a clamping bar (4, 4') can be moved along a removal curve, wherein the removal curve is one of the following function selected from the group consisting of:

- polynomial,
- root function,
- logarithmic function,
- trigonometric function, and
- step function.

28. The method according to claim 27, wherein the polynomial is a straight line or parabola.

29. The method according to claim 27 or 28, wherein the trigonometric function is a sine function.

30. A stamp system (5), comprising:

a structured stamp (1)for embossing micro- or nanostructures (31),

a carrier (17) connected to the structured stamp (1), and

an embossing element suspension system (21, 21', 21", 21''') for suspending a mobile embossing element (8), the embossing element suspension system (21, 21', 21", 21''') is constituted such that a force (F, F') acting on the structured stamp (1) or the carrier (17) of the structured stamp (1) can be adjusted by a counterforce (F_A, $F_{A'}$),

wherein the structured stamp (1) and the carrier (17) are constituted elastically, in such a way that they can be deformed by an embossing element (8), wherein a clamping bar (4, 4') can be moved along a removal

curve, wherein the removal curve is one of the following function selected from the group consisting of:

- polynomial,
- root function,
- logarithmic function,
- trigonometric function, and
- step function.

31. The stamp system (5) according to claim 30, wherein the structured stamp (1) is a soft stamp.

32. The stamp system (5) according to claim 30 or 31, wherein the carrier (17) is made of glass.

33. The stamp system (5) according to any one of claims 30 to 32, wherein the carrier (17) is connected to the structured stamp (1) in a planar manner.

34. The stamp system (5) according to any one of claims 30 to 33, wherein the polynomial is a straight line or parabola.

35. The stamp system (5) according to any one of claims 30 to 34, wherein the trigonometric function is a sine function.

36. A removal means (19) for separating a structured stamp (1) from embossing material (6, 6') for an apparatus (24, 24') according to any one of the preceding claims, wherein the removal means (19) are constituted for effecting a linear movement of a side of the structured stamp (1).

37. The removal means (19) according to claim 36, wherein the linear movement of the removal means (19) of the side of the structured stamp (1) is directed normal to an embossing surface (6o).