

CLAIMS

1. An etch mask for a wafer singulation process, the etch mask comprising:
a water-soluble matrix based on a solid component and water; and
a plurality of particles dispersed throughout the water-soluble matrix, the plurality of particles having an average diameter approximately in the range of 5-100 nanometers, wherein a ratio of weight % of the solid component to weight % of the plurality of particles is approximately in the range of 1:0.1 – 1:4, and wherein the plurality of particles is a plurality of particles selected from the group consisting of alumina (Al_2O_3) particles, alumina-coated silicon particles, polytetrafluoroethylene (PTFE) particles, and combinations thereof.
2. The etch mask of claim 1, wherein the plurality of particles have an average diameter approximately in the range of 5-50 nanometers.
3. The etch mask of claim 1, wherein the ratio of weight % of the solid component to weight % of the plurality of particles is approximately in the range of 1:0.5 – 1:2.
4. The etch mask of claim 1, wherein the water soluble matrix is a water soluble matrix selected from the group consisting of a polyvinyl alcohol (PVA)-based water soluble matrix, a polyethylene oxide-based water soluble matrix, a polyethylene glycol-based water soluble matrix, and a polyacrylamide-based water soluble matrix.

5. The etch mask of claim 1, wherein the water-soluble matrix comprises approximately 10-40 weight % of the solid component with the remainder water.

6. A method of dicing a semiconductor wafer comprising a plurality of integrated circuits, the method comprising:

forming a mask above the semiconductor wafer, the mask comprising a water-soluble matrix based on a solid component and water, and a plurality of particles dispersed throughout the water-soluble matrix, wherein a ratio of weight % of the solid component to weight % of the plurality of particles is approximately in the range of 1:0.1 – 1:4, and wherein one or both of: wherein the plurality of particles is a plurality of particles selected from the group consisting of alumina (Al_2O_3) particles, alumina-coated silicon particles, polytetrafluoroethylene (PTFE) particles, and combinations thereof, or wherein the water soluble matrix is a water soluble matrix selected from the group consisting of a polyethylene oxide-based water soluble matrix, a polyethylene glycol-based water soluble matrix, and a polyacrylamide-based water soluble matrix;

patterning the mask with a laser scribing process to provide a patterned mask with gaps,

exposing regions of the semiconductor wafer between the integrated circuits; and

plasma etching the semiconductor wafer through the gaps in the patterned mask to singulate the integrated circuits, wherein the patterned mask protects the integrated circuits during the plasma etching.

7. The method of claim 6, wherein forming the mask comprises forming the mask having the plurality of particles with an average diameter approximately in the range of 5-100 nanometers.

8. The method of claim 6, wherein plasma etching the semiconductor wafer through the gaps comprises plasma etching a single crystalline silicon wafer, and wherein a ratio of an etch rate of the single crystalline silicon wafer to an etch rate of the mask is approximately in the range of 15:1 – 170:1 during the plasma etching.
9. The method of claim 6, wherein forming the mask above the semiconductor wafer comprises spin-coating the mask on the semiconductor wafer.
10. The method of claim 6, wherein the plurality of particles of the mask do not substantially interfere with the laser scribing process during the patterning of the mask with a laser scribing process.
11. The method of claim 6, further comprising:
subsequent to plasma etching the semiconductor wafer through the gaps in the patterned mask, removing the patterned mask using an aqueous solution.
12. The method of claim 6, wherein forming the mask above the semiconductor wafer comprises mixing the plurality of particles with the water-soluble matrix on a same tool platform used for patterning the mask with the laser scribing process.
13. The method of claim 6, further comprising:

subsequent to patterning the mask and prior to plasma etching the semiconductor wafer through the gaps in the patterned mask to singulate the integrated circuits, cleaning the exposed regions of the semiconductor wafer with a plasma cleaning process.

14. A method of dicing a semiconductor wafer comprising a plurality of integrated circuits, the method comprising:

forming a mask above the semiconductor wafer, the mask comprising a water-soluble matrix based on a solid component and water, and a plurality of particles dispersed throughout the water-soluble matrix, the plurality of particles having an average diameter approximately in the range of 5-100 nanometers, and wherein one or both of: wherein the plurality of particles is a plurality of particles selected from the group consisting of alumina (Al_2O_3) particles, alumina-coated silicon particles, polytetrafluoroethylene (PTFE) particles, and combinations thereof, or wherein the water soluble matrix is a water soluble matrix selected from the group consisting of a polyethylene oxide-based water soluble matrix, a polyethylene glycol-based water soluble matrix, and a polyacrylamide-based water soluble matrix;

patterning the mask with a laser scribing process to provide a patterned mask with gaps, exposing regions of the semiconductor wafer between the integrated circuits; and plasma etching the semiconductor wafer through the gaps in the patterned mask to singulate the integrated circuits, wherein the patterned mask protects the integrated circuits during the plasma etching.

15. The method of claim 14, wherein plasma etching the semiconductor wafer through the gaps comprises plasma etching a single crystalline silicon wafer, and wherein a ratio of an etch rate of the single crystalline silicon wafer to an etch rate of the mask is approximately in the range of 15:1 – 170:1 during the plasma etching.

16. The method of claim 14, wherein forming the mask above the semiconductor wafer comprises spin-coating the mask on the semiconductor wafer.

17. The method of claim 14, wherein the plurality of particles of the mask do not substantially interfere with the laser scribing process during the patterning of the mask with a laser scribing process.

18. The method of claim 14, further comprising:

subsequent to plasma etching the semiconductor wafer through the gaps in the patterned mask, removing the patterned mask using an aqueous solution.

19. The method of claim 14, wherein forming the mask above the semiconductor wafer comprises mixing the plurality of particles with the water-soluble matrix on a same tool platform used for patterning the mask with the laser scribing process.

20. An etch mask for a wafer singulation process, the etch mask comprising:

a water-soluble matrix based on a solid component and water; and

a plurality of particles dispersed throughout the water-soluble matrix, the plurality of particles having an average diameter approximately in the range of 5-100 nanometers, wherein a ratio of weight % of the solid component to weight % of the plurality of particles is approximately in the range of 1:0.1 – 1:4, and wherein the water soluble matrix is a water soluble matrix selected from the group consisting of a polyethylene oxide-based water soluble matrix, a polyethylene glycol-based water soluble matrix, and a polyacrylamide-based water soluble matrix.

21. The etch mask of claim 20, wherein the plurality of particles have an average diameter approximately in the range of 5-50 nanometers.

22. The etch mask of claim 20, wherein the ratio of weight % of the solid component to weight % of the plurality of particles is approximately in the range of 1:0.5 – 1:2.

23. The etch mask of claim 20, wherein the water-soluble matrix comprises approximately 10-40 weight % of the solid component with the remainder water.

24. The method of claim 6, wherein the plurality of particles is a plurality of particles selected from the group consisting of alumina (Al_2O_3) particles, alumina-coated silicon particles, polytetrafluoroethylene (PTFE) particles, and combinations thereof.

25. The method of claim 6, wherein the water soluble matrix is a water soluble matrix selected from the group consisting of a polyethylene oxide-based water soluble matrix, a polyethylene glycol-based water soluble matrix, and a polyacrylamide-based water soluble matrix.

26. The method of claim 14, wherein the plurality of particles is a plurality of particles selected from the group consisting of alumina (Al_2O_3) particles, alumina-coated silicon particles, polytetrafluoroethylene (PTFE) particles, and combinations thereof.

27. The method of claim 14, wherein the water soluble matrix is a water soluble matrix selected from the group consisting of a polyethylene oxide-based water soluble matrix, a polyethylene glycol-based water soluble matrix, and a polyacrylamide-based water soluble matrix.