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DESCRIPTION

Selective influencing of oscillation in fine or micromechanical cantilever sytems

Area of the invention

The invention presented refers to a means for the selective influencing of natural oscillation in fine and micromechanical cantilever systems. In particular, the invention refers to magnet head suspension systems in magnetic disk drives.

Background to the invention

Magnetic disk drives which use a transducer mounted on a slider for reading and/or writing data to at least one rotating magnetic disk are generally known. In such systems, the slider is normally coupled using a suspension system to an actuator arm. A suspension system normally consists of the base plate which creates the connection to the actuator, the actual suspension arm (loadbeam) and the gimbal, a flexible connecting element to the slider. The suspension is normally designed in steel.

The use of laminated materials is also known in the manufacture of slider suspension systems (see US-A-4,996,623 and US-A-4,761,699).

In addition it is also known that oscillations in the arm and the suspension in magnetic disk drives can produce undesired effects such as departing from the read/write track or variations in the distance between the slider and the disk.

These oscillations occur due to the resonance phenomena at certain natural frequencies of the slider. In this, extreme mechanical influences through the drive, air flow, etc. play a part. When resonance phenomena are excited, the whole structure (suspension) is deformed in wave-type movements, so-called oscillation modes.

The aim of a so-called "modal analysis" is to characterise the dynamic characteristics of the system. The modal parameters of resonance frequency, damping and form of the modes can be established experimentally or through finite-element simulation.

One known possibility for reducing such oscillations is to bring an elastico-viscous material into the suspension system supporting the slider (see US-A-4,760,478, amongst others), whereby oscillation energy is converted to heat.

To damp undesired oscillations, so-called "constrained layers" can also be used (see US-A-5,606,477).

With the increasing storage density in information storage media such as magnetic disk drives, the necessity for slider suspension systems which reduce oscillations to a minimum is increasing.

State of technology

US-A-5,572,387 describes a "Head Suspension Assembly" where the loadbeam is at least partly equipped with an elasto-viscous coating in order to dampen oscillations.

In US-A-5,606,477, a slider suspension system is described which has a laminated suspension where the laminate is a conductive layer consisting of a copper alloy, a dielectric poly-

imide layer and a strengthening layer of special steel. A pattern of "land areas" is etched into the conductive layer, which function as a constraining area for the elasto-viscous dielectric layer. This construction damps existing oscillations in the suspension system.

Solutions known in the current state of technology have the disadvantage that although they damp oscillations they are unable selectively to influence natural oscillations (characterised by resonance frequencies and the shape of modes). In this way, the oscillation modes in normal systems are already established by the form and material of the suspension. However, if one changes, for example, the external form in order to achieve an effect on oscillation modes, there is the danger that one will simultaneously inadvertently affect the air flow. Conversely, this can lead to a changed excitation of oscillations.

A need thus exists to selectively prevent undesired natural oscillations in the suspension.

A further need exists to be able to carry out a control of the oscillation modes without changing the basic material and geometric form of the suspension.

Summary

According to an aspect of the present invention, there is provided a suspension system comprising:

a load beam;

a gimbal for receiving a transducer element; and

a structure hardened surface attached to the load beam, the hardened surface comprising a thin film material having a hardness and being adhesive to the load beam.

According to another aspect of the present invention, there is provided a data storage system comprising:

a load beam;

a gimbal for receiving a transducer element; and

a structure hardened attached to the load beam, the hardened surface comprising a thin film material having a hardness and being adhesive to the load beam;

a transducer element attached to the gimbal;

a data recording media located proximate to the transducer element;

a media movement device for moving the media; and

a transducer movement device for moving the transducer element relative to the media.

Advantageously, embodiments of the invention may be realisable without problem for fine or micromechanical systems using normal coating and photolithographic processes.

Brief description of the drawings

In the following, certain embodiments of the invention are explained using drawings in connection with slider suspensions for magnetic disk drives.

The drawings show:

Fig. 1A	a schematic diagram of a suspension system as an overview
Fig. 1B	the same suspension system as a side view
Fig. 2	two examples for oscillation modes which can affect the read signal and
Figs. 3A and 3B	a schematic diagram of a suspension system modified according to the invention.

Description of the invention

Embodiments of the invention are not limited to magnetic head suspension systems for magnetic disk drives and can be used generally for fine and micromechanical systems such as cantilevers, as used in scanning probe microscopy. For the sake of simplicity, however, the description that follows is in terms of magnetic suspension systems.

Fig. 1 shows a schematic diagram of the structure of a suspension system 2. Basically, it consists of the suspension arm 4, a cardanic suspension 6 (gimbal) and the base plate 8. This is used as a connection element between the actuator arm (not shown) and the magnet head suspension 2. The suspension arm is the backbone of this suspension. The magnet head 10 is cardanically suspended at the end of the arm.

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The natural frequencies of the suspension are given by the use of certain materials and the geometry. In the most unfavourable case, these natural oscillations are excited by other components of the overall system such as the drive. As a result, this leads to resonance which can lead to faulty read/write behaviour and, in the worst case, to the failure of the whole system.

One example of such oscillation states is shown in Fig. 2. In this, fig. 2a shows the "out-of-plane" mode and Fig. 2b shows the "in-plane" mode (from C. Denis Mee and Eric D. Daniels, "Magnetic recording", Vol. 2, page 45, New York 1988).

In order selectively to influence these natural oscillations therefore, a structured hard material layer is applied. This means that the whole suspension does not necessarily have to be coated with this hard material layer but that a more or less large area of the suspension has to be coated according to the existing oscillations. An example of this is shown in Fig. 3a. Here, the suspension arm is coated with the hard material 12 in stripes. From the side view shown in Fig. 3b it can be seen that the geometry is unaffected by the application of the hard material layer.

In this way, the existing natural oscillations in the suspension can be selectively influenced or translated as the material characteristics and the spring rate of the suspension change through the application of the hard material layer.

The hard material layer consists of a thin film of great hardness and good adhesive force so that it can be applied to the magnet head suspension in such a way that it is not loosened through normal stresses.

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Possible materials for the hard material layer in the invention are adamantine carbon such as nitrides and carbides, particularly TiN and BN.

By the structured application of this layer, the natural frequencies of the slider suspension are selectively translated. This can be done as required, i.e. depending on which of the natural frequencies is critical for the special system. Equally, the form of the oscillation modes can be influenced by the structure so that the locations of the oscillation bulges can generally be moved to a non-critical range. Even different modes can be affected in different ways by non-isotropic structuring. The thickness of the thin film layer normally moves in the range of approx. 10 - 100 nm.

Particular advantages of this invention are offered by a monolithic integration of slider and suspension as will be required in increasing future miniaturisation in storage systems. Here the hard material layers which are applied to the slider to minimise wear can be structured so that in a second function they can selectively influence the oscillations.

An additional application of the described procedure can be found in the application in a scanning probe cantilever, whose natural frequency and oscillation modes represent critical parameters for certain applications and which can be generally adapted using the described procedure.

CLAIMS

1. A suspension system comprising:

a load beam;

a gimbal for receiving a transducer element; and

a structure hardened surface attached to the load beam, the hardened surface comprising a thin film material having a hardness and being adhesive to the load beam.

2. The system of claim 1, wherein the hardened surface overlies only a portion of the load beam.

3. The system of claim 1, further comprising a slider having the transducer element connected to the gimbal.

4. The system of claim 1, wherein the hardened surface consists of a material selected from the group containing nitrides, carbides, and adamantine carbon.

5. The system of claim 4, wherein the hardened surface in TiN or BN.

6. The system of claim 1, wherein the hardened surface has a thickness in the range of 10-100 nanometers.

7. The system of claim 1, wherein the hardened surface comprises a plurality of longitudinal stripe sections.

8. The system of claim 7, wherein the longitudinal stripes comprise three parallel stripes, a first stripe running along the centre longitudinal axis of the load beam, from the base region to the gimbal, the second and third stripes flanking the first stripe and running from the base to an edge of the load beam.

9. A data storage system comprising:

a load beam;

a gimbal for receiving a transducer element; and

a structure hardened surface attached to the load beam, the hardened surface comprising a thin film material having a hardness and being adhesive to the load beam;

a transducer element attached to the gimbal;

a data recording media located proximate to the transducer element;

a media movement device for moving the media; and

a transducer movement device for moving the transducer element relative to the media.

10. The system of claim 9, wherein the hardened surface overlies only a portion of the load beam.

11. The system of claim 9, further comprising a slider having the transducer element connected to the gimbal.

12. The system of claim 9, wherein the hardened surface consists of a material selected from the group containing nitrides, carbides, and adamantine carbon.

13. The system of claim 12, wherein the hardened surface is TiN or BN.

14. The system of claim 9, wherein the hardened surface has a thickness in the range of 10-100 nanometers.

15. The system of claim 9, wherein the hardened surface comprises a plurality of longitudinal stripe sections.

16. The system of claim 15, wherein the longitudinal stripes comprise three parallel stripes, a first stripe running along the center longitudinal axis of the load beam, from the base region to the gimbal, the second and third stripes flanking the first stripe and running from the base to an edge of the load beam.