as those available for flat sheet mould fabrication. Moreover, imprint drums, or nanoimprinting roll bodies, typically have a large radius to minimize pattern feature distortion. The roll bodies are therefore expensive, heavy and difficult to handle when interchanging or replacing moulds.

Removable nanoimprinting moulds have been proposed, whereby metal bars are riveted or screwed to the nanoimprinting mould, and the bars are detachably attached to the nanoimprinting roll. To avoid the metal bars imprinting on the substrate, they are attached to the roll body at positions recessed inwardly of the circumference of the roll body (e.g. insets or recesses). Also, to ensure the pattern is accurately imprinted, the moulds are tensioned to pull flat against the circumference of a body of the nanoimprinting roll.

Methods employing removable nanoimprinting moulds create stress concentrations in the mould, at the locations of the rivets or screws, which damage or distort the moulds particularly during tensioning. Moreover, in order to pass inwardly from the circumference of the roll body, the mould must bend around a radius that is less than that of the circumference of the roll body. As a result, moulds are often bent past their plastic radius – the radius above which the mould will return to a flat condition once removed from the roll body, and below which plastic deformation of the mould begins to occur.

Summary

According to a first aspect, the present disclosure provides a nanoimprinting mould device comprising:

a nanoimprinting mould for forming a pattern in a substrate; and

a connector adhered to a surface of the nanoimprinting mould and comprising engagement means for engaging a nanoimprinting shell or roll thereby to secure the nanoimprinting mould to the shell or roll, the shell or roll being rotatable, in use, to bring the nanoimprinting

mould against the substrate to form the pattern in the substrate; wherein the nanoimprinting mould comprises a patterned surface facing, in use, outwardly of the shell or roll and an opposing rear surface facing, in use, towards the shell or roll, the connector being adhered to the opposing rear surface; wherein the connector comprises a slot for receiving the nanoimprinting mould and: opposed sides of the slot are adhered to respectively opposite ones of the patterned surface and opposing rear surface; and/or the slot is narrower than a thickness of the nanoimprinting mould so that the connector is adhered to the nanoimprinting mould at least partially by friction between the slot and nanoimprinting mould.

According to a second aspect, the present disclosure provides a nanoimprinting roll assembly comprising:

a nanoimprinting roll; and

at least one nanoimprinting mould device of the first aspect, the at least one nanoimprinting mould being secured to the nanoimprinting roll.

According to a third aspect, the present disclosure provides a nanoimprinting roll assembly comprising:

a nanoimprinting shell fittable over a nanoimprinting roll and rotatable with rotation of the nanoimprinting roll; and

at least one nanoimprinting mould device of the first aspect, the at least one nanoimprinting mould being secured to the nanoimprinting shell.

According to a fourth aspect, the present disclosure provides a nanoimprinting machine comprising:

a nanoimprinting roll assembly according to the second or the third aspect; and

a motor for rotating the nanoimprinting roll assembly.

According to a fifth aspect, the present disclosure provides a method of forming a nanoimprinting mould device, the method comprising:

providing a nanoimprinting mould and a connector;

applying adhesive to a surface of the nanoimprinting mould and/or the connector; and

bringing the nanoimprinting mould and connector together so that the adhesive forms a bond between the nanoimprinting mould and connector; wherein the nanoimprinting mould comprises a patterned surface facing, in use, outwardly of the shell or roll and an opposing rear surface facing, in use, towards the shell or roll, the connector being adhered to the opposing rear surface; wherein the connector comprises a slot for receiving the nanoimprinting mould and: opposed sides of the slot are adhered to respectively opposite ones of the patterned surface and opposing rear surface; and/or the slot is narrower than a thickness of the nanoimprinting mould so that the connector is adhered to the nanoimprinting mould at least partially by friction between the slot and nanoimprinting mould.

The mould may be attached to the roll drum by fasteners. The fasteners may be screws or bolts the rotation of which selectively increase or decreases tension in the nanoimprinting mould.

As used herein, the terms “adhere”, “adhesion” and similar are intended to include within their scope the connection of a nanoimprinting mould to a connector using means other than those requiring penetrations to be formed in the mould, for example, bolting or riveting the mould to the connector. Forms of connection within the scope of the term “adhere” include, but are not limited to, friction-fitting, adhesive connection, magnetic attraction and vacuum suction.

Similarly, the term “continuous” when used in the context of a surface refers to the body, which comprises the surface, having no full thickness penetrations.

As used herein, the terms “plastic bending radius” or “plastic radius” refer to the radius above which a mould will return to a flat condition once removed from the roll body, and below which plastic deformation of the mould begins to occur. In other words, if a bending force is

Claims

1. A nanoimprinting mould device comprising:

a nanoimprinting mould for forming a pattern in a substrate; and

a connector adhered to a surface of the nanoimprinting mould and comprising engagement means for engaging a nanoimprinting shell or roll thereby to secure the nanoimprinting mould to the shell or roll, the shell or roll being rotatable, in use, to bring the nanoimprinting mould against the substrate to form the pattern in the substrate;

wherein the nanoimprinting mould comprises a patterned surface facing, in use, outwardly of the shell or roll and an opposing rear surface facing, in use, towards the shell or roll, the connector being adhered to the opposing rear surface;

wherein the connector comprises a slot for receiving the nanoimprinting mould and:

opposed sides of the slot are adhered to respectively opposite ones of the patterned surface and opposing rear surface; and/or

the slot is narrower than a thickness of the nanoimprinting mould so that the connector is adhered to the nanoimprinting mould at least partially by friction between the slot and nanoimprinting mould.

2. The nanoimprinting mould device of claim 1, wherein the connector is adhered to the nanoimprinting mould by an adhesive.

3. The nanoimprinting mould device of claim 1, wherein the connector is adhered to the nanoimprinting mould by welding.

4. The nanoimprinting mould device of any preceding claim, wherein a region of the surface over which the connector adheres to the surface is continuous.

5. The nanoimprinting mould device of claim 1, wherein the connector adheres to the nanoimprinting mould by magnetic attraction.

6. The nanoimprinting mould device of any preceding claim, wherein the connector projects from an end of the nanoimprinting mould so as to extend, in use, at least part way around a circumference of the shell or roll.

7. The nanoimprinting mould device of claim 6, wherein the connector comprises two extensions extending from respectively opposite ends of the nanoimprinting mould.

8. The nanoimprinting mould device of claim 7, wherein the engagement means comprises an engagement member formed on each extension.

9. The nanoimprinting mould device of claim 8, wherein the engagement members engage the shell or roll at positions of the shell or roll that are spaced from the respectively opposite ends of the nanoimprinting mould.

10. The nanoimprinting mould device of claim 9, wherein the engagement members engage corresponding engagement members of the shell or roll, each corresponding engagement member comprising a curved section, and wherein the extensions extend from the nanoimprinting mould around the respective curved sections.

11. The nanoimprinting mould device of claim 10, wherein the curved sections have a radius that is less than the plastic radius of the nanoimprinting mould, and the nanoimprinting mould is positioned between the curved sections.

12. The nanoimprinting mould device of any one of claims 8 to 11, wherein at least one of the engagement members of the connector, when in engagement with the shell or roll, is adjustable to apply a selected amount of tension to the nanoimprinting mould.

13. The nanoimprinting mould device of claim 12, where one engagement member of the connector comprises a first reinforcement bar and the other engagement member of the connector comprises a second reinforcement bar, one or more fastener holes and, in use, one or more fasteners project through the fastener holes to secure the nanoimprinting mould to the shell or roll.

14. The nanoimprinting mould device of claim 13, wherein the second reinforcement bar comprises two sets of fastener holes, the holes in one set extending in a substantially perpendicular direction to the holes in the other set.

15. The nanoimprinting mould device of claim 14, wherein fasteners extending through the holes in one of the sets of holes are used to apply tension to the nanoimprinting mould, in use, and fasteners extending through the other set of holes are used to anchor the second reinforcement bar in position after tension has been applied.

16. The nanoimprinting mould device of any one of claims 13 to 15, wherein the first reinforcement bar is rectangular.

17. The nanoimprinting mould device of any one of claims 13 to 16, wherein the second reinforcement bar is triangular.

18. The nanoimprinting mould device of any preceding claim, wherein the engagement means reversibly secure the nanoimprinting mould to the shell or roll.

19. A nanoimprinting roll assembly comprising:

a nanoimprinting roll; and

at least one nanoimprinting mould device of any one of claims 1 to 18, the at least one nanoimprinting mould being secured to the nanoimprinting roll.

20. A nanoimprinting roll assembly comprising:

a nanoimprinting shell fittable over a nanoimprinting roll and rotatable with rotation of the nanoimprinting roll; and

at least one nanoimprinting mould device of any one of claims 1 to 18, the at least one nanoimprinting mould being secured to the nanoimprinting shell.

21. A nanoimprinting machine comprising:

a nanoimprinting roll assembly according to claim 19 or 20; and

a motor for rotating the nanoimprinting roll assembly.

22. A method of forming a nanoimprinting mould device, the method comprising:

providing a nanoimprinting mould and a connector;

applying adhesive to a surface of the nanoimprinting mould and/or the connector; and

bringing the nanoimprinting mould and connector together so that the adhesive forms a bond between the nanoimprinting mould and connector;

wherein the nanoimprinting mould comprises a patterned surface facing, in use, outwardly of the shell or roll and an opposing rear surface facing, in use, towards the shell or roll, the connector being adhered to the opposing rear surface;

wherein the connector comprises a slot for receiving the nanoimprinting mould and:

opposed sides of the slot are adhered to respectively opposite ones of the patterned surface and opposing rear surface; and/or

the slot is narrower than a thickness of the nanoimprinting mould so that the connector is adhered to the nanoimprinting mould at least partially by friction between the slot and nanoimprinting mould.

23. A method according to claim 22, wherein the step of bringing the nanoimprinting mould and connector together comprises applying pressure to the nanoimprinting mould and connector, at or near the adhesive, so as to strengthen the bond as it is formed.

24. A method of fitting a nanoimprinting mould device according to any one of claims 12 to 18, to a nanoimprinting shell or roll, the method comprising:

engaging one of the engagement members of the connector with the shell or roll;

bringing the nanoimprinting mould into contact with a circumferential surface of the shell or roll along the entire length of the nanoimprinting mould;

engaging the other engagement member of the connector with the shell or roll; and

adjusting the one of the engagement members to apply tension to the nanoimprinting mould.