

lower semiconductor die 102. As such, upper semiconductor die 106 may be termed an "overhang die".

[0005] In FIG. 1, it is desirable to form another wire loop between upper semiconductor die 106 and another location (e.g., substrate 100). FIG. 1 illustrates the beginning of the bonding process, as a ball bond 112 is being bonded (as a first bond) to a bonding location on upper semiconductor die 106 using a wire bonding tool 110 (where wire bonding tool 110 is carried by a bond head assembly 114). Because upper semiconductor die 106 is an overhang die, the die bends (i.e., die deflection, as shown in FIG. 1). This die deflection can result in damage to the overhang die itself (e.g., cracking, etc.) or damage through contact with other structures below the overhang die (e.g., such as wire loop 108).

[0006] Thus, it would be desirable to provide improved methods of controlling potential damage in connection with wire bonding in overhang die applications.

SUMMARY

[0007] There is disclosed a method of providing a z-axis force profile applied to a plurality of bonding locations during a wire bonding operation is provided. The method includes: (a) determining a z-axis force profile for each of a plurality of bonding locations on an unsupported portion of at least one reference semiconductor device; and (b) applying the z-axis force profile during subsequent bonding of a subject semiconductor device.

[0008] According to an exemplary embodiment of the invention, a method of determining a maximum bond force to be applied to a bonding location during formation of a wire bond is provided. The method includes: (a) providing a maximum z-axis deflection value for a semiconductor device; (b) measuring z-axis deflection values at a plurality of bonding locations on at least one reference semiconductor device at a plurality of bond force values; and (c) determining the maximum bond force for each of the bonding locations.

[0009] According to another exemplary embodiment of the invention, a method of determining a z-axis constant velocity profile for formation of a wire bond is provided. The method includes: (a) providing a maximum z-axis deflection value for a semiconductor device; (b) measuring z-axis deflection values at a plurality of bonding locations on at least one reference semiconductor device at a plurality of z-axis

constant velocity profiles; and (c) determining a z-axis constant velocity profile for each of the bonding locations.

[0010] There is also disclosed a method of determining a maximum bonded ball diameter is provided. The method includes: (a) determining a maximum bond force for a bonding location for the formation of wire bonds; (b) determining a z-axis constant velocity profile for formation of wire bonds at the bonding location; and (c) determining, on a computer, a maximum bonded ball size for the bonding location using the maximum bond force determined in step (a) and the z-axis constant velocity profile in step (b).

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The invention is best understood from the following detailed description when read in connection with the accompanying drawings. It is emphasized that, according to common practice, the various features of the drawings are not to scale. On the contrary, the dimensions of the various features are arbitrarily expanded or reduced for clarity. Included in the drawings are the following figures:

[0012] FIG. 1 is a block diagram side view of a portion of a conventional stacked die device including an overhang die;

[0013] FIG. 2 is a timing diagram illustrating a z-axis position profile of a portion of a bond head assembly of a wire bonding machine during formation of first bond of a wire loop useful in illustrating various exemplary embodiments of the invention;

[0014] FIG. 3 is a timing diagram illustrating a z-axis position profile of a portion of a bond head assembly of a wire bonding machine during formation of first bond of a wire loop in accordance with an exemplary embodiment of the invention;

[0015] FIG. 4 is a force profile illustrating a force applied by a bonding tool of a wire bonding machine during formation of a wire bond useful in illustrating various exemplary embodiments of the invention;

[0016] FIG. 5A is a simplified overhead block diagram view of an overhang die including three bonding locations useful in illustrating various exemplary embodiments of the invention;

[0017] FIG. 5B is a timing diagram illustrating a z-axis position of a portion of a bond head assembly of a wire bonding machine during formation of wire bonds at

CLAIMS

1. A method of determining a maximum bond force to be applied to a bonding location during formation of a wire bond, the method comprising the steps of:
 - (a) providing a maximum z-axis deflection value for a semiconductor device;
 - (b) measuring z-axis deflection values at a plurality of bonding locations on at least one reference semiconductor device at a plurality of bond force values; and
 - (c) determining the maximum bond force for each of the bonding locations.
2. The method of claim 1 wherein the z-axis deflection values are measured using a z-axis encoder of a bond head assembly of a wire bonding machine.
3. The method of claim 1 wherein step (c) includes determining the maximum bond force as a single value that may be applied to each of the bonding locations.
4. The method of claim 1 wherein step (c) includes determining the maximum bond force as a plurality of values, each of the bonding locations having a corresponding maximum bond force included in the plurality of values.
5. The method of claim 1 wherein step (a) includes a user providing the maximum z-axis deflection value.
6. A method of determining a z-axis constant velocity profile for formation of a wire bond, the method comprising the steps of:

(a) providing a maximum z-axis deflection value for a semiconductor device;

(b) measuring z-axis deflection values at a plurality of bonding locations on at least one reference semiconductor device at a plurality of z-axis constant velocity profiles; and

(c) determining a z-axis constant velocity profile for each of the bonding locations.

7. The method of claim 6 wherein the z-axis deflection values are measured using a z-axis encoder of a bond head assembly of a wire bonding machine.

8. The method of claim 6 wherein step (c) includes determining the z-axis constant velocity profile as a single profile that may be applied to each of the bonding locations.

9. The method of claim 6 wherein step (c) includes determining the z-axis constant velocity profile as a plurality of profiles, each of the bonding locations having a corresponding z-axis constant velocity profile included in the plurality of profiles.

10. The method of claim 6 wherein step (a) includes a user providing the maximum z-axis deflection value.

11. The method of claim 6 wherein the z-axis constant velocity profile is a z-axis slope during a predetermined period of time.