

CLAIMS

What is claimed is:

1. A polishing pad for polishing a substrate, the polishing pad comprising:
 - a foundation layer having a first hardness; and
 - a polishing surface layer bonded directly to the foundation layer, the polishing surface layer having a second hardness less than the first hardness, wherein the polishing surface layer is covalently bonded to the foundation layer.
2. The polishing pad of claim 1, wherein the polishing surface layer comprises a continuous layer portion with a plurality of polishing features protruding there from, the continuous layer portion bonded directly to the foundation layer.
3. The polishing pad of claim 1, wherein the polishing surface layer comprises a plurality of discrete polishing protrusions bonded directly to the foundation layer.
- ~~4. The polishing pad of claim 1, wherein the polishing surface layer is covalently bonded to the foundation layer.~~
45. The polishing pad of claim 1, wherein the foundation layer and the polishing surface layer have a peel resistance sufficient to withstand a shear force applied during the useful lifetime of the polishing pad.
- ~~56. The polishing pad of claim 1, wherein the foundation layer has a surface roughness greater than approximately 1 micrometer Ra (root mean square) ~~where the polishing surface layer is bonded directly to the foundation layer.~~~~
67. The polishing pad of claim 65, wherein the surface roughness is approximately in the range of 5 – 10 micrometers Ra (root mean square).
- ~~78. The polishing pad of claim 1, wherein the foundation layer has a smooth surface with a surface roughness less than approximately 1 micrometer Ra (root mean square) ~~where the polishing surface layer is bonded directly to the foundation layer.~~~~

89. The polishing pad of any one of claims 5-78, wherein the polishing surface layer comprises a material formed from polyurethane.

940. The polishing pad of claim 1, wherein the foundation layer has an energy loss factor of less than approximately 100 KEL at 1/Pa at 40°C.

1044. The polishing pad of claim 1, wherein the foundation layer has a compressibility of less than approximately 1 % under a central pressure of substantially 34 kPa (5 PSI).

1142. The polishing pad of claim 1, wherein the foundation layer has a hardness greater than approximately 75 Shore D.

1243. The polishing pad of claim 1, wherein the foundation layer comprises a polycarbonate material.

1344. The polishing pad of claim 1, wherein the foundation layer comprises a material selected from the group consisting of an epoxy board material and a metal sheet.

1445. The polishing pad of claim 1, wherein the polishing surface layer has an energy loss factor of greater than approximately 1000 KEL at 1/Pa at 40°C.

1546. The polishing pad of claim 1, wherein the polishing surface layer has a compressibility of greater than approximately 0.1 % under a central pressure of substantially 34 kPa (5 PSI).

1647. The polishing pad of claim 1, wherein the polishing surface layer has a hardness less than approximately 70 Shore D.

1748. The polishing pad of claim 1, wherein the polishing surface layer is a homogeneous polishing surface layer.

1849. The polishing pad of claim 1, wherein the homogeneous polishing surface layer comprises a thermoset polyurethane material.

1920. The polishing pad of claim 1, wherein the polishing surface layer has a pore density of closed cell pores approximately in the range of 6% - 50% total void volume.

2021. The polishing pad of claim 1, wherein the foundation layer has an energy loss factor of less than approximately 100 KEL at 1/Pa at 40°C, wherein the polishing surface layer has an energy loss factor of greater than approximately 1000 KEL at 1/Pa at 40°C, and wherein the foundation layer and the polishing surface layer together have an energy loss factor of less than approximately 100 KEL at 1/Pa at 40°C.

2122. The polishing pad of claim 1, wherein the foundation layer has a hardness approximately in the range of 70 – 90 Shore D, and the polishing surface layer has a hardness approximately in the range of 50 – 60 Shore D.

2223. The polishing pad of claim 1, wherein the foundation layer has a hardness approximately in the range of 70 – 90 Shore D, and the polishing surface layer has a hardness approximately in the range of 20 – 50 Shore D.

2324. The polishing pad of claim 1, wherein the polishing surface layer has a first modulus of elasticity, and the foundation layer has a second modulus of elasticity greater than approximately 10 times the first modulus of elasticity.

2425. The polishing pad of claim 2423, wherein the polishing surface layer has a first modulus of elasticity, and the foundation layer has a second modulus of elasticity greater than approximately 100 times the first modulus of elasticity.

2526. The polishing pad of claim 1, wherein the polishing surface layer has a thickness approximately in the range of 50 – 1270 microns (2 – 50 mils), and the foundation layer has a thickness of greater than approximately 500 microns (20 mils).

2627. The polishing pad of claim 2625, wherein the thickness of the foundation layer is greater than the thickness of the polishing surface layer.

27~~28~~. The polishing pad of claim 1, wherein the foundation layer has a thickness and hardness relative to the thickness and hardness of the polishing surface layer sufficient to dictate the bulk polishing characteristics of the polishing pad.

28~~29~~. The polishing pad of claim 1, wherein the foundation layer is sufficiently thick for the polishing pad to provide die-level polishing planarity, but sufficiently thin for the polishing pad to provide wafer-level polishing uniformity.

29~~30~~. The polishing pad of claim 1, further comprising:
a detection region disposed in the foundation layer.

30~~31~~. The polishing pad of claim 1, further comprising:
an aperture disposed in the polishing pad, through the polishing surface layer and the foundation layer; and
an adhesive sheet disposed on a back surface of the foundation layer but not in the aperture, the adhesive sheet providing an impermeable seal for the aperture at the back surface of the foundation layer.

31~~32~~. The polishing pad of claim 1, further comprising:
a sub pad having a third hardness less than the first hardness, wherein the foundation layer is disposed proximate to the sub pad.

32~~33~~. The polishing pad of claim ~~32~~31, wherein the foundation layer has a hardness approximately in the range of 70 – 90 Shore D, the polishing surface layer has a hardness approximately in the range of 20 – 60 Shore D, and the sub pad has a hardness less than approximately 90 Shore A.

33~~34~~. The polishing pad of claim ~~32~~31, wherein the polishing pad provides die-level polishing planarity and wafer-level polishing uniformity.

34~~35~~. The polishing pad of claim 1, wherein the foundation layer comprises a stack of sub layers.

3536. A polishing pad for polishing a substrate, the polishing pad comprising:
a foundation layer having a first hardness; and
a polishing surface layer bonded directly to the foundation layer, the polishing surface layer having a second hardness equal to or greater than the first hardness, wherein the polishing surface layer is covalently bonded to the foundation layer.

~~37. The polishing pad of claim 36, wherein the polishing surface layer is covalently bonded to the foundation layer.~~

3638. The polishing pad of claim 3635, wherein the foundation layer and the polishing surface layer have a peel resistance sufficient to withstand a shear force applied during the useful lifetime of the polishing pad.

3739. The polishing pad of claim 3635, wherein the polishing surface layer comprises a continuous layer portion with plurality of polishing features protruding there from, the continuous layer portion bonded directly to the foundation layer.

3840. The polishing pad of claim 3635, wherein the polishing surface layer comprises a plurality of discrete polishing protrusions bonded directly to the foundation layer.

3941. A polishing pad for polishing a substrate, the polishing pad comprising:
a foundation layer having an energy loss factor of less than approximately 100 KEL at 1/Pa at 40°C; and
a polishing surface layer attached to the foundation layer, the polishing surface layer having an energy loss factor of greater than approximately 1000 KEL at 1/Pa at 40°C, wherein the foundation layer and the polishing surface layer together have an energy loss factor of less than approximately 100 KEL at 1/Pa at 40°C, wherein the polishing surface layer is covalently bonded to the foundation layer.

4042. The polishing pad of claim 4139, wherein the polishing surface layer comprises a continuous layer portion with plurality of polishing features protruding there from, the continuous layer portion attached to the foundation layer.

4143. The polishing pad of claim 4139, wherein the polishing surface layer comprises a plurality of discrete polishing protrusions attached to the foundation layer.

4244. The polishing pad of claim 4139, wherein the polishing surface layer comprises a thermoset polyurethane material.

4345. A polishing pad for polishing a substrate, the polishing pad comprising:
a foundation layer having a first hardness; and
a polishing surface layer attached to the foundation layer, the polishing surface layer having a second hardness less than the first hardness and comprising a thermoset material, wherein the polishing surface layer is covalently bonded to the foundation layer.

4446. The polishing pad of claim 4543, wherein the polishing surface layer is a homogeneous polishing surface layer.

4547. The polishing pad of claim 4543, wherein the thermoset material is polyurethane.

4648. The polishing pad of claim 4543, wherein the foundation layer has a hardness approximately in the range of 70 – 90 Shore D, and the polishing surface layer has a hardness approximately in the range of 50 – 60 Shore D.

4749. The polishing pad of claim 4543, wherein the foundation layer has a hardness approximately in the range of 70 – 90 Shore D, and the polishing surface layer has a hardness approximately in the range of 20 – 50 Shore D.

4850. The polishing pad of claim 4543, wherein the polishing surface layer comprises a continuous layer portion with plurality of polishing features protruding there from, the continuous layer portion attached to the foundation layer.

4951. The polishing pad of claim 4543, wherein the polishing surface layer comprises a plurality of discrete polishing protrusions attached to the foundation layer.

5052. The polishing pad of claim 4543, wherein the polishing surface layer has a pore density of closed cell pores approximately in the range of 6% - 50% total void volume.

5153. A polishing pad for polishing a substrate, the polishing pad comprising:
a nonporous foundation layer; and
a polishing surface layer bonded directly to the foundation layer, the polishing surface layer having a pore density of closed cell pores, wherein the polishing surface layer is covalently bonded to the foundation layer.

5254. The polishing pad of claim 5351, wherein the pore density of closed cell pores is approximately in the range of 6% - 50% total void volume.

5355. The polishing pad of claim 5351, wherein the polishing surface layer comprises a continuous layer portion with plurality of polishing features protruding there from, the continuous layer portion bonded directly to the foundation layer.

5456. The polishing pad of claim 5351, wherein the polishing surface layer comprises a plurality of discrete polishing protrusions bonded directly to the foundation layer.

5557. A method of fabricating a polishing pad for polishing a substrate, the method comprising:
providing, in a formation mold, a foundation layer and a mixture formed from mixing a set of polymerizable materials;
coupling a pattern of protrusions of the formation mold with the mixture; and, with the pattern of protrusions coupled with the mixture,
at least partially curing the mixture to form a molded homogeneous polishing surface layer directly on the foundation layer, the molded homogeneous polishing surface layer comprising a pattern of grooves corresponding to the pattern of protrusions of the formation mold, wherein the molded homogeneous polishing surface layer is covalently bonded to the foundation layer.

5658. The method of claim 5755, wherein providing the foundation layer comprises placing the foundation layer in a base of the formation mold, wherein providing the

mixture comprises providing the mixture in the base of the formation mold, on the foundation layer, wherein coupling the pattern of protrusions of the formation mold comprises coupling a lid of the formation mold with the mixture, the lid having disposed thereon the pattern of protrusions, and wherein at least partially curing the mixture comprises heating the base of the formation mold.

5759. The method of claim 5755, further comprising:

removing the foundation layer having the molded homogeneous polishing surface layer formed thereon from the base of the formation mold when the extent of curing is sufficient to maintain geometry of the molded homogeneous polishing surface layer but insufficient for the molded homogeneous polishing surface layer to withstand mechanical stress.

5860. The method of claim 5957, wherein the foundation layer extends beyond the molded homogeneous polishing surface layer, and wherein removing the foundation layer having the molded homogeneous polishing surface layer formed thereon from the base of the formation mold comprises taking hold of the foundation layer but not the molded homogeneous polishing surface layer.

5961. The method of claim 5755, wherein at least partially curing the mixture comprises heating both the mixture and the foundation layer.

6062. The method of claim 5755, further comprising:

removing the molded homogeneous polishing surface layer from the foundation layer;
and
forming a second homogeneous polishing surface layer on the foundation layer.

6163. The method of claim 5755, wherein providing the foundation layer in the formation mold comprises first removing a previously formed polishing surface layer from the foundation layer.

6264. The method of claim 5755, wherein providing the foundation layer in the formation mold comprises first roughening a surface of the foundation layer.

6365. The method of claim 5755, wherein forming the molded homogeneous polishing surface layer comprises forming a thermoset polyurethane material.

6466. The method of claim 5755, wherein mixing the set of polymerizable materials further comprises adding a plurality of porogens to the set of polymerizable materials to form a plurality of closed cell pores in the molded homogeneous polishing surface layer, each closed cell pore having a physical shell.

6567. The method of claim 5755, wherein mixing the set of polymerizable materials further comprises injecting a gas into the set of polymerizable materials, or into a product formed there from, to form a plurality of closed cell pores in the molded homogeneous polishing surface layer, each closed cell pore having no physical shell.

6668. The method of claim 5755, wherein mixing the set of polymerizable materials comprises mixing an isocyanate and an aromatic diamine compound.

6769. The method of claim 5755, wherein mixing the set of polymerizable materials further comprises adding an opacifying particle filler to the set of polymerizable materials to form an opaque molded homogeneous polishing surface layer.

6870. The method of claim 5755, further comprising:
further curing the molded homogeneous polishing surface layer by heating the foundation layer having the molded homogeneous polishing surface layer formed thereon in an oven.

6971. The method of claim 5755, wherein a polishing pad comprising the foundation layer having the molded homogeneous polishing surface layer formed thereon is suitable for performing a polishing process without performing a backside cut of the foundation layer.

7072. The method of claim 5755, wherein at least partially curing the mixture forms the molded homogeneous polishing surface layer covalently bonded with the foundation layer.

7173. A method of fabricating a polishing pad for polishing a substrate, the method comprising:

providing, in a formation mold, a foundation layer and a mixture formed from mixing a set of polymerizable materials;

coupling a pattern of protrusions of the formation mold with the mixture; and, with the pattern of protrusions coupled with the mixture,

at least partially curing the mixture to form a molded homogeneous polishing surface layer attached to the foundation layer, the molded homogeneous polishing surface layer comprising a pattern of grooves corresponding to the pattern of protrusions of the formation mold; and

removing the foundation layer having the molded homogeneous polishing surface layer attached thereto from the base of the formation mold when the extent of curing is sufficient to maintain geometry of the molded homogeneous polishing surface layer but insufficient for the molded homogeneous polishing surface layer to withstand mechanical stress, wherein the molded homogeneous polishing surface layer is covalently bonded to the foundation layer.

7274. The method of claim 7371, wherein the foundation layer having the molded homogeneous polishing surface layer attached thereto is removed from the base of the formation mold less than approximately 4 minutes after coupling the pattern of protrusions of the formation mold with the mixture.

7375. The method of claim 7371, wherein removing the foundation layer having the molded homogeneous polishing surface layer attached thereto from the formation mold is performed immediately after the material of the molded homogeneous polishing surface layer gels.

7476. The method of claim 7371, wherein the foundation layer extends beyond the molded homogeneous polishing surface layer, and wherein removing the foundation layer having the molded homogeneous polishing surface layer attached thereto from the base of the formation mold comprises taking hold of the foundation layer but not the molded homogeneous polishing surface layer.

7577. The method of claim 7371, wherein at least partially curing the mixture comprises heating both the mixture and the foundation layer.

7678. The method of claim 7371, further comprising:

removing the molded homogeneous polishing surface layer from the foundation layer;
and
forming a second homogeneous polishing surface layer attached to the foundation layer.

7779. The method of claim 7371, wherein providing the foundation layer in the formation mold comprises first removing a previously formed polishing surface layer from the foundation layer.

7880. The method of claim 7371, wherein providing the foundation layer in the formation mold comprises first roughening a surface of the foundation layer.

7981. The method of claim 7371, further comprising:

further curing the molded homogeneous polishing surface layer by heating the foundation layer having the molded homogeneous polishing surface layer attached thereto in an oven.

8082. The method of claim 7371, wherein a polishing pad comprising the foundation layer having the molded homogeneous polishing surface layer attached thereto is suitable for performing a polishing process without performing a backside cut of the foundation layer.

8183. A polishing pad for polishing a substrate, the polishing pad comprising:

a foundation layer having a pattern of grooves disposed therein; and
a continuous polishing surface layer attached to the pattern of grooves of the foundation layer, wherein the continuous polishing surface layer is covalently bonded to the foundation layer.

8284. The polishing pad of claim 8381, wherein the continuous polishing surface layer is bonded directly to the foundation layer.

~~85. The polishing pad of claim 84, wherein the continuous polishing surface layer is covalently bonded to the foundation layer.~~

8386. The polishing pad of claim 8381, wherein the foundation layer has an energy loss factor of less than approximately 100 KEL at 1/Pa at 40°C.

8487. The polishing pad of claim 8381, wherein the foundation layer has a compressibility of less than approximately 1 % under a central pressure of substantially 34 kPa (5 PSI).

8588. The polishing pad of claim 8381, wherein the foundation layer has a hardness greater than approximately 75 Shore D.

8689. The polishing pad of claim 8381, wherein the foundation layer comprises a polymeric material selected from the group consisting of a polyurethane material and a polycarbonate material.

8790. The polishing pad of claim 8381, wherein the foundation layer comprises a material selected from the group consisting of an epoxy board material and a metal sheet.

8891. The polishing pad of claim 8381, wherein the continuous polishing surface layer has an energy loss factor of greater than approximately 1000 KEL at 1/Pa at 40°C.

8992. The polishing pad of claim 8381, wherein the continuous polishing surface layer has a compressibility of greater than approximately 0.1 % under a central pressure of substantially 34 kPa (5 PSI).

9093. The polishing pad of claim 8381, wherein the continuous polishing surface layer has a hardness less than approximately 70 Shore D.

9194. The polishing pad of claim 8381, wherein the continuous polishing surface layer is a homogeneous polishing surface layer.

9295. The polishing pad of claim 9491, wherein the homogeneous polishing surface layer comprises a thermoset polyurethane material.

9396. The polishing pad of claim 8381, wherein the continuous polishing surface layer has a pore density of closed cell pores approximately in the range of 6% - 50% total void volume.

9497. The polishing pad of claim 8381, wherein the foundation layer has an energy loss factor of less than approximately 100 KEL at 1/Pa at 40°C, wherein the continuous polishing surface layer has an energy loss factor of greater than approximately 1000 KEL at 1/Pa at 40°C, and wherein the foundation layer and the continuous polishing surface layer together have an energy loss factor of less than approximately 100 KEL at 1/Pa at 40°C.

9598. The polishing pad of claim 8381, wherein the foundation layer has a hardness approximately in the range of 70 – 90 Shore D, and the continuous polishing surface layer has a hardness approximately in the range of 50 – 60 Shore D.

9699. The polishing pad of claim 8381, wherein the foundation layer has a hardness approximately in the range of 70 – 90 Shore D, and the continuous polishing surface layer has a hardness approximately in the range of 20 – 50 Shore D.

97400. The polishing pad of claim 8381, wherein the continuous polishing surface layer has a first modulus of elasticity, and the foundation layer has a second modulus of elasticity greater than approximately 10 times the first modulus of elasticity.

98401. The polishing pad of claim 8381, wherein the continuous polishing surface layer has a first modulus of elasticity, and the foundation layer has a second modulus of elasticity greater than approximately 100 times the first modulus of elasticity.

99402. The polishing pad of claim 8381, wherein the continuous polishing surface layer has a thickness approximately in the range of 50 – 1270 microns (2 - 50 mils), and the foundation layer has a thickness of greater than approximately 500 microns (20 mils).

100403. The polishing pad of claim 8381, wherein the foundation layer has a thickness and hardness relative to the thickness and hardness of the continuous polishing surface layer sufficient to dictate the bulk polishing characteristics of the polishing pad.

101404. The polishing pad of claim 8381, wherein the foundation layer is sufficiently thick for the polishing pad to provide die-level polishing planarity, but sufficiently thin for the polishing pad to provide wafer-level polishing uniformity.

102405. The polishing pad of claim 8381, further comprising:
a detection region disposed in the foundation layer.

103406. The polishing pad of claim 8381, further comprising:
an aperture disposed in the polishing pad, through the continuous polishing surface layer and the foundation layer; and
an adhesive sheet disposed on a back surface of the foundation layer but not in the aperture, the adhesive sheet providing an impermeable seal for the aperture at the back surface of the foundation layer.

104407. The polishing pad of claim 8381, further comprising:
a sub pad, wherein the foundation layer is disposed proximate to the sub pad.

105408. The polishing pad of claim 107104, wherein the foundation layer has a hardness approximately in the range of 70 – 90 Shore D, the continuous polishing surface layer has a hardness approximately in the range of 20 – 60 Shore D, and the sub pad has a hardness less than approximately 90 Shore A.

106409. The polishing pad of claim 107104, wherein the polishing pad provides die-level polishing planarity and wafer-level polishing uniformity.

107410. The polishing pad of claim 8381, wherein the foundation layer comprises a stack of sub layers.

108444. A polishing pad for polishing a substrate, the polishing pad comprising:
a foundation layer with a surface having a pattern of protrusions disposed thereon,
each protrusion having a top surface and sidewalls; and
a non-continuous polishing surface layer attached to the foundation layer and
comprising discrete portions, each discrete portion attached to the top surface of a
corresponding one of the protrusions of the foundation layer, wherein the non-
continuous polishing surface layer is covalently bonded to the foundation layer.

109442. The polishing pad of claim 444108, wherein each discrete portion is further
attached to a portion of the sidewalls of the corresponding one of the protrusions of the
foundation layer.

~~113. The polishing pad of claim 111, wherein the non-continuous polishing surface layer
is bonded directly to the foundation layer.~~

~~114. The polishing pad of claim 113, wherein the non-continuous polishing surface layer
is covalently bonded to the foundation layer.~~

110445. The polishing pad of claim 444108, wherein the foundation layer has an energy
loss factor of less than approximately 100 KEL at 1/Pa at 40°C.

111446. The polishing pad of claim 444108, wherein the foundation layer has a
compressibility of less than approximately 1 % under a central pressure of substantially 34
kPa (5 PSI).

112447. The polishing pad of claim 444108, wherein the foundation layer has a hardness
greater than approximately 75 Shore D.

113448. The polishing pad of claim 444108, wherein the foundation layer comprises a
polycarbonate material.

114~~119~~. The polishing pad of claim ~~444~~108, wherein the foundation layer comprises a material selected from the group consisting of an epoxy board material and a metal sheet.

115~~120~~. The polishing pad of claim ~~444~~108, wherein the non-continuous polishing surface layer has an energy loss factor of greater than approximately 1000 KEL at 1/Pa at 40°C.

116~~121~~. The polishing pad of claim ~~444~~108, wherein the non-continuous polishing surface layer has a compressibility of greater than approximately 0.1 % under a central pressure of substantially 34 kPa (5 PSI).

117~~122~~. The polishing pad of claim ~~444~~108, wherein the non-continuous polishing surface layer has a hardness less than approximately 70 Shore D.

118~~123~~. The polishing pad of claim ~~444~~108, wherein the non-continuous polishing surface layer is a homogeneous polishing surface layer.

119~~124~~. The polishing pad of claim ~~423~~118, wherein the homogeneous polishing surface layer comprises a thermoset polyurethane material.

120~~125~~. The polishing pad of claim ~~444~~108, wherein the non-continuous polishing surface layer has a pore density of closed cell pores approximately in the range of 6% - 50% total void volume.

121~~126~~. The polishing pad of claim ~~444~~108, wherein the foundation layer has an energy loss factor of less than approximately 100 KEL at 1/Pa at 40°C, wherein the non-continuous polishing surface layer has an energy loss factor of greater than approximately 1000 KEL at 1/Pa at 40°C, and wherein the foundation layer and the non-continuous polishing surface layer together have an energy loss factor of less than approximately 100 KEL at 1/Pa at 40°C.

122~~427~~. The polishing pad of claim ~~444~~108, wherein the foundation layer has a hardness approximately in the range of 70 – 90 Shore D, and the non-continuous polishing surface layer has a hardness approximately in the range of 50 – 60 Shore D.

123~~428~~. The polishing pad of claim ~~444~~108, wherein the foundation layer has a hardness approximately in the range of 70 – 90 Shore D, and the non-continuous polishing surface layer has a hardness approximately in the range of 20 – 50 Shore D.

124~~429~~. The polishing pad of claim ~~444~~108, wherein the non-continuous polishing surface layer has a first modulus of elasticity, and the foundation layer has a second modulus of elasticity greater than approximately 10 times the first modulus of elasticity.

125~~430~~. The polishing pad of claim ~~444~~108, wherein the non-continuous polishing surface layer has a first modulus of elasticity, and the foundation layer has a second modulus of elasticity greater than approximately 100 times the first modulus of elasticity.

126~~431~~. The polishing pad of claim ~~444~~108, wherein the non-continuous polishing surface layer has a thickness approximately in the range of 50 – 1270 microns (2 - 50 mils), and the foundation layer has a thickness of greater than approximately 500 microns (20 mils).

127~~432~~. The polishing pad of claim ~~444~~108, wherein the foundation layer has a thickness and hardness relative to the thickness and hardness of the non-continuous polishing surface layer sufficient to dictate the bulk polishing characteristics of the polishing pad.

128~~433~~. The polishing pad of claim ~~444~~108, wherein the foundation layer is sufficiently thick for the polishing pad to provide die-level polishing planarity, but sufficiently thin for the polishing pad to provide wafer-level polishing uniformity.

129~~434~~. The polishing pad of claim ~~444~~108, further comprising:
a detection region disposed in the foundation layer.

130~~435~~. The polishing pad of claim ~~444~~108, further comprising:

an aperture disposed in the polishing pad, through the non-continuous polishing surface layer and the foundation layer; and
an adhesive sheet disposed on a back surface of the foundation layer but not in the aperture, the adhesive sheet providing an impermeable seal for the aperture at the back surface of the foundation layer.

131~~436~~. The polishing pad of claim ~~444~~108, further comprising:

a sub pad, wherein the foundation layer is disposed proximate to the sub pad.

132~~437~~. The polishing pad of claim ~~436~~131, wherein the foundation layer has a hardness approximately in the range of 70 – 90 Shore D, the non-continuous polishing surface layer has a hardness approximately in the range of 20 – 60 Shore D, and the sub pad has a hardness less than approximately 90 Shore A.

133~~438~~. The polishing pad of claim ~~436~~131, wherein the polishing pad provides die-level polishing planarity and wafer-level polishing uniformity.

134~~439~~. The polishing pad of claim ~~444~~108, wherein the foundation layer comprises a stack of sub layers.

~~140. A method of fabricating a polishing pad for polishing a substrate, the method comprising:~~

~~providing a foundation layer with a surface having a pattern of protrusions formed thereon, each protrusion having a top surface and sidewalls; and
forming a polishing surface layer above the foundation layer.~~

~~141. The method of claim 140, wherein forming the polishing surface layer comprises forming a continuous polishing surface layer attached to the foundation layer, conformal with the pattern of protrusions.~~

~~142. The method of claim 140, wherein forming the polishing surface layer comprises forming a non-continuous polishing surface layer attached to the foundation layer and~~

~~comprising discrete portions, each discrete portion attached to the top surface of a corresponding one of the protrusions of the foundation layer.~~

~~143. The method of claim 140, wherein forming the polishing surface layer comprises forming the polishing surface layer directly on the foundation layer.~~

~~144. The method of claim 140, wherein forming the polishing surface layer comprises using a technique selected from the group consisting of rolling on the polishing surface layer, spraying on the polishing surface layer, double molding the polishing surface layer with the foundation layer, printing the polishing surface layer, and stamping on the polishing surface layer.~~

~~145. The method of claim 140, further comprising:~~

~~removing the polishing surface layer from the foundation layer; and
forming a second polishing surface layer above the foundation layer.~~

~~146. The method of claim 140, wherein providing the foundation layer comprises first removing a previously formed polishing surface layer from the foundation layer.~~