

MAGNETIC HEAD HAVING t-head with IMPROVED BILAYER P1 DESIGN**BACKGROUND OF THE INVENTION****Field of the Invention**

The present invention relates generally to magnetic heads that are utilized with thin film hard disk data storage devices, and more particularly to the design and fabrication of the magnetic poles of the write head components of such magnetic heads.

Description of the Prior Art

As is well known to those skilled in the art, standard magnetic heads include write head elements that include two magnetic poles, commonly termed the P1 and P2 poles, with a write gap layer formed between them. During a data recording procedure, the passage of magnetic flux across the write gap between the two poles creates a magnetic field which influences a thin film layer of magnetic media on a magnetic recording surface such as a hard disk that is located proximate the magnetic head, such that the changing magnetic flux creates data bits within the magnetic media.

To create narrow written data track widths, one or sometimes both of the magnetic poles are fabricated with narrow pole tips, where the write gap layer is formed between the pole tips. A typical magnetic head design includes a rather large P1 pole and a narrow P2 pole tip portion of the P2 pole, with the write gap layer formed therebetween. The write gap of the magnetic head is thus located at the bottom end of the P2 pole tip across from the bottom end of the P1 pole. However, even such small P2 pole tips have a physical shape such that top end portions of the P2 pole tip that are formed away from the write gap are close enough to the P1 pole to allow significant magnetic flux to pass therebetween. The magnetic flux that passes between the

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magnetic poles at areas away from the write gap is termed magnetic flux leakage, and a magnetic head that has high magnetic flux leakage is less efficient than a head with lower magnetic flux leakage.

The ongoing efforts to increase the efficiency of the write head elements of magnetic heads, therefore, include efforts to limit the magnetic flux leakage between the two magnetic poles in areas away from the write gap. One of the areas of significant concern is at the top end portion of the P2 pole tip, which is disposed away from the write gap but which is separated from the P1 pole by only the thickness of the write gap layer. This gap at the top end of the P2 pole tip will be termed the "top gap" in this application. Magnetic flux that leaks through this top gap thus reduces the efficiency of the write head element.

The present invention seeks to minimize magnetic flux leakage through the top gap by removing portions of the P1 magnetic pole in the top gap area, such that the overall top gap distance is increased and magnetic flux leakage is thereby decreased.

SUMMARY OF THE INVENTION

The magnetic head of the present invention includes a bilayer P1 magnetic pole, including a P1A layer that is formed upon the read head element and a P1B layer that is formed upon a P1A layer. The P1B layer is patterned with an opening formed proximate the location of the top end of the P2 pole tip that is subsequently fabricated, such that the top gap distance between the top end of the P2 pole tip and the P1 layer is increased, whereby the magnetic flux leakage across the top gap is decreased.

In one magnetic head embodiment the P1B layer is formed as a single, integrally formed layer with the opening formed therethrough. In an alternative embodiment the P1B layer is formed as two separate pieces with the opening formed therebetween. The method for fabricating the magnetic head of the present invention includes the additional steps of fabricating the patterned P1B layer upon the P1A layer, followed by the deposition of insulator material to fill the

opening in the P1B layer, followed by a CMP³ step to polish the surface of the P1B layer prior to the deposition of the write gap layer thereon. In a further embodiment of the present invention the second magnetic pole is formed from two pieces, a pole tip piece and a yoke piece, and a bottom end of the yoke piece is recessed from the air bearing surface (ABS) of the magnetic head.

It is an advantage of the magnetic head of the present invention that it has decreased magnetic flux leakage.

It is another advantage of the magnetic head of the present invention that it has decreased magnetic flux leakage at the top gap of the second magnetic pole tip.

It is a further advantage of the magnetic head of the present invention that it has increased in efficiency and greater overwriting characteristics.

It is an advantage of the hard disk drive of the present invention that it includes a magnetic head having decreased magnetic flux leakage at the top gap of the second magnetic pole tip.

It is a further advantage of the hard disk drive of the present invention that it includes a magnetic head that it has increased in efficiency and greater overwriting characteristics.

These and other features and advantages of the present invention will no doubt become apparent to those skilled in the art upon reviewing the following detailed description which makes reference to the several figures of the drawings.

IN THE DRAWINGS

Fig. 1 is a schematic top plan view of a hard disk drive including the magnetic head of the present invention;

Fig. 2 is a perspective view with cut away portions depicting a prior art magnetic head including a T-head P2 pole tip design;

Fig. 3 is a perspective view with cut away portions depicting a first magnetic head embodiment of the present invention;

Fig. 4 is a side cross-sectional view of the magnetic head depicted in Fig. 3;

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Fig. 5 is a top plan view of the P1B pole of the magnetic head depicted in Figs. 3 and 4;

Fig. 6 is a perspective view with cut away portions depicting an alternative magnetic head embodiment of the present invention;

Fig. 7 is a side sectional view of the magnetic head depicted in Fig. 6;

Fig. 8 is a top plan view of the P1B pole of the magnetic head depicted in Figs. 6 and 7;

Fig. 9 is a side cross-sectional view of another magnetic head embodiment of the present invention; and

Fig. 10 is a side cross-sectional view of a further embodiment of the magnetic head of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Efforts to increase areal data storage density of hard disk drives have lead to improvements in the structure and function of the write head elements of magnetic heads. A simplified top plan view of a typical hard disk drive 10 which is suitable to include the magnetic head of the present invention is presented in Fig. 1. As depicted therein, at least one hard disk 14 is rotatably mounted upon a motorized spindle 18. A slider 22, having a magnetic head 26 disposed thereon, is mounted upon an actuator arm 30 to fly above the surface of each rotating hard disk 14, as is well known to those skilled in the art. The present invention includes improved features and manufacturing methods for such magnetic heads 26, and to better described the present invention a prior art magnetic head including a T-head pole tip design is next described.

Fig. 2 is a perspective view depicting portions of a prior art magnetic head 38 including a T-head P2 pole tip design. This magnetic head 38 includes a first shield layer 40 that is formed upon a surface 44 of the slider body material 22. A read head sensor element 52 is disposed within insulation layers 56 and a second read head shield layer 60 is formed upon the insulation layers 56. An insulation layer 64 is formed upon the second shield layer 60 and a first P1

magnetic pole layer 68 is formed upon the insulation layer 64, and a write gap layer 72 is thereafter formed upon the P1 pole layer 68.

In the T-head P2 pole tip design, a separate P2 pole tip piece 76 is next fabricated upon the write gap layer 72, and a back gap piece 77 is simultaneously fabricated through a hole formed in the write gap layer 72 to make a magnetic connection with the P1 layer 68, as is well known to those skilled in the art. Thereafter, alumina fill 78 is deposited and a chemical mechanical polishing (CMP) step is performed to provide a flat surface that exposes the top surface of the P2 pole tip 76 and the back gap piece 77. Thereafter, an induction coil 80 is fabricated within insulation layers 84 and a separate second pole piece 88, termed the P3 pole, is fabricated upon the insulation layer 84. The P3 pole 88 is formed with a narrow bottom end 92 that makes magnetic contact with the P2 pole tip 76 and a yoke portion 96 that covers portions of the coils 80, whereby electrical energy that passes through the coils 80 creates a magnetic flux within the yoke 88, and the back gap piece 77 serves to magnetically connect the top 100 of the yoke 88 with the P1 pole layer 68. The bottom surface of the magnetic head 38 is thereafter fabricated into an air bearing surface (ABS) 108, in which the write gap 112 is formed between the bottom end of the P2 pole tip 76 and the bottom end of the P1 pole 68.

The T-head design was developed to allow narrower track width definition on the recording head 38, and thereby increase the number of tracks per inch on the disk, such that the areal data storage density of the disk is increased. The T-head design includes the separate fabrication of the P2 pole tip 76, such that the width W of the P2 pole tip, which generally controls the written data track width, can be more narrowly and accurately fabricated. The bottom end 92 of the P3 pole layer 88 is generally wider than the P2 pole tip 76, and forms a T-shaped structure from which the T-head design is named. The magnetic flux which passes across the write gap 112 from the bottom end of the P2 pole tip 76 to the P1 pole layer 68 at the ABS surface 108 influences the thin film magnetic layer on the hard disk surface in writing information to the hard

disk. Therefore, the stronger the magnetic flux⁶ is at the write gap 112, the better will be the overwriting properties of the magnetic head.

A problem associated with write heads in general and still present in the T-head design of Fig. 2 is magnetic flux leakage across the write gap layer 72 between the P2 pole tip 76 and the P1 layer 68 at locations other than the write gap 112 at the ABS surface 108. Specifically, undesirable magnetic flux leakage 120 across the gap 122 from the top portion 124 of the P2 pole tip 76 to the P1 layer 68 is undesirable. This gap 122 at the top portion 124 of the P2 pole tip 76 is termed the "top gap" in this application. This flux leakage 120 weakens the efficiency of the write head, and therefore detracts from optimal write head performance, which is achieved when the magnetic flux flows across the write gap 112 between the P2 pole tip 76 and the P1 layer 68 at the ABS surface 108, such that the full magnetic flux is experienced by the magnetic disk media and maximum overwriting thereby occurs.

The present invention includes a modification of the P1 layer that reduces the top gap magnetic flux leakage of the prior art magnetic heads. Although the following description makes specific reference to the T-head design depicted in Fig. 2, it will be understood by those skilled in the art that the modifications to the P1 pole as described in the present invention are generally applicable to many different write head designs.

A first embodiment of the magnetic head 200 of the present invention is depicted in Figs. 3, 4 and 5, wherein Fig. 3 is a perspective view of a magnetic head including a first embodiment of the bilayer P1 pole 202 of the present invention with cutaway portions, Fig. 4 is a side cross-sectional view of Fig. 3, and Fig. 5 is a top plan view of the bilayer P1 pole 202 of the present invention shown in Figs. 3 and 4. As depicted in Figs. 3, 4 and 5, the magnetic head embodiment 200 includes a read head portion including a first read head shield 204 formed on a slider body 206, a read element 208 disposed within an insulation layer 210 and a second S2 read head shield 212. The structure of the read head element is not a part of the present invention; indeed, the present invention, as described herebelow, is suitable for use with many different types

of read head designs. Therefore, the fabrication steps utilized in the formation of the read head are not described herein in detail as they are well known to those skilled in the art.

Following the deposition of an insulator layer 216 upon the S2 shield 212 a first P1 pole layer 220 (the P1A layer) is deposited. This P1A layer 220 is formed utilizing well known photolithographic and plating techniques. The P1 layer 220 is preferably formed of a material having high permeability that provides good magnetic flux flow and has low magnetostrictive properties, and a material such as NiFe 81-19 Permalloy is suitable for the P1A pole layer 220. Additionally, while not depicted herein, the present invention also applies to a merged magnetic head design wherein the S2 read element shield 212 and the P1 pole layer 220 are formed from a single layer that performs dual functions as the second read element shield (S2) and the P1 magnetic pole.

A novel feature of the present invention is the deposition of a second (P1B) P1 pole layer 230 on top of the P1A pole layer 220. The P1B layer 230 is formed utilizing standard photolithographic and electroplating techniques. In the embodiment depicted in Figs. 3, 4 and 5, a hole or window 234 is formed within the P1B layer 230 proximate the location that the P2 pole tip will be subsequently formed. Specifically, as depicted in Fig. 5, the hole 234 is located such that the top end 240 of the P2 pole tip 244 (shown in phantom) will ultimately be formed over the hole 234, whereas the bottom end 248 of the P1B layer 230 and the bottom end 246 of the P2 pole tip 244 will be exposed at the ABS surface 256 of the magnetic head 200. Following the formation of the P1B layer 230 and hole 234, an insulative layer 260 is deposited to fill the hole 234.

The P1B layer 230 can advantageously be formed from a material, such as NiFe 45/55, having a higher magnetic moment than the Permalloy P1A layer 220 to provide improved magnetic flux flow properties and a stronger magnetic field, such that sufficient overwriting properties are obtained for the magnetic head 200 on higher coercivity hard disks. Such higher magnetic moment materials may have higher magnetostrictive properties and lower permeability

than the Permalloy of the P1A layer; however, the read head element is generally not adversely affected because the P1B layer 230 is disposed further away from the read head element. A chemical mechanical polishing step (CMP) is preferably undertaken following the deposition of the insulative 260 layer that fills the hole 234, and the write gap layer 268 is thereafter deposited upon the P1B pole layer 230 and insulation layer 260.

The P2 pole tip 244 is next fabricated upon the write gap layer 268 and, as indicated above, various known types of P2 pole designs are advantageously improved by the bilayer P1 pole 202 described hereabove. The back gap pole piece 245 is fabricated through a hole in the write gap layer 268 to make magnetic contact with the upper portion of the P1B layer 230. With specific regard to the T-head P2 pole design depicted in Figs. 3 and 4, utilizing standard photolithographic techniques the P2 pole tip 244 is first fabricated upon the write gap layer 268. Significantly, as depicted in Figs. 3, 4 and 5, the top portion 240 of the P2 pole tip 244 is fabricated on top of the hole 234, while the bottom portion 246 of the P2 pole tip 244 is fabricated to be in alignment with the bottom portion 248 of the P1B layer 230. Thereafter, when the magnetic head is lapped to form the ABS surface 256 as depicted in Figs. 3 and 4, the bottom portions 248 and 246 of the P1B layer and P2 pole tip respectively will form the write gap 270 of the magnetic head 200. Following the formation of the P2 pole tip 244, and utilizing the well known magnetic head fabrication techniques, an alumina fill layer 274 is deposited, followed by a CMP step, and the induction coil components 288 and the P3 magnetic layer 292 which include the yoke 296 are fabricated. The back gap piece 245 joins the top of the yoke 296 with the P1B layer 230. Thereafter, standard magnetic head fabrication steps and encapsulation (not shown) are performed to complete the manufacture of the magnetic head 200 of the present invention.

As is best seen in Fig. 5, the bottom edge 298 of the hole 234 is formed a distance L away from the bottom end 248 of the P1B layer 230 at the ABS surface 256, and the top end 240 of the P2 pole tip 244 is formed a distance K away from the ABS surface 256, where K is greater than L.

A significant feature of the preferred embodiment 200 of the present invention is that the unwanted flux leakage across the top gap 122 of the prior art write heads is significantly reduced. Specifically, because the hole 234 is located beneath the top portion 240 of the P2 pole tip 244, leakage of magnetic flux from the top end 240 of the P2 pole tip 244 to the P1A pole 220 or P1B pole 230 is substantially reduced. As a result, the magnetic head 200 of the present invention has reduced flux leakage, such that a stronger magnetic flux passes across the write gap 270 at the ABS surface 256, and greater overwriting properties of the magnetic head 200 are achieved.

An alternative embodiment of the present invention is depicted in Figs. 6, 7 and 8, wherein Fig. 6 is a perspective view with cutaway portions of a magnetic head 300 including an alternative bilayer P1 pole 302, Fig. 7 is a side cross-sectional view of Fig. 8, and Fig. 9 is a top plan view of the alternative P1B layer 308 depicted in Figs. 7 and 8. The alternative magnetic head 300 of the present invention may include the same read head elements as the embodiment 200, and may be formed with a separate read head S2 shield layer, or formed as a merged head (not shown) wherein the S2 shield layer and the P1A layer are fabricated as a single layer that performs dual service. Identical elements of the embodiment 300 and the embodiment 200 are numbered identically for ease of understanding. As with the first embodiment 200, the P1A layer 220 of this alternative embodiment is preferably formed from a low magnetostrictive material such as Permalloy.

The significant difference between this embodiment 300 and the first embodiment 200 is the configuration of the P1B layer 308. Specifically, in this embodiment 300 the P1B layer 308 is formed with a full gap 312 between two separate layer portions 316 and 320, as is best seen in Fig. 8. The P1B layer 308 includes a bottom portion 316 that is disposed to form part of the ABS surface 256. This bottom portion 316 is formed with a length L at the location where the bottom portion 246 of the P2 pole tip 244 proximate the ABS surface 256 will be fabricated, and the length L is less than the length K of the P2 pole tip 244 (shown in phantom in Fig. 8). It is therefore to be understood that, as with the embodiment 200 depicted above, the open gap portion

312 of the P1B layer 308 is formed across the write gap layer 268 opposite from the top portion 240 of the P2 pole tip 244.

The P1B layer 308 also includes a top portion 320 that is formed to magnetically interconnect to the back gap piece 245 and the yoke 296 of the P3 pole 292 that is fabricated later. As with the preferred embodiment 200 the P1B layer 308 is preferably formed from a high magnetic moment material such as NiFe 45/55 to provide improved magnetic flux flow properties. However, a significant difference between the alternative embodiment 300 and the embodiment 200 is that in the alternative embodiment 300 the magnetic flux must flow through the P1A layer 220, whereas in the embodiment 200, the magnetic flux can primarily flow through the P1B layer 230 as it is fully formed between the back gap piece 245 and the bottom portion 248. As with the first embodiment 200, magnetic flux leakage from the top portion 240 of the P2 pole tip 244 is significantly reduced owing to the lack of a portion of the P1 pole layer being formed directly across the write gap layer 268 from the top 240 of the P2 pole tip 244.

Magnetic heads of the present invention were fabricated for testing with P1B layers of varying thickness. It was generally determined that an increase in the thickness of the P1B layer resulted in a desirable increase in the magnetic flux across the write gap 270 at the ABS surface; this increase being due to a decrease in the magnetic flux leakage across the top gap of the P2 pole tip. Generally, for the magnetic head embodiments 200 and 300 described above, where the P1B length L is .5 to 2 microns, the P2 tip length K is 1 to 6 microns, and the P2 tip thickness is 1 to 3 microns, a P1B layer having a thickness of 0.2 to 2 microns produced a significant increase in the overwriting properties of the magnetic head. A preferred embodiment is fabricated where L is 2 microns, K is approximately 4 microns, the P2 tip thickness is approximately 1.5 microns and the P1B layer has a thickness of approximately 0.8 microns.

A further magnetic head 340 of the present invention is an improvement to the T-head P2 pole design, and is depicted in Fig. 9. As is seen by comparing Figs. 2 and 4 with Fig. 9, the improvement resides in the recessed formation of the bottom end 350 of the P3 pole 358 upon the

P2 pole tip 244. This recessed P3 pole 358 is fabricated utilizing standard photolithographic and electroplating techniques wherein the patterned photolithographic trench for the P3 pole 358 is shortened such that it does not extend all the way down to the ABS surface 256. Following removal of the P3 pole photoresist patterning layer, encapsulation material is used to fill the space 362 in front of the first end 350 of the P3 pole 358 at the ABS surface 256. An advantage of the recessed P3 layer 358 is that reduced sidewriting of the magnetic head 340 is produced where the P3 layer is recessed away from the ABS surface 256.

The recessed P3 layer is not necessarily, but advantageously combined with the bilayer P1 pole design of the present invention, and Fig. 9 depicts the bilayer P1 head embodiment 200 of Figs. 3, 4 and 5 joined with the recessed P3 pole 358. As depicted in Fig. 9, the top portion 240 of the P2 pole tip 244 is fabricated over the hole 234 of the P1B layer 230, and the P3 pole 358 is fabricated in a recessed manner onto the P2 pole tip 244. A significant advantage of this combined magnetic head structure is that the length K of the P2 pole tip 244 can be increased over the prior art P2 pole tip because flux leakage is reduced in the P2 pole tip top gap region due to the hole 234 fabricated in the P1B layer 230. Thus, the increased length K of the P2 pole tip 244 allows for the fabrication of a recessed P3 pole 358 which still provides a good magnetic interconnection between the recessed P3 layer 358 and the P2 pole tip 244.

Another magnetic head 370 of the present invention is depicted in Fig. 10. As can be seen by comparing Figs. 7, 9 and 10, it will be understood that Fig. 10 depicts the magnetic head of Fig. 7 having the recessed bottom end 350 of the P3 pole 358 upon the P2 pole tip 244. Thus, the embodiment 370 depicted in Fig. 10 possesses the features and advantages of the recessed P3 pole, as described hereabove with regard to Fig. 9, as well as the features and advantages of the magnetic head embodiment 300 depicted and described hereabove.

While the present invention has been shown and described with regard to certain preferred embodiments, it is to be understood that modifications in form and detail will no doubt be developed by those skilled in the art upon reviewing this disclosure. It is therefore intended that

the following claims cover all such alterations and modifications that nevertheless include the true spirit and scope of the inventive features of the present invention.

CLAIMS

1. A magnetic head, comprising:
 - a bilayer first magnetic pole having a first magnetic pole layer (P1A) and a second magnetic pole layer (P1B); said P1B layer having an opening formed therethrough;
 - a write gap layer being formed on a portion of said P1B layer;
 - a second magnetic pole being formed upon said write gap layer; said second magnetic pole including a pole tip portion that is formed in part over said opening in said P1B layer.
2. A magnetic head as described in claim 1 wherein said P1B layer is formed as a single integrally formed layer having said opening formed therethrough.
3. A magnetic head as described in claim 1 wherein said P1B layer is formed as two separate pieces, wherein said first piece is disposed proximate said second pole tip, and wherein said second piece is disposed proximate a back gap member of said magnetic head to magnetically connect portions of said second magnetic pole with said P1A layer.

4. A magnetic head as described in claim 1 wherein said opening in said P1B layer is formed with a bottom edge that is disposed a distance L from an air bearing surface (ABS) of said magnetic head, and wherein said pole tip is formed with a length K, and wherein K is greater than L.



5. A magnetic head as described in claim 1 wherein said P1A layer and said P1B layer are formed from different materials.

6. A magnetic head as described in claim 5 wherein said P1A layer is formed from a material having a higher permeability than said P1B layer.

7. A magnetic head as described in claim 6 wherein said P1A layer is formed of Permalloy, and said P1B layer is formed of NiFe 45/55.

8. A magnetic head as described in claim 1 wherein said P1B layer has a thickness of from 0.2 microns to 2.0 microns.

9. A magnetic head as described in claim 4 wherein L is 0.5 to 2 microns, K is 1 to 6 microns and said PIB layer has a thickness of from 0.2 microns to 2.0 microns.



10. A magnetic head as described in claim 9 wherein L is approximately 2 microns, K is approximately 4 microns and the PIB layer thickness is approximately 0.8 microns.

11. A magnetic head as described in claim 1 wherein said second magnetic pole is formed from two magnetically connected pieces, wherein said first piece is said pole tip and wherein said second piece is a yoke portion that is engaged to said pole tip at a bottom end of said yoke and magnetically engaged to said PIB layer at a top end of said yoke.

12. A magnetic head as described in claim 11 wherein said bottom end of said yoke is recessed from an ABS surface of said magnetic head.

13. A hard disk drive comprising:
at least one hard disk being adapted for rotary motion upon a disk drive;
at least one slider device having a slider body portion being adapted to fly over said hard disk;

a magnetic head being formed on said slider body for writing data to said hard disk, said magnetic head including:

a bilayer first magnetic pole having a first magnetic pole layer (P1A) and a second magnetic pole layer (P1B); said P1B layer having an opening formed therethrough;

a write gap layer being formed on a portion of said P1B layer;

a second magnetic pole being formed upon said write gap layer; said second magnetic pole including a pole tip portion that is formed in part over said opening in said P1B layer.



14. A hard disk drive as described in claim 13 wherein said P1B layer is formed as a single integrally formed layer having said opening formed therethrough.

15. A hard disk drive as described in claim 13 wherein said P1B layer is formed as two separate pieces, wherein said first piece is disposed proximate said second pole tip, and wherein said second piece is disposed proximate a back gap member of said magnetic head to magnetically connect portions of said second magnetic pole with said P1A layer.

16. A hard disk drive as described in claim 13 wherein said opening in said P1B layer is formed with a bottom edge that is disposed a distance L from an air bearing surface (ABS) of said magnetic head, and wherein said pole tip is formed with a length K, and wherein K is greater than L.



17. A hard disk drive as described in claim 13 wherein said P1A layer and said P1B layer are formed from different materials.

18. A hard disk drive as described in claim 17 wherein said P1A layer is formed from a material having a higher permeability than said P1B layer.

19. A hard disk drive as described in claim 18 wherein said P1A layer is formed of Permalloy, and said P1B layer is formed of NiFe 45/55.

20. A hard disk drive as described in claim 13 wherein said P1B layer has a thickness of from 0.2 microns to 2.0 microns.

21. A magnetic head as described in claim 16 wherein L is 0.5 to 2 microns, K is 1 to 6 microns and said P1B layer has a thickness of from 0.2 microns to 2.0 microns.



22. A magnetic head as described in claim 21 wherein L is approximately 2 microns, K is approximately 4 microns and the P1B layer thickness is approximately 0.8 microns.

23. A hard disk drive as described in claim 13 wherein said second magnetic pole is formed from two magnetically connected pieces, wherein said first piece is said pole tip and wherein said second piece is a yoke portion that is engaged to said pole tip at a bottom end of said yoke and magnetically engaged to said P1B layer at a top end of said yoke.

24. A hard disk drive as described in claim 23 wherein said bottom end of said yoke is recessed from an ABS surface of said magnetic head.

25. A method for fabricating a magnetic head comprising the steps of:
fabricating a bilayer first magnetic pole upon a substrate surface, including the steps of:
forming an initial first magnetic pole layer (P1A) upon said substrate surface;
forming a second first magnetic pole layer (P1B) upon said P1A layer, said P1B layer being formed with an opening therethrough;
forming a write gap layer upon said P1B layer;
forming a second magnetic pole upon said write gap layer in electromagnetic connection with said P1B layer.

26. A method for fabricating a magnetic head as described in claim 25, including the further steps of depositing a layer of insulator material upon said P1B layer to fill said opening, and performing a CMP polishing step upon said layer to remove portions of said insulator material and to polish an upper surface of said P1B layer.



27. A method for fabricating a magnetic head as described in claim 25 wherein said P1B layer is formed as a single integrally formed layer having said opening formed therethrough.

28. A method for fabricating a magnetic head as described in claim 25 wherein said P1B layer is formed as two separate pieces with said opening disposed between said two pieces.

29. A method for fabricating a magnetic head as described in claim 25 wherein said P1B layer is formed with a distance L from a first edge of said opening to an air bearing surface (ABS) of said magnetic head, and wherein said second magnetic pole includes a second magnetic pole tip member having a length K, and wherein K is greater than L.

30. A magnetic head as described in claim 29 wherein L is 0.5 to 2 microns, K is 1 to 6 microns and said P1B layer has a thickness of from 0.2 microns to 2.0 microns.

31. A magnetic head as described in claim 30 wherein L is approximately 2 microns, K is approximately 4 microns and the P1B layer thickness is approximately 0.8 microns.

32. A method for fabricating a magnetic head as described in claim 25 wherein said P1A layer and said P1B layer are formed of different material.



33. A method for fabricating a magnetic head as described in claim 32 wherein said P1A layer is formed from a material having a greater permeability than said P1B layer.

34. A method for fabricating a magnetic head as described in claim 33 wherein said P1A layer is formed from Permalloy and said P1B layer is formed from NiFe 45/55.

35. A method for fabricating a magnetic head as described in claim 25 wherein said second magnetic pole includes a pole tip portion and a yoke portion, and wherein said yoke portion has a bottom end that is magnetically connected to said pole tip and a top end that is magnetically connected to said P1B layer.

36. A method for fabricating a magnetic head as described in claim 35 wherein said bottom portion of said yoke is recessed from an ABS surface of said magnetic head.

