CLAIMS

What is claimed is:

1. A polishing pad for polishing a semiconductor substrate, the polishing pad comprising:

a homogeneous polishing body comprising:

a thermoset polyurethane material; and

a plurality of closed cell pores disposed in the thermoset polyurethane material, the plurality of closed cell pores having a multi-modal distribution of diameters.

2. The polishing pad of claim 1, wherein each of the closed cell pores comprises a physical shell.

3. The polishing pad of claim 1, wherein the multi-modal distribution of diameters is a bimodal distribution of diameters comprising a small diameter mode and a large diameter mode.

4. The polishing pad of claim 3, wherein the diameter value for the maximum population of the large diameter mode is approximately twice the diameter value of the maximum population of the small diameter mode.

5. The polishing pad of claim 4, wherein the diameter value for the maximum population of the large diameter mode is approximately 40 microns, and the diameter value of the maximum population of the small diameter mode is approximately 20 microns.

6. The polishing pad of claim 4, wherein the diameter value for the maximum population of the large diameter mode is approximately 80 microns, and the diameter value of the maximum population of the small diameter mode is approximately 40 microns.

7. The polishing pad of claim 3, wherein the diameter value for the maximum population of the large diameter mode is approximately four times greater than the diameter value of the maximum population of the small diameter mode.

8. The polishing pad of claim 7, wherein the diameter value for the maximum population of the large diameter mode is approximately 80 microns, and the diameter value of the maximum population of the small diameter mode is approximately 20 microns.

9. The polishing pad of claim 3, wherein the diameter of the maximum population of the closed cell pores of the small diameter mode is suitable to provide a polishing surface of the polishing pad with highly uniform polishing slurry distribution, and the diameter of the maximum population of the closed cell pores of the large diameter mode is suitable to provide reservoirs for storing polishing slurry for use with the closed cell pores of the small diameter mode.

10. The polishing pad of claim 3, wherein the diameter of the maximum population of the closed cell pores of the small diameter mode is suitable to provide a polishing surface of the polishing pad with highly uniform polishing slurry distribution, and the diameter of the maximum population of the closed cell pores of the large diameter mode is suitable to provide locations for receiving a diamond tip during conditioning of the polishing pad.

11. The polishing pad of claim 3, wherein the diameter of the maximum population of the closed cell pores of the small diameter mode provides an insufficient heat sink during a polishing process, the diameter of the maximum population of the closed cell pores of the large diameter mode is suitable to provide an excessive heat sink during a polishing process, and the combination of the closed cell pores of the small diameter mode and the closed cell pores of the large diameter mode is suitable to provide thermal stability during the polishing process.

12. The polishing pad of claim 3, wherein the population of the large diameter mode overlaps with the population of the small diameter mode.

13. The polishing pad of claim 3, wherein the population of the large diameter mode has essentially no overlap with the population of the small diameter mode.

14. The polishing pad of claim 3, wherein the total population of the large diameter mode is not equal to the total population of the small diameter mode.

15. The polishing pad of claim 3, wherein the total population of the large diameter mode is approximately equal to the total population of the small diameter mode.

16. The polishing pad of claim 1, wherein the multi-modal distribution of diameters is a trimodal distribution of diameters comprising a small diameter mode, a medium diameter mode, and a large diameter mode.

17. The polishing pad of claim 16, wherein the diameter value for the maximum population of the large diameter mode is approximately 80 microns, the diameter value of the maximum population of the medium diameter mode is approximately 40 microns, and the diameter value of the maximum population of the small diameter mode is approximately 20 microns.

18. The polishing pad of claim 1, wherein the multi-modal distribution of diameters is distributed essentially evenly throughout the thermoset polyurethane material.

19. The polishing pad of claim 1, wherein the homogeneous polishing body further comprises:

a first, grooved surface; and

a second, flat surface opposite the first surface, wherein the multi-modal distribution of diameters is graded throughout the thermoset polyurethane material with a gradient from the first, grooved surface to the second, flat surface.

20. The polishing pad of claim 19, wherein the multi-modal distribution of diameters is a bimodal distribution of diameters comprising a small diameter mode proximate to the first, grooved surface, and comprising a large diameter mode proximate to the second, flat surface.

21. The polishing pad of claim 1, wherein the homogeneous polishing body is a molded homogeneous polishing body.

22. The polishing pad of claim 1, wherein the homogeneous polishing body further comprises:

an opacifying lubricant distributed approximately evenly throughout the homogeneous polishing body.

23. The polishing pad of claim 1, further comprising:

a local area transparency (LAT) region disposed in, and covalently bonded with, the homogeneous polishing body.

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

mixing a pre-polymer and a curative to form a mixture in a formation mold; and

curing the mixture to provide a molded homogeneous polishing body comprising a thermoset polyurethane material and a plurality of closed cell pores disposed in the thermoset polyurethane material, the plurality of closed cell pores having a multi-modal distribution of diameters.

25. The method of claim 24, wherein the mixing further comprises adding a plurality of porogens to the pre-polymer and the curative to provide the closed cell pores, each having a physical shell.

26. The method of claim 24, wherein the mixing further comprises injecting a gas into the pre-polymer and the curative, or into a product formed there from, to provide the closed cell pores, each having no physical shell.

27. The method of claim 24, wherein the mixing further comprises adding a plurality of porogens to the pre-polymer and the curative to provide a first portion of the closed cell pores, each having a physical shell, and wherein the mixing further comprises injecting a gas into the pre-polymer and the curative, or into a product formed there from, to provide a second portion of the closed cell pores, each having no physical shell.

28. The method of claim 24, wherein the pre-polymer is an isocyanate and the mixing further comprises adding water to the pre-polymer and the curative to provide the closed cell pores, each having no physical shell.

29. The method of claim 24, wherein curing the mixture comprises distributing the multi-modal distribution of diameters essentially evenly throughout the thermoset polyurethane material.

30. The method of claim 24, wherein the molded homogeneous polishing body further comprises a first, grooved surface and a second, flat surface opposite the first surface, and wherein curing the mixture comprises grading the multi-modal distribution of diameters throughout the thermoset polyurethane material with a gradient from the first, grooved surface to the second, flat surface.

31. The method of claim 30, wherein the multi-modal distribution of diameters is a bimodal distribution of diameters comprising a small diameter mode proximate to the first, grooved surface, and comprising a large diameter mode proximate to the second, flat surface.

32. The method of claim 24, wherein mixing the pre-polymer and the curative comprises mixing an isocyanate and an aromatic diamine compound, respectively.

33. The method of claim 24, wherein the mixing further comprises adding an opacifying lubricant to the pre-polymer and the curative to provide an opaque molded homogeneous polishing body.

34. The method of claim 24, wherein curing the mixture comprises first partially curing in the formation mold and then further curing in an oven.

Claims:

1. A polishing pad for polishing a semiconductor substrate, the polishing pad comprising:

a homogeneous polishing body having a first, grooved surface and a second, flat surface opposite the first surface, the homogeneous polishing body comprising:

a thermoset polyurethane material; and

a plurality of closed cell pores disposed in the thermoset polyurethane material, the plurality of closed cell pores having a multi-modal distribution of diameters, wherein the multi-modal distribution of diameters is graded throughout the thermoset polyurethane material with a gradient from the first, grooved surface to the second, flat surface.

2. The polishing pad of claim 1, wherein each of the closed cell pores comprises a physical shell.

3. The polishing pad of claim 1, wherein the multi-modal distribution of diameters is a bimodal distribution of diameters comprising a small diameter mode and a large diameter mode.

4. The polishing pad of claim 3, wherein the diameter value for the maximum population of the large diameter mode is approximately twice the diameter value of the maximum population of the small diameter mode.

5. The polishing pad of claim 4, wherein the diameter value for the maximum population of the large diameter mode is approximately 40 microns, and the diameter value of the maximum population of the small diameter mode is approximately 20 microns.

6. The polishing pad of claim 4, wherein the diameter value for the maximum population of the large diameter mode is approximately 80 microns, and the diameter value of the maximum population of the small diameter mode is approximately 40 microns.

7. The polishing pad of claim 3, wherein the diameter value for the maximum population of the large diameter mode is approximately four times greater than the diameter value of the maximum population of the small diameter mode.

8. The polishing pad of claim 7, wherein the diameter value for the maximum population of the large diameter mode is approximately 80 microns, and the diameter value of the maximum population of the small diameter mode is approximately 20 microns.

9. The polishing pad of claim 3, wherein the diameter of the maximum population of the closed cell pores of the small diameter mode is suitable to provide a polishing surface of the polishing pad with highly uniform polishing slurry distribution, and the diameter of the maximum population of the closed cell pores of the large diameter mode is suitable to provide reservoirs for storing polishing slurry for use with the closed cell pores of the small diameter mode.

10. The polishing pad of claim 3, wherein the diameter of the maximum population of the closed cell pores of the small diameter mode is suitable to provide a polishing surface of the polishing pad with highly uniform polishing slurry distribution, and the diameter of the maximum population of the closed cell pores of the large diameter mode is suitable to provide locations for receiving a diamond tip during conditioning of the polishing pad.

11. The polishing pad of claim 3, wherein the diameter of the maximum population of the closed cell pores of the small diameter mode provides an insufficient heat sink during a polishing process, the diameter of the maximum population of the closed cell pores of the large diameter mode is suitable to provide an excessive heat sink during a polishing process, and the combination of the closed cell pores of the small diameter mode and the closed cell pores of the large diameter mode is suitable to provide thermal stability during the polishing process.

12. The polishing pad of claim 3, wherein the population of the large diameter mode overlaps with the population of the small diameter mode.

13. The polishing pad of claim 3, wherein the population of the large diameter mode has essentially no overlap with the population of the small diameter mode.

14. The polishing pad of claim 3, wherein the total population of the large diameter mode is not equal to the total population of the small diameter mode.

15. The polishing pad of claim 3, wherein the total population of the large diameter mode is approximately equal to the total population of the small diameter mode.

16. The polishing pad of claim 1, wherein the multi-modal distribution of diameters is a trimodal distribution of diameters comprising a small diameter mode, a medium diameter mode, and a large diameter mode.

17. The polishing pad of claim 16, wherein the diameter value for the maximum population of the large diameter mode is approximately 80 microns, the diameter value of the maximum population of the medium diameter mode is approximately 40 microns, and the diameter value of the maximum population of the small diameter mode is approximately 20 microns.

18. The polishing pad of claim 1, wherein the multi-modal distribution of diameters is a bimodal distribution of diameters comprising a small diameter mode proximate to the first, grooved surface, and comprising a large diameter mode proximate to the second, flat surface.

19. The polishing pad of claim 1, wherein the homogeneous polishing body is a molded homogeneous polishing body.

20. The polishing pad of claim 1, wherein the homogeneous polishing body further comprises:

an opacifying lubricant distributed approximately evenly throughout the homogeneous polishing body.

21. The polishing pad of claim 1, further comprising:

a local area transparency (LAT) region disposed in, and covalently bonded with, the homogeneous polishing body.

22. A polishing pad for polishing a semiconductor substrate, the polishing pad comprising:

a homogeneous polishing body comprising:

a thermoset polyurethane material; and

a plurality of closed cell pores disposed in the thermoset polyurethane material, the plurality of closed cell pores having a multi-modal distribution of diameters, wherein each of the plurality of closed cell pores comprises a physical shell.

23. The polishing pad of claim 22, wherein the multi-modal distribution of diameters is a bimodal distribution of diameters comprising a small diameter mode and a large diameter mode.

24. The polishing pad of claim 23, wherein the diameter value for the maximum population of the large diameter mode is approximately twice the diameter value of the maximum population of the small diameter mode.

25. The polishing pad of claim 24, wherein the diameter value for the maximum population of the large diameter mode is approximately 40 microns, and the diameter value of the maximum population of the small diameter mode is approximately 20 microns.

26. The polishing pad of claim 24, wherein the diameter value for the maximum population of the large diameter mode is approximately 80 microns, and the diameter value of the maximum population of the small diameter mode is approximately 40 microns.

27. The polishing pad of claim 23, wherein the diameter value for the maximum population of the large diameter mode is approximately four times greater than the diameter value of the maximum population of the small diameter mode.

28. The polishing pad of claim 27, wherein the diameter value for the maximum population of the large diameter mode is approximately 80 microns, and the diameter value of the maximum population of the small diameter mode is approximately 20 microns.

29. The polishing pad of claim 23, wherein the diameter of the maximum population of the closed cell pores of the small diameter mode is suitable to provide a polishing surface of the polishing pad with highly uniform polishing slurry distribution, and the diameter of the maximum population of the closed cell pores of the large diameter mode is suitable to provide reservoirs for storing polishing slurry for use with the closed cell pores of the small diameter mode.

30. The polishing pad of claim 23, wherein the diameter of the maximum population of the closed cell pores of the small diameter mode is suitable to provide a polishing surface of the polishing pad with highly uniform polishing slurry distribution, and the diameter of the

maximum population of the closed cell pores of the large diameter mode is suitable to provide locations for receiving a diamond tip during conditioning of the polishing pad.

31. The polishing pad of claim 23, wherein the diameter of the maximum population of the closed cell pores of the small diameter mode provides an insufficient heat sink during a polishing process, the diameter of the maximum population of the closed cell pores of the large diameter mode is suitable to provide an excessive heat sink during a polishing process, and the combination of the closed cell pores of the small diameter mode and the closed cell pores of the large diameter mode is suitable to provide thermal stability during the polishing process.

32. The polishing pad of claim 23, wherein the population of the large diameter mode overlaps with the population of the small diameter mode.

33. The polishing pad of claim 23, wherein the population of the large diameter mode has essentially no overlap with the population of the small diameter mode.

34. The polishing pad of claim 23, wherein the total population of the large diameter mode is not equal to the total population of the small diameter mode.

35. The polishing pad of claim 23, wherein the total population of the large diameter mode is approximately equal to the total population of the small diameter mode.

36. The polishing pad of claim 22, wherein the multi-modal distribution of diameters is a trimodal distribution of diameters comprising a small diameter mode, a medium diameter mode, and a large diameter mode.

37. The polishing pad of claim 36, wherein the diameter value for the maximum population of the large diameter mode is approximately 80 microns, the diameter value of the maximum population of the medium diameter mode is approximately 40 microns, and the diameter value of the maximum population of the small diameter mode is approximately 20 microns.

38. The polishing pad of claim 22, wherein the multi-modal distribution of diameters is distributed essentially evenly throughout the thermoset polyurethane material.

39. The polishing pad of claim 22, wherein the homogeneous polishing body further comprises:

a first, grooved surface; and

a second, flat surface opposite the first surface, wherein the multi-modal distribution of diameters is graded throughout the thermoset polyurethane material with a gradient from the first, grooved surface to the second, flat surface, wherein the multi-modal distribution of diameters is a bimodal distribution of diameters comprising a small diameter mode proximate to the first, grooved surface, and comprising a large diameter mode proximate to the second, flat surface.

40. The polishing pad of claim 22, wherein the homogeneous polishing body is a molded homogeneous polishing body.

41. The polishing pad of claim 22, wherein the homogeneous polishing body further comprises:

an opacifying lubricant distributed approximately evenly throughout the homogeneous polishing body.

42. The polishing pad of claim 22, further comprising:

a local area transparency (LAT) region disposed in, and covalently bonded with, the homogeneous polishing body.