

What is claimed is:

1. A method of growing single crystal diamond assisted by polycrystalline diamond, the method comprising:
 - a) thermally mating a diamond seed on a top surface of a substrate holder so as to provide a growth surface of a combined single crystal diamond and polycrystalline diamond substrate where there is a predetermined temperature difference between the diamond seed and the substrate holder during processing which causes a single crystal diamond growth rate in a direction perpendicular to a top surface of the diamond seed to be different from a polycrystalline growth rate in a direction perpendicular to the top surface of the diamond seed by a desired amount; and
 - b) providing process gasses and forming a plasma to grow both single crystal diamond and polycrystalline diamond on the growth surface, where the polycrystalline diamond grown adjacent to the single crystal diamond shields lateral surfaces of the growing single crystal diamond from the plasma and process gases, thereby improving thermal uniformity across the growing single crystal diamond.
2. The method of claim 1 further comprising providing a spacer between the diamond seed and the substrate holder that adjusts a height of the diamond seed relative to the top surface of the substrate holder to change a growth rate of the diamond seed in the direction perpendicular to the top surface of the diamond seed relative to the growth rate of the polycrystalline diamond in the direction perpendicular to the top surface of the diamond seed.

3. The method of claim 1 further comprising providing a spacer between the diamond seed and the substrate holder that adjusts a height of the diamond seed to change a growth rate of the diamond seed in the direction perpendicular to the top surface of the diamond seed relative to a growth rate of the diamond seed in a lateral direction.
4. The method of claim 1 wherein providing the process gasses and forming the plasma are provided so that there is a temperature difference over the growth surface of the combined single crystal diamond and polycrystalline diamond substrate that is greater than 25 degrees C during at least a portion of the growth.
5. The method of claim 1 wherein the diamond seed comprises a single crystal diamond.
6. The method of claim 1 wherein the providing process gasses and forming the plasma to grow both the single crystal diamond and the polycrystalline diamond on the growth surface is performed so that the single crystal growth rate in the direction perpendicular to the top surface of the diamond seed is greater than the polycrystalline growth rate in the direction perpendicular to the top surface of the diamond seed.
7. The method of claim 1 wherein the substrate holder comprises molybdenum.
8. The method of claim 1 wherein the substrate holder comprises tungsten.
9. The method of claim 1 wherein the substrate holder comprises silicon.

10. The method of claim 1 wherein the substrate holder comprises silicon carbide.
11. The method of claim 1 wherein the substrate holder comprises diamond.
12. The method of claim 1 wherein the top surface of the substrate holder comprises a recess for supporting the diamond seed.
13. The method of claim 1 wherein the top surface of the substrate holder is formed with a polished surface.
14. The method of claim 1 wherein the top surface of the substrate holder is formed with a textured finish.
15. The method of claim 1 further comprising attaching the diamond seed to the holder with a thermally conductive material.
16. The method of claim 1 further comprising attaching the diamond seed to the holder with a material having a coefficient of thermal expansion that is chosen to reduce stress in the single crystal material during growth.
17. The method of claim 1 further comprising attaching the diamond seed to the holder so that there a desired temperature difference between the diamond seed and the substrate holder during growth.
18. The method of claim 1 further comprising selecting a bonding material to attach the diamond seed to the holder so that there a desired temperature difference between the diamond seed and the substrate holder during growth.

19. The method of claim 1 wherein the thermally mating the diamond seed on the top surface of a substrate holder is performed by mating the seed to the holder with a material reduces stresses caused by thermal expansion.
20. The method of claim 1 wherein the thermally mating the diamond seed on the top surface of a substrate holder is performed such that there a temperature difference exists between the diamond seed and the polycrystalline material during growth.
21. The method of claim 1 wherein the providing process gasses and forming the plasma to grow both single crystal diamond and polycrystalline diamond on the growth surface comprises forming a pressure that is greater than 50 Torr in the process chamber.
22. The method of claim 1 wherein the providing process gasses and forming the plasma to grow both single crystal diamond and polycrystalline diamond on the growth surface comprises establishing a temperature that is in the range of 600 degrees C to 1400 degrees C at the growth surface.
23. The method of claim 1 wherein the providing process gasses and forming the plasma to grow both single crystal diamond and polycrystalline diamond on the growth surface results in an ending thickness of the polycrystalline material that is between 20% and 150% of the ending thickness of the single-crystal material.
24. The method of claim 1 further comprising changing the holder after a predetermined growth period.

25. The method of claim 1 further comprising changing process conditions during the growth in order to maintain the desired relative growth rate of the single crystal and polycrystalline material.
26. The method of claim 1 further comprising changing process conditions during the growth in order to maintain the desired growth characteristic of the single crystal material.
27. The method of claim 1 further comprising producing plates of single crystal diamond material by cutting the grown single crystal diamond.
28. The method of claim 1 wherein a mass of the grown single crystal diamond is greater than one gram in a single process run.
29. The method of claim 1 wherein a mass of the grown single crystal diamond is greater than two grams in a single process run.
30. The method of claim 1 wherein the providing process gases comprises providing hydrogen, oxygen, and a carbon-containing gas.
31. The method of claim 30 further comprises providing argon proximate to growth surface of the seed.
32. The method of claim 1 wherein the thermally mating the diamond seed on the top surface of the substrate holder so as to provide the growth surface of the combined single crystal diamond and polycrystalline diamond substrate comprises thermally mating a plurality of diamond seed on the top surface of the substrate

holder so as to provide a plurality of growth surfaces of a plurality of combined single crystal diamond and polycrystalline diamond substrates.

33. A method of growing single crystal diamond assisted by polycrystalline diamond, the method comprising:

- a) thermally mating a diamond seed on a top surface of a substrate holder so as to provide a growth surface for a combined single crystal diamond and polycrystalline diamond substrate where there is a predetermined temperature difference between the diamond seed and the substrate holder during processing which causes a desired relative growth rate of single crystal diamond in a direction lateral to a top surface of the diamond seed to a growth rate of single crystal diamond in a direction perpendicular to the top surface of the diamond seed; and
- b) providing process gasses and forming a plasma to grow both single crystal diamond and polycrystalline diamond on the growth surface, where the polycrystalline diamond grown adjacent to the single crystal diamond shields lateral surfaces of the growing single crystal diamond from the plasma and process gases, thereby improving thermal uniformity across the growing single crystal diamond.

34. The method of claim 33 further comprising providing a spacer between the diamond seed and the substrate holder that adjusts a height of the diamond seed relative to the top surface of the substrate holder to achieve the relative growth rate.

- 35. The method of claim 33 wherein the desired relative growth rate is less than one half.
- 36. The method of claim 33 wherein the desired relative growth rate is greater than one half.
- 37. The method of claim 33 wherein providing the process gasses and forming the plasma are provided so that there is a temperature difference over the growth surface that is greater than 25 degrees C during at least a portion of the growth.
- 38. The method of claim 33 wherein the diamond seed comprises a single crystal diamond.
- 39. The method of claim 33 wherein the substrate holder comprises molybdenum.
- 40. The method of claim 33 wherein the substrate holder comprises tungsten.
- 41. The method of claim 33 wherein the substrate holder comprises silicon.
- 42. The method of claim 33 wherein the substrate holder comprises silicon carbide.
- 43. The method of claim 33 wherein the substrate holder comprises diamond.
- 44. The method of claim 33 wherein the top surface of the substrate holder comprises a recess for supporting the diamond seed.
- 45. The method of claim 33 wherein the top surface of the substrate holder is formed with a polished surface.

46. The method of claim 33 wherein the top surface of the substrate holder is formed with a textured finish.
47. The method of claim 33 further comprising attaching the diamond seed to the holder with a thermally conductive material.
48. The method of claim 33 further comprising attaching the diamond seed to the holder with a material having a coefficient of thermal expansion that is chosen to reduce stress in the single crystal material during growth.
49. The method of claim 33 further comprising attaching the diamond seed to the holder so that there a desired temperature difference between the diamond seed and the polycrystalline material during growth.
50. The method of claim 33 further comprising selecting a bonding material to attach the diamond seed to the holder so that there a desired temperature difference between the diamond seed and the polycrystalline material during growth.
51. The method of claim 33 wherein the thermally mating the diamond seed on the top surface of a substrate holder is performed by mating the seed to the holder with a material that reduces stress due to thermal expansion.
52. The method of claim 33 wherein the thermally mating the diamond seed on the top surface of a substrate holder is performed such that there a temperature difference exists between the diamond seed and the polycrystalline material during growth.

53. The method of claim 33 wherein the providing process gasses and forming the plasma to grow both single crystal diamond and polycrystalline diamond on the growth surface comprises forming a pressure that is greater than 50 Torr in the process chamber.
54. The method of claim 33 wherein the providing process gasses and forming the plasma to grow both single crystal diamond and polycrystalline diamond on the growth surface comprises establishing a temperature that is in the range of 600 degrees C to 1400 degrees C at the growth surface.
55. The method of claim 33 wherein the providing process gasses and forming the plasma to grow both single crystal diamond and polycrystalline diamond on the growth surface results in an ending thickness of the polycrystalline material that is between 20% and 150% of the ending thickness of the single-crystal material.
56. The method of claim 33 further comprising changing the holder after a predetermined growth period.
57. The method of claim 33 further comprising changing process conditions during the growth in order to maintain the desired relative growth rate of the single crystal and polycrystalline material.
58. The method of claim 33 further comprising changing process conditions during the growth in order to maintain the desired growth characteristic of the single crystal material.

59. The method of claim 33 further comprising producing plates of single crystal diamond material by cutting the grown single crystal diamond.
60. The method of claim 33 wherein a mass of the grown single crystal diamond is greater than one gram.
61. The method of claim 33 wherein a mass of the grown single crystal diamond is greater than two grams.
62. The method of claim 33 wherein the providing process gases comprising providing hydrogen, oxygen, and a carbon-containing gas.
63. The method of claim 62 further comprises providing argon.
64. The method of claim 33 wherein the thermally mating the diamond seed on the top surface of the substrate holder so as to provide the growth surface of the combined single crystal diamond and polycrystalline diamond substrate comprises thermally mating a plurality of diamond seed on the top surface of the substrate holder so as to provide a plurality of growth surfaces of a plurality of combined single crystal diamond and polycrystalline diamond substrates.
65. A single crystal diamond material grown to dimensions equal to or greater than six millimeters in a single uninterrupted run made by a process comprising the steps of:
- a) thermally mating a diamond seed on a top surface of a substrate holder so as to provide a growth surface of a combined single crystal diamond and

polycrystalline diamond substrate where there is a predetermined temperature difference between the diamond seed and the substrate holder during processing which causes a single crystal diamond growth rate in a direction perpendicular to a top surface of the diamond seed to be different from a polycrystalline growth rate in a direction perpendicular to the top surface of the diamond seed by a desired amount; and

- b) providing process gasses and forming a plasma to grow both single crystal diamond and polycrystalline diamond on the growth surface, where the polycrystalline diamond grown adjacent to the single crystal diamond shields lateral surfaces of the growing single crystal diamond from the plasma and process gases, thereby improving thermal uniformity across the growing single crystal diamond.

66. The method of claim 65 wherein a ratio of a growth rate of the polycrystalline diamond grown adjacent to the single crystal diamond to a growth rate of single crystal diamond grown perpendicular to the top surface of the diamond seed is in a range of 20% to 150%.

67. A single crystal diamond material grown to a weight equal to or greater than two grams in a single uninterrupted run made by a process comprising the steps of:

- a) thermally mating a diamond seed on a top surface of a substrate holder so as to provide a growth surface of a combined single crystal diamond and polycrystalline diamond substrate where there is a predetermined temperature difference between the diamond seed and the substrate holder

during processing which causes a single crystal diamond growth rate in a direction perpendicular to a top surface of the diamond seed to be different from a polycrystalline growth rate in a direction perpendicular to the top surface of the diamond seed by a desired amount; and

- b) providing process gasses and forming a plasma to grow both single crystal diamond and polycrystalline diamond on the growth surface, where the polycrystalline diamond grown adjacent to the single crystal diamond shields lateral surfaces of the growing single crystal diamond from the plasma and process gases, thereby improving thermal uniformity across the growing single crystal diamond.

68. The method of claim 67 wherein a ratio of a growth rate of the polycrystalline diamond grown adjacent to the single crystal diamond to a growth rate of single crystal diamond grown perpendicular to the top surface of the diamond seed is in a range of 20% to 150%.