CLAIMS

WHAT IS CLAIMED:

1. A method, comprising:

performing a lateral force test on a pillar bump formed above a metallization system of a semiconductor chip, said lateral force test comprising contacting a side of said pillar bump with a test probe while moving said test probe at a substantially constant speed that is less than approximately 1 μm/sec along a path that is oriented at a substantially non-zero angle relative to a plane of said metallization system, wherein said substantially non-zero angle is established so that said test probe is moving substantially away from said metallization system and so that a force imposed on said pillar bump by said test probe during said lateral force test comprises a component that is directed away from and induces a tensile load on said metallization system; and

determining a behavioral interaction between said pillar bump and said metallization system during said lateral force test.

2. The method of claim 1, further comprising orienting said plane of said metallization system at a substantially non-zero angle relative to a horizontal plane during said lateral force test.

3. The method of claim 1, further comprising moving said test probe at a substantially constant speed that is less than approximately 0.1 μm/sec.

4. The method of claim 1, wherein determining said behavioral interaction between said pillar bump and said metallization system comprises:

measuring a force imposed on said pillar bump by said test probe and a distance traveled by said test probe during a duration of said lateral force test; and

generating a force/distance response curve from said measured force and distance traveled.

5. The method of claim 1, further comprising generating a comparative behavioral interaction curve and comparing said behavioral interaction between said pillar bump and said metallization system to said comparative behavioral interaction curve.

6. The method of claim 5, wherein comparing said behavioral interaction between said pillar bump and said metallization system to said comparative behavioral interaction curve comprises determining a material strength of at least one material comprising said metallization system.

7. The method of claim 5, wherein generating said comparative behavioral interaction curve comprises:

performing a first lateral force test on each of a plurality of first pillar bumps formed above a first metallization system of a first semiconductor chip, wherein performing each of said first lateral force tests comprises contacting a side of a one of said plurality of first pillar bumps with a first test probe while moving said first test probe at a first substantially constant speed that is less than approximately 1 μm/sec;

measuring a force imposed on each one of said plurality of first pillar bumps by said first test probe and a distance traveled by said first test probe during a duration of each respective first lateral force test; and

generating said comparative behavioral interaction curve using said measured force and distance data from each of said first lateral force tests.

8. The method of claim 7, wherein moving said first test probe comprises moving said first test probe along a path that is substantially parallel to a plane of said first metallization system during each respective first lateral force test.

9. The method of claim 1, wherein said metallization system comprises a plurality of metallization layers, and wherein at least one of said metallization layers comprises one of a low-k dielectric material and an ultra-low-k dielectric material.

10. The method of claim 1, wherein performing said lateral force test comprises contacting a surface of said pillar bump with a test probe comprising a test probe tip that is adapted to grip said surface of said pillar bump during said lateral force test.

11. The method of claim 10, wherein performing said lateral force test comprises contacting said surface of said pillar bump with a test probe comprising a wedge shaped test probe tip.

12. The method of claim 10, wherein performing said lateral force test comprises contacting said surface of said pillar bump with a test probe comprising a serrated test probe tip.

13. The method of claim 1, further comprising forming an asymmetrically shaped notch in said pillar bump during said lateral force test.

14. A method, comprising:

performing a first lateral force test on a first pillar bump formed above a first metallization system of a first semiconductor chip, said first lateral force test comprising contacting said first pillar bump with a first test probe while moving said first test probe at a substantially constant speed that is less than approximately 0.1 μm/sec along a path that is oriented at a substantially non-zero angle relative to a plane of said metallization

system, wherein said substantially non-zero angle is established so that said test probe is moving substantially away from said metallization system and so that a force imposed on said first pillar bump by said test probe during said first lateral force test comprises a component that is directed away from and induces a tensile load on said metallization system;

determining a first behavioral interaction between said first pillar bump and said first metallization system during said first lateral force test;

generating a comparative behavioral interaction curve representing a behavioral interaction between a second metallization system of a second semiconductor chip and a plurality of second pillar bumps formed thereabove; and

comparing said first behavioral interaction to said comparative behavioral interaction curve.

15. The method of claim 14, wherein determining said first behavioral interaction between said first pillar bump and said first metallization system comprises measuring said force imposed on said first pillar bump by said first test probe and a distance traveled by said first test probe during a duration of said first lateral force test, and generating a first force/distance response curve from said measured force and distance traveled.

16. The method of claim 14, wherein said comparative behavioral interaction curve comprises a first curve portion that occurs immediately after a second test probe contacts one of said plurality of second pillar bumps and a second curve portion that occurs immediately following said first curve portion, said first curve portion illustrating a substantially non-linear force/distance relationship and said second curve portion illustrating a substantially linear force/distance relationship.

17. The method of claim 14, further comprising performing a second lateral force test on at least one additional pillar bump formed above said first metallization system, determining a second behavioral interaction between said at least one additional pillar bump and said first metallization system during a duration of said second lateral force test, and comparing said second behavioral interaction to said comparative behavioral interaction curve.

18. A device, comprising:

a plurality of pillar bumps formed above a metallization system of a semiconductor chip; and

at least one notch formed in a side of each of said plurality of pillar bumps, wherein said at least one notch is a substantially asymmetrically shaped notch.

19. The device of claim 18, wherein said metallization system comprises a plurality of metallization layers, and wherein at least one of said metallization layers comprises one of a low-k dielectric material and an ultra-low-k dielectric material.

20. The device of claim 18, wherein at least one of said plurality of pillar bumps comprises copper.

CLAIMS

1. A method, comprising:

performing a lateral force test on a pillar bump formed above a metallization system of a semiconductor chip, said lateral force test comprising contacting a side of said pillar bump with a test probe while moving said test probe at a substantially constant speed that is less than approximately 1 μm/sec along a path that is oriented at a substantially non-zero angle relative to a plane of said metallization system, wherein said substantially non-zero angle is established so that said test probe is moving substantially away from said metallization system and so that a force imposed on said pillar bump by said test probe during said lateral force test comprises a component that is directed away from and induces a tensile load on said metallization system; and

determining a behavioral interaction between said pillar bump and said metallization system during said lateral force test.

2. The method of claim 1, further comprising orienting said plane of said metallization system at a substantially non-zero angle relative to a horizontal plane during said lateral force test.

3. The method of claim 1, further comprising moving said test probe at a substantially constant speed that is less than approximately 0.1 μm/sec.

4. The method of claim 1, wherein determining said behavioral interaction between said pillar bump and said metallization system comprises:

measuring a force imposed on said pillar bump by said test probe and a distance traveled by said test probe during a duration of said lateral force test; and

generating a force/distance response curve from said measured force and distance traveled.

5. The method of claim 1, further comprising generating a comparative behavioral interaction curve and comparing said behavioral interaction between said pillar bump and said metallization system to said comparative behavioral interaction curve.

6. The method of claim 5, wherein comparing said behavioral interaction between said pillar bump and said metallization system to said comparative behavioral interaction curve comprises determining a material strength of at least one material comprising said metallization system.

7. The method of claim 5, wherein generating said comparative behavioral interaction curve comprises:

performing a first lateral force test on each of a plurality of first pillar bumps formed above a first metallization system of a first semiconductor chip, wherein performing each of said first lateral force tests comprises contacting a side of each one of said plurality of first pillar bumps with a first test probe while moving said first test probe at a first substantially constant speed that is less than approximately 1 μm/sec;

measuring a force imposed on each one of said plurality of first pillar bumps by said first test probe and a distance traveled by said first test probe during a duration of each respective first lateral force test; and

generating said comparative behavioral interaction curve using said measured force and distance data from each of said first lateral force tests.

8. The method of claim 7, wherein moving said first test probe comprises moving said first test probe along a path that is substantially parallel to a plane of said first metallization system during each respective first lateral force test.

9. The method of claim 1, wherein said metallization system comprises a plurality of metallization layers, and wherein at least one of said metallization layers comprises one of a low-k dielectric material and an ultra-low-k dielectric material.

10. The method of claim 1, wherein performing said lateral force test comprises contacting a surface of said pillar bump with a test probe comprising a test probe tip that is adapted to grip said surface of said pillar bump during said lateral force test.

11. The method of claim 10, wherein performing said lateral force test comprises contacting said surface of said pillar bump with a test probe comprising a wedge shaped test probe tip.

12. The method of claim 10, wherein performing said lateral force test comprises contacting said surface of said pillar bump with a test probe comprising a serrated test probe tip.

13. The method of claim 1, further comprising forming an asymmetrically shaped notch in said pillar bump during said lateral force test.

14. A method, comprising:

performing a first lateral force test on a first pillar bump formed above a first metallization system of a first semiconductor chip, said first lateral force test comprising contacting said first pillar bump with a first test probe while moving said first test probe at a substantially constant speed that is less than approximately 0.1 μm/sec along a path that is oriented at a substantially non-zero angle relative to a plane of said metallization system, wherein said substantially non-zero angle is established so that said test probe is moving substantially away from said metallization system and so that a force imposed on said first pillar bump by said test probe during said first lateral force test comprises a component that is directed away from and induces a tensile load on said metallization system;

determining a first behavioral interaction between said first pillar bump and said first metallization system during said first lateral force test;

generating a comparative behavioral interaction curve representing a behavioral interaction between a second metallization system of a second semiconductor chip and a plurality of second pillar bumps formed thereabove; and

comparing said first behavioral interaction to said comparative behavioral interaction curve.

15. The method of claim 14, wherein determining said first behavioral interaction between said first pillar bump and said first metallization system comprises measuring said force imposed on said first pillar bump by said first test probe and a distance traveled by said first test probe during a duration of said first lateral force test, and generating a first force/distance response curve from said measured force and distance traveled.

16. The method of claim 14, wherein said comparative behavioral interaction curve comprises a first curve portion that occurs immediately after a second test probe contacts one of said plurality of second pillar bumps and a second curve portion that occurs immediately following said first curve portion, said first curve portion illustrating a substantially non-linear force/distance relationship and said second curve portion illustrating a substantially linear force/distance relationship.

17. The method of claim 14, further comprising performing a second lateral force test on at least one additional pillar bump formed above said first metallization system, determining a second behavioral interaction between said at least one additional pillar bump and said first metallization system during a duration of said second lateral force test, and comparing said second behavioral interaction to said comparative behavioral interaction curve.

18. A method, comprising:

performing a first lateral force test on each of a plurality of first pillar bumps formed above a first metallization system of a first semiconductor chip, wherein performing each of said first lateral force tests comprises contacting a side of each one of said plurality of first pillar bumps with a first test probe while moving said first test probe at a first substantially constant speed that is less than approximately 1 μm/sec;

measuring a force imposed on each one of said plurality of first pillar bumps by said first test probe and a distance traveled by said first test probe during a duration of each respective first lateral force test;

generating a comparative behavioral interaction curve using said measured force and distance data from each of said first lateral force tests;

performing a second lateral force test on a second pillar bump formed above a second metallization system of a second semiconductor chip, said second lateral force test comprising contacting a side of said second pillar bump with a second test probe while moving said second test probe at a second substantially constant speed that is less than approximately 1 μm/sec along a path that is oriented at a substantially non-zero angle relative to a plane of said second metallization system;

measuring a force imposed on said second pillar bump by said second test probe and a distance traveled by said second test probe during a duration of said second lateral force test;

determining a behavioral interaction between said second pillar bump and said second metallization system during said second lateral force test using said measured force imposed on said second pillar bump and said distance traveled by said second test probe during said duration of said second lateral force test; and

comparing said behavioral interaction between said second pillar bump and said second metallization system to said comparative behavioral interaction curve.

19. The method of claim 18, wherein said substantially non-zero angle of said path of said second test probe is established so that said second test probe is moving substantially away from said second metallization system and so that a force imposed on said second pillar bump by said second test probe during said second lateral force test comprises a component that is directed away from and induces a tensile load on said second metallization system.

20. The method of claim 19, wherein moving said first test probe comprises moving said first test probe along a path that is substantially parallel to a plane of said first metallization system during each respective first lateral force test.

21. A system employed for testing and evaluating the metallization layers of a back-end-of-line (BEOL) metallization system and pillar bumps formed thereon in accordance with method of any one of the preceding claims.

22. A test configuration for testing the behavioral interaction between a representative pillar bump and an underlying metallization system of semiconductor chip in accordance with any one of the claims 1-20.