CLAIMS

1. A method for cleaning a substrate, comprising method operations of:

applying an activation solution to a surface of the substrate;

contacting the activation solution and the surface of the substrate with a surface of a solid cleaning element;

absorbing the activation solution into a portion of the solid cleaning element; and

moving one of the substrate or the solid cleaning element relative to each other to clean the surface of the substrate.

2. The method of claim 1, wherein the activation solution is an alkaline solution.

3. The method of claim 1, wherein the activation solution is an alkaline solution that includes a base selected from the group consisting of ammonium hydroxide, sodium hydroxide, potassium hydroxide, triethanol amine, and tetramethylammonium hydroxide.

4. The method of claim 1, wherein the solid cleaning element is a planar surface composed of a fatty acid.

5. The method of claim 1, wherein the solid cleaning element is a planar surface composed of components selected from a group consisting of a carboxylic acid, a sulfonic acid, and a phosphonic acid.

6. The method of claim 1, wherein the method operation of contacting the activation solution and the surface of the substrate with a surface of the solid cleaning element results in ionizing the surface of the solid cleaning element and the surface of the substrate.

7. The method of claim 1, wherein the solid cleaning element is composed of components selected from a group consisting of an alkyl sulfonate, an alkyl phosphate, and an alkyl phosphonate.

8. The method of claim 1, wherein the activation solution diffuses into the portion of the solid cleaning element causing the portion of the solid cleaning element to become softer relative to a remainder of the solid cleaning element.

9. The method of claim 1, wherein the activation solution is a surfactant.

10. The method of claim 9, wherein the surfactant is an ionic surfactant.

11. A cleaning apparatus for cleaning a substrate, comprising:

a solid material having an outer surface, the outer surface configured to become softer relative to a remainder of the solid material when exposed to an activation solution disposed over a surface of the substrate; and

a support structure configured to support the solid material and apply a force causing the outer surface to contact the surface of the substrate.

12. The apparatus of claim 11, wherein the solid material is selected from a group consisting of a fatty acid, an alkyl sulfonate, an alkyl phosphate, and an alkyl phosphonate.

13. The apparatus of claim 11, wherein the support structure includes a shaft through an axis of the solid material and wherein the solid material rotates around the axis.

14. The apparatus of claim 11, wherein the support structure is gimbaled and provides rotation to the solid material, relative to the substrate.

15. The apparatus of claim11, further comprising:

a fluid delivery system providing an activation solution to the surface of the substrate.

16. The apparatus of claim 11, wherein the activation solution is alkaline.

17. The apparatus of claim 11, wherein the activation solution is a surfactant.

18. The apparatus of claim 11 wherein a component of the outer surface is ionized by the activation solution and wherein the outer surface is a planar surface.

19. A cleaning system for cleaning a substrate, comprising:

a support configured to support the substrate;

a fluid delivery system configured to deliver an activation solution to a surface of the substrate;

a solid phase cleaning element having an exposed surface, the exposed surface having a component that softens relative to a remaining portion of the solid phase cleaning element when the exposed surface interfaces with the activation solution; and

a support structure supporting the solid phase cleaning element, the support structure configured to maintain the exposed surface against a surface of the substrate during a cleaning operation.

20. The cleaning system of claim 19, wherein the solid phase cleaning element consists essentially of a fatty acid.

21. The cleaning system of claim 19, wherein the solid phase cleaning element is a material selected from a group consisting of an alkyl sulfonate, an alky, phosphate, and an alkyl phosphonate.

22. The cleaning system of claim 19, wherein a pH of the activation solution is above 7.0.

23. The cleaning system of claim 19, wherein the activation solution is a surfactant.

24. The cleaning system of claim 23, wherein the surfactant is ammonium dodecyl sulphate.

25. The cleaning system of claim 19, wherein the support structure is configured to rotate the solid phase cleaning element.

26. The cleaning system of claim 19, wherein the support structure is configured to translate the solid phase cleaning element parallel to and perpendicular to the surface of the substrate.

27. The cleaning system of claim 19, wherein the support structure holds the solid phase cleaning element stationary.

28. The cleaning system of claim 19, wherein the activation solution reacts with the exposed surface to develop a gelatinous interface portion of the solid phase cleaning element against the surface of the substrate.

29. The cleaning system of claim 28, wherein the gelatinous interface portion captures particles disposed on the surface of the substrate.

30. The cleaning system of claim 19, further comprising;

a plurality of solid phase cleaning elements, the plurality of solid phase cleaning elements each composed of a different material, wherein the substrate support moves the substrate under each of the plurality of solid phase cleaning elements, and wherein the fluid delivery system provides the activation solution to the substrate prior to the substrate moving under each of the plurality of solid phase cleaning elements.

31. A method for cleaning a substrate, comprising method operations of:

contacting a substrate surface with a surface of a solid cleaning element;

forcing the solid cleaning element against the substrate surface;

moving one of the solid cleaning element or the substrate relative to each other, the moving causing a plastic deformation of the surface of the solid cleaning element thereby depositing a layer of the solid cleaning element onto the substrate surface; and

rinsing the layer of the solid cleaning element off of the substrate surface.

32. The method of claim 31, wherein a hardness of the solid cleaning element is less than a hardness of the substrate.

33. The method of claim 31, wherein an alkaline aqueous solution is used for rinsing the layer of the solid cleaning element off of the substrate surface.

34. The method of claim 34, wherein a mixture of water, sulfuric acid, and hydrogen peroxide is used for rinsing the layer of the solid cleaning element off of the substrate surface.

35. The method of claim 31, wherein the method operation of moving one of the solid cleaning element or the substrate relative to each other includes interacting the solid cleaning element with contaminants disposed on the substrate surface.

36. A cleaning apparatus for cleaning a substrate, comprising:

a solid material having an outer surface, the outer surface configured to plastically deform to leave a film disposed over the substrate in response to a downward force being applied to the solid material while one of the substrate or the solid material moves relative to each other; and

a support structure configured to support the solid material and transfer the downward force.

37. The apparatus of claim 36, wherein the solid material has a hardness that is less than a hardness of the substrate, and wherein the solid material consists essentially of stearic acid.

38. The apparatus of claim 36, further comprising;

a fluid delivery system for rinsing off the film disposed over the substrate.

39. The apparatus of claim 36, wherein the solid material consists essentially of a fatty acid.

40. The apparatus of claim 36, wherein the solid material is a material selected from a group consisting of an alkyl sulfonate, an alky, phosphate, and an alkyl phosphonate.

What is claimed is:

1. A cleaning system for a semiconductor substrate, comprising:

a support configured to support the semiconductor substrate;

an activation solution;

a fluid delivery system configured to deliver the activation solution to a surface of the semiconductor substrate;

a solid phase cleaning element defined as a bar having a grain structure and an exposed surface that is disposed facing the support, the exposed surface having a component that softens relative to a remaining portion of the solid phase cleaning element when the exposed surface interfaces with the activation solution, and wherein the component that softens is ionized by the activation solution to provide negatively charged functional groups at the exposed surface; and

a support structure for holding the solid phase cleaning element from a holding side that is opposite the exposed surface, the support structure having a gimbal interfaced with the holding side, wherein the exposed surface is defined to be disposed against the surface of the semiconductor substrate, the support structure providing for vertical force and lateral force to the solid phase cleaning element.

2. The cleaning system of claim 1, wherein the solid phase cleaning element consists essentially of a fatty acid.

3. The cleaning system of claim 1, wherein the solid phase cleaning element is a material selected from a group consisting of an alkyl sulfonate, an alky, phosphate, and an alkyl phosphonate.

4. The cleaning system of claim 1, wherein a pH of the activation solution is above 7.0.

5. The cleaning system of claim 1, wherein the activation solution is a surfactant.

6. The cleaning system of claim 5, wherein the surfactant is ammonium dodecyl sulphate.

7. The cleaning system of claim 1, wherein the support structure is configured to rotate the solid phase cleaning element.

8. The cleaning system of claim 1, wherein the support structure is configured to translate the solid phase cleaning element parallel to and perpendicular to the surface of the substrate.

9. The cleaning system of claim 1, wherein the support structure holds the solid phase cleaning element stationary.

10. The cleaning system of claim 1, wherein the activation solution reacts with the exposed surface to develop a gelatinous interface portion of the solid phase cleaning element against the surface of the substrate.

11. The cleaning system of claim 10, wherein the gelatinous interface portion captures particles disposed on the surface of the substrate.

12. The cleaning system of claim 1, further comprising;

a plurality of solid phase cleaning elements, the plurality of solid phase cleaning elements each composed of a different material, wherein the substrate support moves the substrate under each of the plurality of solid phase cleaning elements, and wherein the fluid

delivery system provides the activation solution to the substrate prior to the substrate moving under each of the plurality of solid phase cleaning elements.

13. A system for processing a semiconductor substrate, comprising:

a support configured to support the semiconductor substrate;

a fluid delivery system configured to deliver an activation solution to a surface of the semiconductor substrate;

a solid phase cleaning element defined as an elongated bar, the solid phase cleaning element having a grain structure and a plastic deformation property, the solid phase cleaning element having an exposed surface that is disposed facing the support, the exposed surface having a component that softens relative to a remaining portion of the solid phase cleaning element when the exposed surface interfaces with the activation solution; and

a support structure for holding the solid phase cleaning element from a holding side that is opposite the exposed surface, the support structure having a gimbal interfacing the holding side, wherein the exposed surface is movable against the surface of the semiconductor substrate, the support structure providing a vertical force and a lateral force to the solid phase cleaning element when the exposed surface is in contact with the surface of the semiconductor substrate, the solid phase cleaning element at least partially deforming over the surface of the substrate using its plastic deformation property during the application of one of the vertical force or lateral force, the vertical force being perpendicular to the semiconductor substrate surface.