CLAIMS

1. A method of imparting a pattern of material to a substrate, comprising the steps of:

a. providing a substrate and a stamp with deformable, spaced apart features, which protrude from an extended surface of the stamp, the features having a length;

b. providing, in at least one region of the substrate, a material that becomes flowable upon heating to a flow temperature, the material being provided to a depth less than the feature length;

c. contacting the protruding features with the flowable material;

d. applying a first pressure to a side of the stamp opposite the protruding features to a degree such that:

i. the protruding features penetrate the flowable material; and

ii. upon contact with the substrate, the protruding features deform to an extent that a gap exists over a majority of the surface of the flowable material, between the flowable material and the extended surface of the stamp;

e. heating the flowable material to a temperature sufficient to allow the flowable materials to flow; and

f. retracting the stamp to reveal patterned material covering regions of the substrate.

2. A method of imparting a patterned of material to a substrate, comprising the steps of:

a. providing a substrate and a stamp with deformable, spaced apart features, which protrude from

an extended surface of the stamp, the features having a length;

b. providing, in at least one region of the substrate, a material that becomes flowable upon heating to a flow temperature;

c. contacting the protruding features with the flowable material;

d. applying a first pressure to a side of the stamp opposite the protruding features to a degree such that:

i. the protruding features penetrate the flowable material; and

ii. upon contact with the substrate, the protruding features deform; and

e. applying a second pressure that is less than the first pressure to a degree that the deformation of the protruding feature is reduced;

f. applying a pressure to the side of the stamp opposite the protruding features which pressure is greater than the second pressure;

g. before or during step f, heating the flowable material to a temperature sufficient to cause the flowable materials to flow; and

h. retracting the stamp to reveal patterned material coveringregions of the substrate.

3. The method of any of claims 1-2, further comprising the step of cooling the flowable material.

4. The method of claim 3, the step of cooling being conducted so that the flowable material becomes unflowing.

5. The method of any of claims 2-4, the step of applying a first pressure comprising applying pressure such that a

predetermined areal extent of the feature of the stamp is deformed elastically into intimate contact with the substrate.

6. The method of any of claims 1-5, which patterned material includes at least one region of substrate not covered by flowable material, which was previously covered with flowable material.

7. The method of claim 6, the not covered region being not covered, as determined by an etching test.

8. The method of any of claims 6-7, the not covered region corresponding to a protruding feature of the stamp.

9. The method of any of claims 1-8, the stamp having an elastic modulus of less than approximately 50 MPa, preferably between approximately .5 MPa and approximately 35 MPa, and more preferably between about 2 MPa and 15 MPa.

10. The method of any of claims 1-9, further comprising subjecting the patterned substrate to a subsequent etching processing step.

11. The method of any of claims 1-10 the material that becomes flowable comprising a wax.

12. The method of any of claims 1-11, the material that becomes flowable comprising a resin.

13. The method of any of claims 1-12, the material that becomes flowable comprising a rosin.

14. The method of any of claims 1-13, the material becoming flowable at a temperature of less than about 100°C.

15. The method of any of claims 1-14, the material that becomes flowable having a viscosity of between about 5,000 and about 500,000 centipoise at the flow temperature and preferably between about 20,000 and about 200,000 centipoise.

16. The method of claim 15, the material that becomes flowable having a viscosity within the specified range over a

temperature range of at least about 2°C and preferably of at least about 5°C.

17. The method of any of claims 1-16, the material that becomes flowable comprising at least two components.

18. The method of any of claims 2-17, the step of applying a first pressure to the stamp being conducted for a contact time of between about .5 and about ten seconds, preferably between about 1 and about 5 seconds.

19. The method of any of claims 1-18, the protruding features having a length of between approximately 2 and approximately 20 microns, preferably about 10 microns.

20. The method of any of claims 1-19, the step of providing material that becomes flowable comprising providing a material of a depth of less than about 5 microns.

21. The method of any of claims 1-19, the step of providing material that becomes flowable comprising providing a material of a depth of between about .7 and about 5 microns, preferably less than about 3.5 microns.

22. The method of any of claims 1-21, the protruding features comprising features having a base and a tip, where the tip is rounded and the feature has a substantially circular cross-section, which decreases in diameter from the base to the tip.

23. The method of any of claims 1-22, the protruding features comprising features having a base and a tip, where the tip has a sharp point in at least one aspect.

24. The method of any of claims 1-23, the protruding features comprising features having a triangular cross section in at least one aspect.

25. The method of any of claims 1-23, the protruding features having a trapezoidal cross section in at least one aspect.

26. The method of any of claims 1-25, the stamp comprising pyramidal pointed protruding features.

27. The method of any of claims 1-26, further comprising processing the substrate to form a photovoltaic cell.

28. The method of any of claims 2-27, the steps (d) (e) and (f) defining a pulse cycle, being conducted at a frequency of at least 1/2 pulse every second.

29. The method of any of claims 2-28, the step of applying a first pressure comprising applying between about .25 to about 2 atm gauge pressure, and the step of applying a second pressure comprising applying a pressure between about .1 atm gauge and about 1 atm gauge.

30. The method of any of claims 2-29, further comprising repeating the steps (e) and (f) at least two additional times.

31. The method of any of claims 1-30, the depth of material that would result in no gap existing between the flowable material and the extended surface being called a Benchmark Unit depth of material, further, the step of providing material comprising providing material such that the gap over the majority of the surface has an extent of between .9 and .3 Benchmark Unit.

32. The method of any of claims 1-30, the depth of material that would result in no gap existing between the flowable material and the extended surface being called a Benchmark Unit depth of material, further, the step of providing material comprising providing material over the majority of the surface to a depth of between .1 and .7 Benchmark Unit.

CLAIMS

1. A method of imparting a pattern of material to a substrate, comprising the steps of:

a. providing a substrate and a stamp with deformable, spaced apart features, which protrude from an extended surface of the stamp, the features having a length;

b. providing, in at least one region of the substrate, a material that becomes flowable upon heating to a flow temperature, the material being provided to a depth less than the feature length;

c. contacting the protruding features with the flowable material;

d. applying a first pressure to a side of the stamp opposite the protruding features to a degree such that:

i. the protruding features penetrate the flowable material; and

ii. upon contact with the substrate, the protruding features deform to an extent that a gap exists over a majority of the surface of the flowable material, between the flowable material and the extended surface of the stamp and such that the gap remains at all times the protruding features contact the substrate;

e. heating the flowable material to a temperature sufficient to allow the flowable materials to flow; and

f. retracting the stamp to reveal patterned material covering regions of the substrate.

2. A method of imparting a patterned of material to a substrate, comprising the steps of:

a. providing a substrate and a stamp with deformable, spaced apart features, which protrude from an extended surface of the stamp, the features having a length;

b. providing, in at least one region of the substrate, a material that becomes flowable upon heating to a flow temperature;

c. contacting the protruding features with the flowable material;

d. applying a first pressure to a side of the stamp opposite the protruding features to a degree such that:

i. the protruding features penetrate the flowable material; and

ii. upon contact with the substrate, the protruding features deform; and

e. while continuously maintaining contact of the protruding features with the substrate, applying a second pressure that is less than the first pressure to a degree that the deformation of the protruding feature is reduced;

f. applying a pressure to the side of the stamp opposite the protruding features which pressure is greater than the second pressure;

g. before or during step f, heating the flowable material to a temperature sufficient to cause the flowable materials to flow; and

h. retracting the stamp to reveal patterned material covering regions of the substrate.

3. The method of claim 1 or claim 2, further comprising the step of cooling the flowable material.

4. The method of claim 3, wherein the step of cooling is conducted so that the flowable material becomes unflowing.

5. The method of any one of claims 2-4, wherein the step of applying a first pressure comprises applying pressure such that a predetermined areal extent of the feature of the stamp is deformed elastically into intimate contact with the substrate.

6. The method of any one of claims 1-5, wherein the patterned material includes at least one region of substrate not covered by flowable material, which was previously covered with flowable material.

7. The method of claim 6, wherein the not covered region which is not covered, is determined by an etching test.

8. The method of any one of claims 6-7, wherein the not covered region corresponds to a protruding feature of the stamp.

9. The method of any one of claims 1-8, wherein the stamp has an elastic modulus of less than approximately 50 MPa, preferably between approximately .5 MPa and approximately 35 MPa, and more preferably between about 2 MPa and 15 MPa.

10. The method of any one of claims 1-9, further comprising subjecting the patterned substrate to a subsequent etching processing step.

11. The method of any one of claims 1-10 wherein the material that becomes flowable comprises:

a) a wax;

b) a resin; or

c) a rosin.

12. The method of any one of claims 1-11, wherein the material becomes flowable at a temperature of less than about 100°C.

13. The method of any one of claims 1-12, wherein the material that becomes flowable has a viscosity of between about 5,000 and about 500,000 centipoise at the flow temperature and preferably between about 20,000 and about 200,000 centipoise.

14. The method of claim 13, wherein the material that becomes flowable has a viscosity within the specified range over a temperature range of at least about 2°C and preferably of at least about 5°C.

15. The method of any one of claims 1-14, wherein the material that becomes flowable comprises at least two components.

16. The method of any one of claims 2-15, wherein the step of applying a first pressure to the stamp is conducted for a contact time of between about .5 and about 10 seconds, preferably between about 1 and about 5 seconds.

17. The method of any one of claims 1-16, wherein the protruding features have a length of between approximately 2 and approximately 20 microns, preferably about 10 microns.

18. The method of any one of claims 1-19, wherein the step of providing material that becomes flowable comprises:

a) providing a material of a depth of less than about 5 microns; or

b) providing a material of a depth of between about .7 and about 5 microns, preferably less than about 3.5 microns.

19. The method of any one of claims 1-18, wherein the protruding features comprise:

a) features having a base and a tip, where the tip is rounded and the feature has a substantially circular cross-section, which decreases in diameter from the base to the tip;

b) features having a base and a tip, where the tip has a sharp point in at least one aspect;

c) features having a triangular cross section in at least one aspect; or

d) features having a trapezoidal cross section in at least one aspect.

20. The method of any one of claims 1-19, wherein the stamp comprises pyramidal pointed protruding features.

21. The method of any one of claims 1-20, further comprising processing the substrate to form a photovoltaic cell.

22. The method of any one of claims 2-21, wherein the steps (d) (e) and (f) define a pulse cycle, being conducted at a frequency of at least 1/2 pulse every second.

23. The method of any one of claims 2-22, wherein the step of applying a first pressure comprises applying between about .25 to about 2 atm gauge pressure, and the step of applying a second pressure comprises applying a pressure between about .1 atm gauge and about 1 atm gauge.

24. The method of any one of claims 2-23, further comprising repeating the steps (e) and (f) at least two additional times.

25. The method of any one of claims 1-24, wherein the depth of material that would result in no gap existing between the flowable material and the extended surface is called a Benchmark Unit depth of material, and the step of providing material comprises:

a) providing material such that the gap over the majority of the surface has an extent of between .9 and .3 Benchmark Unit; or

b) providing material over the majority of the surface to a depth of between .1 and .7 Benchmark Unit.