CLAIMS

1. A probe head (30) for a testing apparatus of electronic devices integrated on a semiconductor wafer of the type comprising:

- a first plurality of contact probes (31) having a first transversal diameter;

- a second plurality of micro contact probes (36) having a second transversal diameter, smaller than said first transversal diameter of said contact probes (31) of said first plurality, said transversal diameter being a maximum extension of a cross section of said contact probes (31) of said first plurality and of said micro contact probes (36) of said second plurality, even non-circular in shape; and

- a flexible membrane (35) comprising suitable conductive tracks (35C) for electrically connecting a contact probe (31) of said first plurality with a corresponding micro contact probe (36) of said second plurality,

said contact probes (31) of said first plurality being arranged between said testing apparatus and said flexible membrane (35) and said micro contact probes (36) of said second plurality being arranged between said flexible membrane (35) and a semiconductor wafer (39), said micro contact probes (36) of said second plurality being configured to abut onto contact pads (37A) of a device under test (37) integrated in said semiconductor wafer (39), each contact probe (31) of said first plurality being in electrical contact with a corresponding micro contact probe (36) of said second plurality through a conductive track (35C) of said flexible membrane (35) and being configured to electrically connect said device under test (37) with said testing apparatus.

2. The probe head (30) according to claim 1, characterized in that said micro contact probes (36) of said second plurality extend from a first face (F1) of said flexible membrane (35) facing towards said device under test (37) made on said semiconductor wafer (39).

3. The probe head (30) according to claim 2, characterized in that said conductive tracks (35C) of said flexible membrane (35) are configured to connect said micro contact probes (36) of said second plurality with said contact probes (31) of said first plurality spatially

redistributed on a plane (π) defined by said flexible membrane (35).

4. The probe head (30) according to claim 3, characterized in that said contact probes (31) of said first plurality have a first relative distance (P1) that is greater than a second relative distance (P2) of said micro contact probes (36) of said second plurality, said relative distance being a distance between corresponding centers of respective contact areas with said flexible membrane (35).

5. The probe head (30) according to claim 4, characterized in that said second relative distance (P2) of said micro contact probes (36) of said second plurality is equal to a pitch of said contact pads (37A) of said device under test (37), said pitch being a distance between centers of said contact pads (37A).

6. ~~The probe head (30) according to claim 5, characterized in that said first relative distance (P1) varies from 40 µm to 250 µm, and said second relative distance (P2) varies from 8 µm to 40 µm~~ The probe head (30) according to claim 1, characterized in that said micro contact probes (36) of said second plurality are integral with said flexible membrane (35) due to a photolithographic growth process of said micro contact probes (36) of said second plurality directly on said flexible membrane (35).

7. ~~The probe head (30) according to any one of the previous claims, characterized in that said micro contact probes (36) of said second plurality are integral with said flexible membrane (35), thanks to a photolithographic growth process of said micro contact probes (36) of said second plurality directly on said flexible membrane (35) or are fixed to said flexible membrane (35) by an adhesive layer, such as a glue or conductive rubber film interposed between said micro contact probes (36) of said second plurality and said flexible membrane (35)~~The probe head (30) according to claim 1, characterized in that said micro contact probes (36) of said second plurality are fixed to said flexible membrane (35) by an adhesive layer interposed between said micro contact probes (36) of said second plurality and said flexible membrane (35).

8. ~~The probe head (30) according to any one of the previous claims, characterized in that each contact probe (31) of said first plurality~~

~~comprises a rod-shaped body (31C) ending with a first end portion (31A, 31A') that is configured to electrically connect with said flexible membrane (35) and with a second end portion (31B, 31B') configured to electrically connect with said testing apparatus~~The probe head (30) according to claim 1, characterized in that each contact probe (31) of said first plurality comprises a rod-shaped body (31C) ending with a first end portion (31A, 31A') that is configured to electrically connect with said flexible membrane (35) and with a second end portion (31B, 31B') configured to electrically connect with said testing apparatus.

9. ~~The probe head (30) according to claim 8, characterized in that said first end portion (31A, 31A') of each of said contact probes (31) of said first plurality is configured to abut onto a contact pad of a plurality of contact pads (35A) made on a second face (F2) of said flexible membrane (35) facing towards said testing apparatus, said contact pads~~

~~(35A) of said flexible membrane (35) having a pitch equal to said first relative distance (P1) of said contact probes (31) of said first plurality, said pitch being a distance between centers of said contact pads (35A), or said first end portion (31A, 31A') of each of said contact probes (31) of said first plurality is fixedly attached to said flexible membrane (35) at said second face (F2), contact portions between end portions (31A, 31A') of each of said contact probes (31) of said first plurality and said flexible membrane (35) having centers at a distance equal to said first relative distance (P1) of said contact probes (31)~~The probe head (30) according to claim 8, characterized in that said first end portion (31A, 31A') of each of said contact probes (31) of said first plurality is configured to abut onto a contact pad of a plurality of contact pads (35A) made on a second face (F2) of said flexible membrane (35) facing towards said testing apparatus, said contact pads (35A) of said flexible membrane (35) having a pitch equal to said first relative distance (P1) of said contact probes (31) of said first plurality, said pitch being a distance between centers of said contact pads (35A).

10. ~~The probe head (30) according to claim 8 or 9, characterized in that said second end portion (31B, 31B') of each of said contact probes (31) of said first plurality is configured to abut onto a respective contact pad of a plurality of contact pads (38A) made on a face (F) facing towards said probe head (30) of an interface board (38) for said testing apparatus, said contact pads (38A) of said interface board (38) having a pitch equal to or greater than said first relative distance (P1) of said contact probes (31) of said first plurality, said pitch being a distance between centers of said contact pads (38A), or said second end portion (31B, 31B') of each of said contact probes (31) of said first plurality is fixedly attached to said interface board (38), contact portions between said second end portion (31B, 31B') of each of said contact probes (31) of said first plurality and said interface board (38) having centers at a distance equal to or greater than said first relative distance (P1) of said contact probes (31) of said first plurality~~The probe head (30) according to claim 8, characterized in that said first end portion (31A, 31A') of each of said contact probes (31) of said first plurality is fixedly attached to said flexible membrane (35) at

said second face (F2), contact portions between end portions (31A, 31A') of each of said contact probes (31) of said first plurality and said flexible membrane (35) having centers at a distance equal to said first relative distance (P1) of said contact probes (31).

11. ~~The probe head (30) according to claim 9 or 10, characterized in that said first end (31A'), respectively said second end (31B'), of said contact probes (31) of said first plurality is fixedly attached to said flexible membrane (35), respectively to said interface board (38), by a welding, or by an adhesive layer, such as a glue or conductive rubber film~~The probe head (30) according to claim 8, characterized in that said second end portion (31B, 31B') of each of said contact probes (31) of said first plurality is configured to abut onto a respective contact pad of a plurality of contact pads (38A) made on a face (F) of an interface board (38) able to connect to said testing apparatus, said face (F) facing towards said probe head (30) and said contact pads (38A) of said interface board (38) having a pitch equal to or greater than said first relative distance (P1) of said contact probes (31) of said first plurality, said pitch being a distance between centers of said contact pads (38A).

12. ~~The probe head (30) according to claim 9, characterized in that said contact pads (35A) of said flexible membrane (35) have an area (A2) that is greater than an area (A1) of a cross-section of said micro contact probes (36) of said second plurality~~The probe head (30) according to claim 8, characterized in that said second end portion (31B, 31B') of each of said contact probes (31) of said first plurality is fixedly attached to an interface board (38) able to connect to said testing apparatus, contact portions between said second end portion (31B, 31B') of each of said contact probes (31) of said first plurality and said interface board (38) having centers at a distance equal to or greater than said first relative distance (P1) of said contact probes (31) of said first plurality.

13. ~~The probe head (30) according to any one of the previous~~

~~claims, characterized in that it further comprises at least one guide (32), possibly at least one pair of guides (32, 33), provided with respective pluralities of guide holes (32A; 32A, 33A) configured to slidingly house said contact probes (31) of said first plurality~~The probe head (30) according to claim 8, characterized in that said first end (31A') of each contact probe (31) of said first plurality is fixedly attached to said flexible membrane (35) and said second end (31B') of each contact probe (31) of said first plurality is fixedly attached to said interface board (38).

14. ~~The probe head (30) according to any one of the previous claims, characterized in that each contact probe (31) of said first plurality comprises at least one pre-deformed section (31D) made in said probe body (31C)~~The probe head (30) according to claim 9, characterized in that said contact pads (35A) of said flexible membrane (35) have an area (A2) that is greater than an area (A1) of a cross-section of said micro contact probes (36) of said second plurality.

15. ~~The probe head (30) according to any one of the previous claims, characterized in that said micro contact probes (36) of said second plurality have cross-section of a shape selected from round, oval, squared, rectangular, triangular and polygonal~~The probe head (30) according to claim 1, characterized in that each contact probe (31) of said first plurality comprises at least one pre-deformed section (31D) made in said probe body (31C).

16. ~~The probe head (30) according to any one of the previous claims, characterized in that said micro contact probes (36) of said second plurality have a transversal diameter between 5 μm and 30 μm, preferably less than 10 μm~~The probe head (30) according to claim 1, characterized in that said micro contact probes (36) of said second plurality have cross-section of a shape selected from round, oval, squared, rectangular, triangular and polygonal.

17. ~~The probe head (30) according to any one of the previous claims, characterized in that said micro contact probes (36) of said second plurality have a height between 10 μm and 300 μm, preferably less than 200 μm~~The probe head (30) according to claim 1, characterized in that said contact probes (31) of said first plurality have a height greater

than a height of said micro contact probes (36) of said second plurality, height being an extension of said contact probes (31), respectively micro contact probes (36), in a longitudinal development direction.

18. ~~The probe head (30) according to any one of the previous claims, characterized in that said contact probes (31) of said first plurality have a height greater than a height of said micro contact probes (36) of said second plurality, height being an extension of said contact probes (31), respectively micro contact probes (36), in a longitudinal development direction~~The probe head (30) according to claim 1, characterized in that said micro contact probes (36) of said second plurality and said contact probes (31) of said first plurality are made of a conductive material selected from nickel, tungsten, cobalt, palladium or alloys thereof, the nickel-manganese, nickel-cobalt, nickel-palladium or nickel-tungsten, palladium-cobalt alloys, palladium-based ternary and quaternary alloys, platinum, rhodium, palladium, silver, copper or an alloy thereof, or a doped semiconductor material, said flexible membrane (35) is made of a dielectric material and said conductive tracks (35C) are made of a conductor material.

19. ~~The probe head (30) according to any one of the previous claims, characterized in that said micro contact probes (36) of said second plurality are made of a first conductive material selected from nickel, tungsten, cobalt, palladium or alloys thereof, such as the nickel-manganese, nickel-cobalt, nickel-palladium or nickel-tungsten, palladium-cobalt alloys, palladium-based ternary and quaternary alloys, preferably palladium-cobalt, or preferably of a second conductive material selected from platinum, rhodium, palladium, silver, copper or~~

~~an alloy thereof, preferably a platinum alloy, or a suitably doped semiconductor material~~The probe head (30) according to claim 18, characterized in that said micro contact probes (36) comprise an end portion or at least one insert made of a resistant material selected from rhodium and palladium.

20. ~~The probe head (30) according to claim 19, characterized in that said micro contact probes (36) comprise an end portion or at least one insert made of a resistant material selected from rhodium and palladium, preferably rhodium~~The probe head (30) according to claim 1, characterized in that said contact probes (31) of said first plurality have a probe body (31C) comprising a slot (40) that runs longitudinally along said probe body (31C) and defines at least one pair of arms (40a, 40b).

~~21. The probe head (30) according to claim 19, characterized in that said contact probes (31) of said first plurality are made of said first conductive material.~~

~~22. The probe head (30) according to any one of the previous claims, characterized in that said flexible membrane (35) is made of a dielectric material, preferably polyamide.~~

~~23. The probe head (30) according to claim 22, characterized in that said flexible membrane (35) has a thickness (Hm) comprised between 10 µm and 100 µm, preferably equal to 50 µm.~~

~~24. The probe head (30) according to any one of the previous claims, characterized in that said conductive tracks (35C) are made of a conductor material, preferably copper.~~

~~25. The probe head (30) according to any one of the previous claims, characterized in that said contact probes (31) of said first plurality have a probe body (31C) comprising a slot (40) that runs longitudinally along said probe body (31C) and defines at least one pair of arms (40a, 40b).~~