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TITLE OF THE INVENTION

HEAD SUSPENSION ASSEMBLY

BACKGROUND OF THE INVENTION

The present invention relates to a head
5 suspension assembly in which a head amplifier IC chip
is mounted.

In general, a magnetic disk apparatus is provided
with a head suspension assembly in which a head
serving as an electromagnetic conversion element for
10 example, a magnetic head is attached to a slider and
supported by a suspension. In the magnetic disk
apparatus, an integrated circuit element including a
read amplifier circuit for amplifying a signal read
from a magnetic disk by the magnetic head and a write
15 driver circuit for changing a direction and supplying
a current to the magnetic head to allow the head to
write data into the magnetic disk is generally called
a head amplifier IC. The conventional head amplifier
IC is generally mounted on a flexible printed wiring
20 board (FPC) as a wiring cable member.

On the other hand, in recent years, as described
in Jpn. Pat. Appln. KOKAI Publication No. 11-213365,
it is proposed that the head amplifier IC should be
mounted in the vicinity of the magnetic head,
25 suspended by the head suspension assembly. Thereby, a
length of a wiring pattern between the magnetic head
and the head amplifier IC is shortened, an inductance

and capacitance of the wiring pattern are reduced, and an electrostatic breakdown is prevented from occurring during connection of the magnetic head to the FPC.

Moreover, when the head suspension assembly with the head amplifier IC mounted thereon in this manner is assembled with the magnetic disk apparatus, the head amplifier IC is positioned in the vicinity of the surface of the magnetic disk. Therefore, in order to thin the head amplifier IC, a so-called bear chip having no package formed of a synthetic resin or the like is used as the head amplifier IC.

However, the head amplifier IC constituted of the bear chip as described above is formed by using a dicing blade or the like to cut a silicon wafer with a circuit formed thereon in a desired size in a manufacturing process. In this case, a micro break or crack of the order of 20 to 30 μm is generated in a portion which directly contacts the dicing blade. Even when various technical countermeasures such as optimizing of the dicing blade and study of an adhesive material are performed to solve the problem, it is difficult to physically completely eliminate the break or the crack.

The head suspension assembly mounted with the head amplifier IC broken or cracked in the manufacturing process is assembled into the magnetic disk apparatus. In this operation, it is expected

that the break or the crack of the head amplifier IC grows by vibration/impact caused by external factors, and a broken piece falls down on the surface of the magnetic disk in a worst case. Moreover, it is
5 considered that the fallen broken piece is dragged on the surface of the magnetic disk by the magnetic head slider, the surface of the magnetic disk is damaged and magnetically recorded data cannot be read.

BRIEF SUMMARY OF THE INVENTION

10 The present invention has been developed in consideration of the aforementioned respect, and its object is to provide a head suspension assembly which is improved in reliability.

15 According to an aspect of the present invention, there is provided a head suspension assembly comprising: a suspension; a wiring pattern disposed on the suspension; a magnetic head including a bear chip, mounted on the wiring pattern, and configured to record/reproduce information with respect to a
20 magnetic recording medium; and a head amplifier IC mounted on the wiring pattern, and configured to amplify a read signal of the magnetic head, an outer surface of the head amplifier IC being coated with a resin.

25 According to another aspect of the present invention, there is provided a head suspension assembly comprising: a suspension; a wiring pattern

disposed on the suspension; a magnetic head including
a bear chip, mounted on the wiring pattern, and
configured to recording/reproduce information with
respect to a magnetic recording medium; a head
5 amplifier IC mounted on the wiring pattern and
configured to amplify a read signal of the magnetic
head; an under fill charged between the head amplifier
IC and the wiring pattern; and a resin tape coating an
outer surface of the head amplifier IC.

10 BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated
in and constitute a part of the specification,
illustrate embodiments of the invention, and together
with the general description given above and the
15 detailed description of the embodiments given below,
serve to explain the principles of the invention.

FIG. 1 is a plan view of a head suspension
assembly according to an embodiment of the present
invention;

20 FIG. 2 is an enlarged sectional view of a head
amplifier IC mounted portion in the head suspension
assembly;

FIG. 3 is a sectional view showing that the head
suspension assembly is assembled into a magnetic disk
25 apparatus;

FIG. 4 is a flowchart showing a process of
manufacturing the head amplifier IC;

FIG. 5 is a sectional view showing a process of dicing the head amplifier IC; and

FIG. 6 is an enlarged sectional view of the head amplifier IC mounted portion in the head suspension assembly according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

A head suspension assembly according to an embodiment of the present invention will be described in detail with reference to the accompanying drawings.

As shown in FIG. 1, a head suspension assembly (hereinafter referred to as HSA) 10 comprises an arm 12, and a suspension 14 whose base end is fixed to a distal end of the arm 12 by spot welding or adhesive and which extends from the arm 12. The arm 12 formed in a shape of a thin flat plate with thickness of about 250 μm by, for example, a stainless steel-based material such as SUS304, and a circular through hole 15 is formed in a base end of the arm. The suspension 14 is constituted of an elongated leaf spring with a thickness of 60 to 70 μm . The suspension 14 may be formed integrally with the arm 12 by the same material as that of the arm.

The HSA 10 is attached to a bearing assembly of a magnetic disk apparatus by passing a hub of the bearing assembly through the through hole 15 of the arm 12, and rotated around the bearing assembly by a

voice coil motor as a drive mechanism. Moreover, when the HSA 10 rotates, the distal end of the suspension 14 moves substantially in a radial direction of a magnetic disk.

5 Moreover, the HSA 10 comprises a trace 20 fixed on the suspension 14 and arm 12 as described later, a magnetic head 16 as an electromagnetic conversion element mounted on the trace 20 and supported by the distal end of the suspension 14, and a head IC chip 18
10 mounted on the trace 20, for amplifying a read signal of the magnetic head 16. As the magnetic head 16, a composite separated magnetic head including a reproducing (reading) MR element (magnetoresistive effect element) and a recording (writing) thin film
15 head is used.

 The magnetic head 16 is fixed to a rectangular slider 22, and the slider 22 is attached to a gimbal portion (not shown) disposed on the distal end portion of the suspension 14. The slider 22 is pressurized
20 toward the magnetic disk by a function of the suspension 14 as the leaf spring, and serves to raise the magnetic head 16 above the surface of the magnetic disk by a substantially constant distance by a pneumatic pressure generated by rotation of the
25 magnetic disk.

 As shown in FIG. 1 and FIG. 2, the head amplifier IC 18 is constituted as the head chip in a flat

rectangular shape. Moreover, ten bumps 24 for electric connection are disposed on one a surface of the head amplifier IC 18, and functions, for example, as input/output terminals. The head amplifier IC 18
5 is mounted in a position on the suspension 14 apart from the slider 22 toward the arm 12, that is, in a position opposite to the magnetic head 16 interposing the slider 22 therebetween.

The magnetic head 16 and head amplifier IC 18 are
10 electrically connected to each other via the trace 20, and electrically connected to a controller of the magnetic disk apparatus. The trace 20 includes a stainless steel plate and a relay flexible printed circuit board (hereinafter referred to as the relay
15 FPC) formed on the stainless steel plate, and is formed in an elongated strip shape. The trace 20 is fixed on the suspension 14 and arm 12, and extends to a midway portion of the arm 12 from the distal end of the suspension 14. A soldering pad portion 26
20 disposed on a base end of the trace 20 extends outwardly from the arm 12. Moreover, the slider 22 and head amplifier IC 18 are mounted on the trace 20.

The relay FPC of the trace 20 includes a wiring pattern including four conductors 32 for connecting,
25 for example, four electrodes of the magnetic head 16 to four out of the ten bumps 24 of the head amplifier IC 18, and a wiring pattern including six conductors

34 for connecting the remaining six bumps 24 of the head amplifier IC 18 to the soldering pad portion 26.

5 The soldering pad portion 26 constitutes a connection end of the trace 20, and has the same number of electrode pads as that of the conductors 34, that is, six electrode pads 35. The soldering pad portion 26 is connected to a main FPC, not shown, of the magnetic disk apparatus. Moreover, testing pads 36 are disposed on the respective conductors 32 and 34
10 in the vicinity of the head amplifier IC 18.

The head amplifier IC 18 is mounted on the trace 20 while the bumps 24 of the IC 18 are aligned with the pads of the trace 20. However, bonding only by the bumps 24 has a low strength. Therefore, when a
15 force is applied from the outside, the bumps 24 are possibly stripped from the pads. To solve the problem, as shown in FIG. 2, for the purpose of increasing the bonding strength, a resin called an under fill 40 is applied to a gap of a bonded portion between the head
20 amplifier IC 18 and the trace 20.

The under fill 40 enters the gap of the bonded portion by capillary action without leaving a bubble. If the bubble permeates the gap, the head amplifier IC is supposedly cracked or the bumps 24 are stripped
25 from the pads because of a difference of thermal expansion coefficient between the resin and the bubble caused by a temperature change. Therefore, a resin

having a superior fluidity is used in the under fill 40, and the under fill is charged without permeation of the bubble. That is, typical examples of the under fill 40 include an epoxy-based resin having a
5 viscosity of about 500 to 2000.

Moreover, according to the present embodiment, after the head amplifier IC 18 is mounted, a small amount of under fill 40 is applied to the back surface, that is, the outer surface of the head amplifier IC 18.
10 For example, a very thin resin film 42 with a thickness of 10 to 20 μm is formed on the whole outer surface of the head amplifier IC, and the outer surface of the head amplifier IC 18 is coated with the film. Moreover, since the under fill 40 has a
15 superior fluidity, even breaks or cracks of the head amplifier IC 18 generated in the manufacturing process are filled by the under fill without any gaps remaining. Therefore, when this treatment is performed, and while the HSA 10 is assembled in the
20 magnetic disk apparatus, breaks or cracks of the head amplifier IC 18 can be prevented from growing by vibration, impact, and the like. The possibility of the broken piece of the head amplifier IC 18 falling down onto the surface of the magnetic disk can be
25 eliminated.

A process of manufacturing the head amplifier IC for use in the aforementioned head suspension assembly

will next be described.

As shown in FIG. 3, similarly as a usual IC manufacturing process, after a circuit and wiring for connecting circuit elements to one another are formed on a silicon wafer by treatments such as exposure, etching, and diffusion, metal bumps for connecting IC signal pads to the pads disposed on the FPC are formed on a circuit forming surface. Typical examples of the metal bump include a solder ball bump, Au stud bump, and the like.

The next polishing step is not often included in the usual IC manufacturing process, but is included in the process of manufacturing the head amplifier IC to be mounted on the head suspension assembly because the IC needs to be thinned. The step includes a back surface polishing step in which the surface with no bump formed thereon is polished. Here, the surface with no bump formed thereon is referred to as the back surface.

As shown in FIG. 4, when the head suspension assembly is assembled into the magnetic disk apparatus, each slider 22 floats at a remarkably low height d of the order of 15 to 30 nm above the surface of the magnetic disk 14. A thickness of the slider 22 itself is about 300 μm , and the thickness of the head amplifier IC 18 mounted in the vicinity of the slider needs to be limited. Therefore, in the manufacturing

process of the head amplifier IC, in order to thin the silicon wafer, after the circuit is formed, the back surface of the silicon wafer is cut by a polishing machine. The back surface is polished until the
5 thickness of the silicon wafer reaches to about 100 μm to 200 μm from 700 μm .

Next a dicing step is performed to divide the silicon wafer to respective chips. As shown in FIG. 5, in the dicing step, after a circuit forming surface
10 50a of a silicon wafer 50 is attached to a base 52 via an adhesive 54, the silicon wafer 50 is cut in a predetermined size by a rotating dicing blade 56, so that the head amplifier IC 18 is completed.

During the dicing, micro breaks or cracks are
15 sometimes generated over about 20 to 30 μm on a back surface 56b of the silicon wafer 50 which directly contacts the dicing blade 56. As described above, according to the present embodiment, after the head amplifier IC 18 is mounted on the suspension trace 20
20 and the under fill 40 is charged, a small amount of under fill 40 is applied to the back surface of the head amplifier IC 18. For example, a resin film 42 with a thickness of 10 to 20 μm is formed on the whole outer surface of the head amplifier IC so that the
25 outer surface of the head amplifier IC is coated.

According to the head suspension assembly constituted as described above, the outer surface of

the head amplifier IC 18 is coated with the under fill,
i.e., the resin film 42. Even when the head amplifier
IC is broken or cracked in the manufacturing process,
the broken piece of the head amplifier IC can be
5 prevented from falling down on the surface of the
magnetic disk, and reliability can be enhanced.

When the epoxy-based resin having a viscosity of
500 to 2000, the silicon-based resin, or the same
material as that of the under fill is used as the
10 resin, the resin penetrates into the break or the
crack generated in the manufacturing process, and
broken pieces can be securely prevented from being
generated.

Additionally, the present invention is not
15 limited to the aforementioned embodiment, and can be
variously modified within the scope of the present
invention. For example, the resin with which the
outer surface of the head amplifier IC 18 is to be
coated may be a resin having the aforementioned
20 predetermined viscosity. The resin is not limited to
the same resin as the under fill, a silicon-based
resin may also be used, and other various resins may
be selected if necessary.

In the aforementioned embodiment, the head
25 amplifier IC is coated with the applied resin.
Instead, as shown in FIG. 6, a resin tape 60 may be
attached to the back surface of the head amplifier IC

18 so that the outer surface of the head amplifier IC
is coated. As the resin tape 60, for example, a tape
formed of the epoxy-based resin and having a thickness
of about 10 to 50 μm can be used. Furthermore, even
5 when the resin tape 60 is used instead of the resin
coat, broken pieces of the head amplifier IC can be
prevented from falling down on the magnetic disk
surface, and the reliability can be enhanced.

Additional advantages and modifications will
10 readily occur to those skilled in the art. Therefore,
the invention in its broader aspects is not limited to
the specific details and representative embodiments
shown and described herein. Accordingly, various
modifications may be made without departing from the
15 spirit or scope of the general inventive concept as
defined by the appended claims and their equivalents.

WHAT IS CLAIMED IS:

1. A head suspension assembly comprising:
a suspension;
a wiring pattern disposed on the suspension;
5 a magnetic head including a bear chip, mounted on
the wiring pattern, and configured to record/reproduce
information with respect to a magnetic recording
medium; and
a head amplifier IC mounted on the wiring pattern,
10 and configured to amplify a read signal of the
magnetic head, an outer surface of the head amplifier
IC being coated with a resin.
2. A head suspension assembly according to
claim 1, wherein the outer surface of the head
15 amplifier IC is coated with an epoxy-based resin or a
silicon-based resin.
3. A head suspension assembly according to
claim 1, wherein the outer surface of the head
amplifier IC is coated with an epoxy-based resin
20 having a viscosity of 500 to 2000.
4. A head suspension assembly according to
claim 1, wherein an under fill is charged to a gap
between the head amplifier IC and the wiring pattern,
and the outer surface of the head amplifier IC is
25 coated with the same material as that of the under
fill.
5. A head suspension assembly comprising:



a suspension;

a wiring pattern disposed on the suspension;

a magnetic head including a bear chip, mounted on
the wiring pattern, and configured to

5 recording/reproduce information with respect to a
magnetic recording medium;

a head amplifier IC mounted on the wiring pattern
and configured to amplify a read signal of the
magnetic head;

10 an under fill charged between the head amplifier
IC and the wiring pattern; and

a resin tape coating an outer surface of the head
amplifier IC.

