

Title: Texturing and Electrodeburring of Magnetic Disk Substrate

Technical field:

This invention relates to the mechanical texturing of the nickel-phosphorus, NiP layer of the magnetic disk aluminium substrate and in the same process electrolytically deburring and smoothing the textured surface profile.

Background:

The recording densities of magnetic hard disks are increasing rapidly year after year. With the current technologies in thin film and conventional recording, one of the ways to increase recording density is to decrease the height of the read/write head from the disk surface.

To achieve low flying height capability, a flat and smooth surface morphology is required. However, a perfectly smooth disk surface causes serious stiction problems. A small amount of roughness or texture is formed to overcome the above stiction problem during contact-start-stop operation. The current method of mechanical texturing involves a piled cloth and a slurry of abrasive grains, such as alumina or diamond, pressing on the disk surfaces as the disk is rotating. Texturing of the data zone is also desirable, and it helps to improve and maintain a high magnetic characteristic, besides enabling a thin lubrication layer to be maintained on the finished disk surfaces.

As the prices of computer and computer peripherals are dropping very fast but the hard disk capacities ever increasing, there is a need to find a new method in the magnetic disk manufacturing process that will improve on the present technology, but yet maintain or lower the manufacturing costs.

Object of the invention:

It is a primary object of the invention to provide a new process for texturing the magnetic disk aluminium substrate that combines mechanical texturing with electro-deburring; electro-deburring microscopically smoothen the textured surface to give the surface a consistently regular and smooth profile. This consistently regular texture allows the read/write head to fly closer to the disk surface, and hence increase the present recording densities.

It is another objective to keep the process simple and cost effective.

Summary of the invention:

Texturing and electro-deburring of magnetic disk aluminium substrate comprising of a combination of mechanical texturing with free abrasive and electrolytic deburring and smoothening of the textured surfaces, wherein the disk substrate is made the anode, the texturing tape is made the cathode and passing a current through the electrolyte.

As the texturing tape presses against the rotating disk, some of the abrasive grains become lodged into the piles and mechanically cut the NiP surfaces in the circumferential direction. At the same time, an electro-chemical film forms on the NiP surfaces; the microscopic peaks of the textured surface dissociate at a faster rate and become rounded off, yielding a regular and smoothened surface texture on the NiP layer.

This regular and smoothened surface profile essentially allows the read/write head to fly at less than 25 nm from the disk surface, enhances the magnetic characteristic and allows a thin lubrication layer to remain on the finished disk surfaces.

Brief Description of the Figures:

The accompanying drawings constitute a part of the description of the invention, illustrate and serve to explain the principles of the invention. It is to be understood, however, that the drawings are for purposes of illustration only, and not as a definition of the limits of the invention for which reference should be made to the claims at the end of this description:

Figure 1 shows an embodiment of the combined mechanical and electrolytic texturing process,

Figure 2 shows the various structures of the new conductive texturing tape,

Figure 3 shows the abrasive grains on the bristles, some of which are lodged into the bristles and cutting into the NiP layer of the Al substrate,

Figure 4 shows the irregularity of the textured surface being electrolytically deburred and the surface profile smoothened, and

Figure 5 shows a variation of the combined mechanical and electrolytic texturing process on a single disk substrate.

Description of the Invention:

Figure 1 shows one embodiment of the present invention. Figure 2 shows the various structures of the conductive texturing tape 1. Referring to Figure 1 and 2, the backing cloth 2 or plastic film 2, such as polyethene (PE) or metal film 2, essentially gives the texturing tape 1 its strength and rigidity. The pile fibres 3, substantially less than 5 micron in diameter, are implanted onto an adhesive binder 4 with the aid of an electrostatic field, after which the pile fibres are clipped flat; the piles 3, of length less than 1 mm long, for example, are essentially perpendicular to the backing material. Non-conductive plastic pile materials can be used, such as, polyamide, polyester, polyethene, polyvinyl chloride and so on.

Both the conductive binder 4 and metallised backing cloth/film 2A/conductive backing cloth/film 2B are made the cathode, while the substrate 5 is made the anode. The abrasive grains 6, typically diamond, aluminium oxide or silicon oxide, is mixed in an electrolyte 7, typically a mixture of phosphoric acid, H_3PO_4 , sulphuric acid, H_2SO_4 , texturing coolant and water. As the texturing process machine is started, a continuous stream or spray of the electrolyte and abrasive slurry is directed at or before the texturing region. As the texturing tape feeds at speed S, the texturing head may oscillate at frequency F, while the Al substrate spins at W revolutions per minute on a spindle 8. As Figure 3 shows, some of the abrasive grains 6 become attached to the piles while some of the grains become lodged between the piles and the NiP surface 5; as the process continues, the grains cut into the NiP surface. Many of this grain cutting process occur on a microscopic scale. Such a cutting process yields an irregular cut surface texture, and when two or more cuttings criss-cross, the cut surface texture can be very irregular, often with burrs.

As the electrolyte flows, an electrolytic cell is set up; a viscous film forms at the NiP surface. The film is effectively thinner over micro-peaks and thicker at micro-valleys. The lower electric resistance, shorter diffusion path and higher charge density at the micro-peaks result in a more rapid dissolution, as shown in Figure 4, resulting in micro-deburring and rounding of the micro-peaks of the NiP surface. This micro-smoothing gives the planar disk surfaces a consistently regular and smooth textured profile, substantially of arithmetic roughness Ra less than 10 nm; this enables the read/write head to both overcome the stiction problem during the contact start/stop cycles and allow the head to fly at substantially less than 25 nm from the disk surface, as compared to the current 25 to 50 nm fly height; overcoming the stiction problem means improvement in the drive reliability, while the lower flying height enables higher recording densities. This smooth textured profile also enhances the magnetic characteristics and enables a thin lubrication layer to remain on the finished disk surface.

Figure 5 shows a variation of the above invention. Mechanical texturing with a non-conductive texturing tape 9, similar to those illustrated in Figure 2 but without the conductive or metallised element, presses against the rotating disk surface with a rubber roller 10. As the texturing tape feeds at a constant speed S, a spray of abrasive slurry 11 is directed at or before the texturing region. The newly textured surface rotates over to the electrodeburring region; a conductive texture tape 1 or a porous piece of cloth tape 12 feeding at a slow speed S over a cathode roller, which is pressed against the disk surfaces. A stream or spray of electrolyte 7 is directed at the interface. As described earlier, the micro-peaks dissociate at a faster rate and such micro-deburring and micro-smoothening of the NiP surface produces a consistently regular and smoothened texture on the NiP surfaces.

The texturing tape 1 can be implanted with a uniform layer of fibres 3, or the implantation can follow any particular patterns. Such patterns can be achieved by depositing the adhesive binder onto the backing material 2, 2A, 2B by means of screen printing, after which the fibres 3 are implanted onto the adhesive binder in an electrostatic field.

While only a few embodiments of the present invention have been described and illustrated, it will now be apparent to those skilled in the art that other modifications, improvements and variations can be made to the electro-texturing process of the present invention without departing from the scope or spirit of this invention.

As no additional process is involved, this should not increase the manufacturing costs to any great extent.

Claims:

1. Texturing and electro-deburring of magnetic disk aluminium substrate comprising of a combination of mechanical texturing with free abrasive and electrolytic deburring and smoothening of the textured surfaces, wherein the disk substrate is made the anode, the texturing tape is made the cathode and passing a current through the electrolyte,
2. Texturing and electro-deburring of magnetic disk aluminium substrate as claimed in 1, wherein the planar disk's microscopically textured surfaces are electrolytically deburred and smoothened to give a consistently regular and smooth textured surface profile, substantially of arithmetic roughness of less than 10 nm,
3. Texturing and electro-deburring of magnetic disk aluminium substrate as claimed in 1, wherein the mechanical texturing and electro-deburring and electro-smoothening of the textured surface profile occur at the same time,
4. Texturing and electro-deburring of magnetic disk aluminium substrate as claimed in 1, wherein the texturing tape adhesive binder and/or backing cloth/film are conductive, or wherein one/or both surfaces of the backing cloth/film is metallised and conductive,
5. Texturing and electro-deburring of magnetic disk aluminium substrate as claimed in 2, wherein the consistently regular and smooth textured surface profile enables the read/write head's fly height to be substantially less than 25 nm.
6. Texturing and electro-deburring of magnetic disk aluminium substrate comprising of separate mechanical texturing and electrolytic deburring and smoothening of disk surfaces, wherein mechanical texturing at one region use a non-conductive texturing tape, while electro-deburring and electro-smoothening process at an adjacent region use a conductive texturing tape or a porous cloth tape with a cathode roller.

7. The fibres of the texturing tape can be uniformly implanted onto the backing material or they can be implanted to any particular patterns.