NONDESTRUCTIVE M-H HYSTERESIS TESTERS FOR MAGNETIC DISCS FOR COMPUTER DISC DRIVES

This application is a continuation, of application Ser. No. 879,670, filed June 27, 1986, now abandoned.

FIELD OF THE INVENTION

The invention is a device for testing magnetic storage media for computers. Specifically, the invention tests the magnetic properties of discs used in computer disc drives.

BACKGROUND OF THE INVENTION

In this application, an item number's highest order digit identifies the figure. The lower order digits identify the item.

FIG. 3 shows an M-H hysteresis loop of a computer disc. H_c 3-33, the coercivity, represents the strength of the applied magnetic field required to switch the magnetization, M, of the disc from a negative polarity to a positive polarity. Likewise, $-H_c$ 3-37, represents the strength of the applied magnetic field where the magnetic field, M, of the disc switches from a positive polarity to a negative polarity. Thus, when writing to a disc the applied magnetic field, H, must exceed H_c to change the polarity of the magnetization from negative to positive or be less than H_c 3-37 to change the polarity of the magnetic field from positive to negative. When reading the discs, the read head detects the magnetization, M, of the disc. The magnitude of the magnetization will be M_r 3-31 or M_{-r} 3-35. Thus, the M-H hysteresis loop properties of the discs must be carefully controlled in the manufacturing procedure.

The most common prior art technique for measuring the M-H hystersis loop property of computer discs requires samples to be cut or punched from the disc. Then, a vibrating sample magnetometer measures the M-H hysteresis loop properties of the sample. This technique has several disadvantages. The cutting or punching process may distort the sample and thereby change the magnetic property being measured because of magnetostriction. Ferromagnetic contamination on the edges of the sample created by the cutting or punching process contributes additional error to measurements of the M-H hysteresis loop. Furthermore, the prior art test methods consume time. The cutting of each sample may require fifteen minutes or more. Additionally, the measurement of the M-H hystersis loop properties in a vibrating sample magnetometer (VSM) usually requires from 20 to 40 minutes per sample. Worst of all this testing method destroys the disc so it can no longer be used for other tests.

There have been several attempts to improve the accuracy and speed of M-H hystersis loop testers. One scheme cuts samples very carefully to minimize distortion of its magnetic properties. Another scheme uses a diamond tip or a tungsten carbide cutting edge to prevent steel or ferromagnetic material from contacting the sample and contaminating it. Another scheme reduces the number of samples tested and the time required for testing. However, reducing the number of test samples sacrifices the quality of the tests.

The disadvantages of destroying the disc are partially offset by conducting the M-H looper test last. However, if the need for further testing becomes apparent, the destruction of the disc makes their execution impossible.

The LDJ Co. of Michigan sells an M-H hystersis loop tester that measures the M-H hysteresis loop of a large part of the disc nondestructively. This device tests large portions of the disc at once by applying a magnetic field to the entire disc. Then it measures the resulting magnetization change in a large part of the disc which includes both sides of the disc along its diameter. Testing large portions of the disc at once produces inaccurate results. Some parts of the tested region are magnetized in a circumferential direction and other parts in a radial direction. The magnetic properties may be different in these two directions. In addition, this method does not measure variations in the M-H hysteresis loop around the circumference of the disc. These measurements are necessary to test the uniformity of the manufacturing process.

Quad Group Inc. sells an M-H hysteresis loop tester that measures the M-H hysteresis loop characteristics of the surface of the magnetic film by using the Kerr effect. It cannot detect the additional magnetization below the surface of a magnetic film coating. Therefore, this M-H hysteresis loop tester cannot determine the magnetization x thickness product, which is important to control in a manufacturing process. The other types of instruments listed above, including this invention, actually measures the magnetization x thickness product. This invention, however, cannot at its present stage of development, accurately measure the squareness, M_r/M_s. Although this is an important parameter, it does not typically vary much for a given manufacturing process on a day-to-day basis.

SUMMARY OF THE INVENTION

The present invention has several advantages. It is an apparatus and method for accurately measuring the M-H hysteresis loop properties, especially M_r and H_c, of a disc without destroying the disc. The testing of entire discs instead of samples cut from the disc eliminates inaccuracies caused by cutting. Also, the elimination of cut samples reduces the time required to measure the M-H hysteresis loop. Also, the invention permits easy and quick measurements of variations in the M-H hysteresis loop around the circumference of the disc.

Therefore an object of the invention is to accurately measure the M-H hysteresis loop properties of a disc without damaging the disc.

Another object of the invention is to accurately measure the M-H hysteresis loop property of a disc around the circumference of the disc.

The invention is an apparatus and a method for accurately measuring the M-H hysteresis loop properties of a disc. The apparatus has a magnetic core and several balanced drive coils to produce a large drive magnetic field to magnetize the sample. A sense coil located in the center of the magnetic core produces a voltage signal proportional to the rate of change of magnetic flux passing through it. As shown by the equation $V=N_2 d\Phi/dt$ where N_2 is the number of turns in the sense winding 1-9 and $d\Phi/dt$ is the time rate of change in magnetic flux. The components of drive magnetic flux cancel each other out in the center leg of the magnetic core. Thus, the sense coil does not detect them. The symmetrical magnetic core contains two gaps with identical characteristics. The disc under test is placed adjacent to one gap. A change in magnetization of the disc changes the magnetic flux in the center leg of the magnetic core. A sense coil located on the center leg of the magnetic core detects the magnetic flux change