

location. These parameters are difficult to tune to improve the quality of the cleave.

[0007] A need exists for new cleave systems that result in a cleaved structure with improved surface roughness characteristics and for cleave methods that involve use of such cleave systems.

[0008] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the disclosure, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present disclosure. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

SUMMARY

[0009] One aspect of the present disclosure is directed to a cleave system for cleaving a semiconductor structure having a top surface and a bottom surface generally parallel to the top surface. The cleave system includes a cleave arm that is moveable from a starting position to a raised position in which a cleave stress is applied to the semiconductor structure. The cleave system includes a suction member for grasping the semiconductor structure on the top surface of the semiconductor structure. A suction rod extends through the cleave arm. The suction rod is connected to the suction member toward a first end of the suction rod. A spring member applies a cleave force to the semiconductor structure when the cleave arm is in the raised position.

incorporated in the above-mentioned aspects of the present disclosure as well. These refinements and additional features may exist individually or in any combination. For instance, various features discussed below in relation to any of the illustrated embodiments of the present disclosure may be incorporated into any of the above-described aspects of the present disclosure, alone or in any combination.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Figure 1 is a perspective view of a cleave system for cleaving a semiconductor structure;

[0014] Figure 2 is a detailed perspective view of a portion of the cleave system;

[0015] Figure 3 is a cross-section side view of the cleave system with the cleave arm at a starting position;

[0016] Figure 4 is a cross-section side view of the cleave system with the cleave arm at a raised position and the spring members being compressed;

[0017] Figure 5 is a schematic front view of the cleave system with the cleave arm in the starting position;

[0018] Figure 6 is a schematic front view of the cleave system with the cleave arm in the raised position;

the upper suction members 13, 15 through vacuum conduits 27 and suction rod channels 25 (FIG. 5) to grasp the top surface 41 of the semiconductor structure S.

[0035] After the semiconductor structure S is grasped, the cleave arm 9 is moved from its starting position (FIG. 5) to a raised position (FIG. 6). The cleave arm 9 is connected to a pivot structure 59 (FIG. 1). The cleave system 5 includes a motor 67 that causes the cleave arm 9 to pivot upon activation of the motor 67. The cleave arm 9 pivots about a pivot axis P that extends through the pivot structure 59. The motor 67 may be connected to the pivot structure 59 by a chain or belt or the motor 67 may be a direct-drive motor embedded in the pivot structure 59. The motor 67 may be a DC or AC servo motor and, optionally, may control acceleration, deceleration and/or velocity of the cleave arm 9.

[0036] As the cleave arm 9 moves from the starting position (FIG. 5) to the raised position (FIG. 6), the cleave arm 9 moves axially upward relative to the suction rods 23. This causes the spring members 33 to be compressed and to exert a cleave force F on the semiconductor structure S (i.e., an upward force which promotes cleaving of the semiconductor structure) and to store spring energy within the spring. In accordance with some embodiments of the present disclosure, the cleave arm 9 is not rotated to a point at which the spring are fully compressed and the spring retainer 57 contacts the cleave arm 9. Compression of the spring members 33 allows spring energy to be stored in the spring members 33 with the spring energy being released upon initiation of the cleave. The cleave force F applied by the spring members 33 (and any additional force

~~WHAT IS CLAIMED IS:~~

1. A cleave system for cleaving a semiconductor structure having a top surface and a bottom surface generally parallel to the top surface, the cleave system comprising:

a cleave arm that is moveable from a starting position to a raised position in which a cleave stress is applied to the semiconductor structure;

a suction member for grasping the semiconductor structure on the top surface of the semiconductor structure;

a suction rod that extends through the cleave arm, the suction rod being connected to the suction member toward a first end of the suction rod; and

a spring member that applies a cleave force to the semiconductor structure when the cleave arm is in the raised position.

2. The cleave system as set forth in claim 1 wherein the suction rod extends through the spring member.

3. The cleave system as set forth in claim 2 comprising a collar that extends radially outward from the suction rod, the spring member being disposed between the collar and the cleave arm, the spring member being compressed when the cleave arm is in the raised position.

4. The cleave system as set forth in claim 3 wherein the collar is part of a collar clamp that is adjustable along a longitudinal axis of the suction rod to change the compression of the spring member.

5. The cleave system as set forth in any one of claims 1 to 4 wherein the spring member is a compression spring.

6. The cleave system as set forth in any one of claims 1 to 4 wherein the spring member is a belleville spring.

7. The cleave system as set forth in any one of claims 1 to 4 wherein the spring member is an extension spring, the spring member being disposed below the cleave arm.

8. The cleave system as set forth in any one of claims 1 to 7 wherein the suction member is a suction cup, the suction rod including a channel defined therein that is fluidly connected to the suction cup to apply a vacuum to the suction cup.

9. The cleave system as set forth in any one of claims 1 to 8 wherein the suction member is a first suction member, the suction rod is a first suction rod, and the spring member is a first spring member, the cleave system comprising

a second suction member for grasping the semiconductor structure;

a second suction rod that extends through the cleave arm, the second suction rod being connected to the second suction member toward a first end of the second suction rod; and

a second spring member that applies a cleave force to the semiconductor structure when the cleave arm is in the raised position.

10. The cleave system as set forth in claim 9 further comprising:

a third suction member for grasping the semiconductor structure;

a third suction rod that extends through the cleave arm, the third suction rod being connected to the third suction member toward a first end of the third suction rod; and

a third spring member that applies a cleave force to the semiconductor structure when the cleave arm is in the raised position.

11. The cleave system as set forth in any one of claims 1 to 10 wherein the cleave arm pivots about a pivot axis to move the cleave arm between the starting position to the raised position, the cleave system comprising a motor that causes the cleave arm to pivot upon activation of the motor.

12. The cleave system as set forth in claim 11 further comprising a bellows suction cup connected to the cleave arm, the bellows suction cup being disposed radially inward to the suction member.

13. The cleave system as set forth in any one of claims 1 to 12 wherein the cleave arm defines a recess, the spring member being at least partially received in the recess, the recess having a floor which abuts the spring member.

14. The cleave system as set forth in any one of claims 1 to 13 wherein the suction rod is not connected to the cleave arm.

15. The cleave system as set forth in any one of claims 1 to 14 comprising a bearing disposed within the cleave arm, the suction rod moving within the bearing as the cleave arm moves from the starting position to the raised position.

16. The cleave system as set forth in any one of claims 1 to 15 comprising one or more suction members for grasping the semiconductor structure on the bottom surface of the semiconductor structure.

17. A cleave system for cleaving a semiconductor structure having a top surface and a bottom surface generally parallel to the top surface, the cleave system comprising:

one or more suction cups for grasping the semiconductor structure on the top surface of the semiconductor structure;

a suction rod connected to the one or more suction cups toward a first end of the suction rod; and

a spring member that applies a cleave force to the semiconductor structure during cleaving, the suction rod extending through the spring member.

18. The cleave system as set forth in claim 17 further comprising a bellows suction cup configured to contact the top surface of the semiconductor structure, the bellows suction cup being disposed radially inward to the one or more suction cups.

19. A method for cleaving a semiconductor structure having a top surface and a bottom surface

generally parallel to the top surface, the method comprising:

contacting the top surface of the semiconductor structure with a suction cup;

applying a vacuum in the suction cup to grasp the top surface of the semiconductor structure;

moving a cleave arm from a starting position to a raised position to cause a spring member to exert a cleave force on the semiconductor structure, the spring member storing spring energy when the cleave arm is raised;

contacting the semiconductor structure with a blade to initiate cleaving the semiconductor structure when the cleave arm is in the raised position; and

releasing the stored spring energy after contacting the semiconductor structure with the blade to separate the semiconductor structure along a cleave plane into two pieces.

20. The method as set forth in claim 19 wherein the suction cup is connected to a suction rod that extends through the cleave arm, the suction rod extending through the spring member.

21. The method as set forth in claim 19 or claim 20 wherein:

the cleave arm moves axially upward relative to the suction rod when the cleave arm is moved to the raised position; and

the suction rod moves axially ~~downward~~ upward relative to the cleave arm when the semiconductor structure is separated into two pieces.

22. The method as set forth in ~~any one of~~
claims ~~19 to 21~~ 20 wherein the cleave force applied by the
spring member is transmitted through the suction rod, the
cleave force applied by the spring member being the only
cleave force applied to the semiconductor structure.

23. The method as set forth in any one of
claims 19 to 22 wherein the cleave arm does not move during
propagation of the cleave.