

Description

This invention relates to the prestructuring of thermomagnetic imaging recording members by the impression of patterns of magnetic gradients and, more particularly, to the orientation of such patterns of magnetic gradients.

Reduced to its fundamental elements, thermomagnetography employs a recording member on which to record the image of a document. Recording of the image is obtained by the selective, imagewise demagnetization of portions of the recording document through exposure to radiation which selectively, in imagewise form, raises momentarily the temperature of portions of the recording member to above its Curie temperature. The latent image thus produced is made visible by the application of a magnetic toner which is attached to the magnetized portions of the recording member. A stream of air may be used to help to completely remove the toner from the unmagnetized portions and thus to provide a cleaner background. The process may also involve transferring this toner from the recording member to a receiving member and fixing it on the receiving member to provide a permanent record.

Magnetography in general and useful materials for its implementation are described in US—A—3,555,556 (NACCI).

The prestructuring of the magnetic member through the imposition of a pattern of magnetic gradients is quite important in obtaining a high quality image in thermomagnetography, as it controls to a great extent the toner attraction to the nondemagnetized portions of the magnetic member surface to form the image. In U.S.—A—3,781,903 (Jeffers et al.) is disclosed a correlation between the frequency of the magnetic gradient pattern and the size of the magnetic toner to optimize resolution and contrast aspects of a thermomagnetically produced image.

Image quality tends to deteriorate as one attempts to reproduce finer and finer lines. This can be understood if one considers that the magnetic image has been created by the selective demagnetization of a magnetic member which has a preimposed magnetic structure in its surface. This magnetic structure may be represented as a pattern of parallel closely spaced lines which present maximum toner attraction separated by spaces of no toner attraction. As the frequency of this premagnetization is optimized, toner covers uniformly the magnetic member. When very fine image lines are produced through demagnetization of the prestructured member, magnetic bridging occurs across the small gaps and it is difficult to prevent toner particles from adhering to the demagnetized areas. Because image lines are rarely parallel to the preimposed magnetic lines, this effect appears as a moire pattern on portions of the image. It is desirable, therefore, to provide a method for the elimination of this problem, preferably through improved cleanliness of the toner from the background.

US—A—4,233,382 discloses reproducing graphic information by forming a magnetic image in a premagnetized layer of chromium dioxide, applying uncharged ferromagnetic toner particles to the magnetized portion of the chromium dioxide and transferring electrostatically the toner particles to a substrate.

It is an object of this invention to provide better cleaning of the background areas of the toned thermomagnetic member. It is a further object of this invention to sufficiently clean the background areas of the toned thermomagnetic member, especially when fine line patterns are present, to minimize the presence of moire patterns in the toned image. This object is achieved by the process as described in claim 1.

Fig. 1 is a schematic representation showing parallel lines of flux in a recording member.

Figs. 2A, 2B and 2C are schematic representations showing removal of excess toner from the recording member.

Referring to Figure 1, a magnetic recording member upon which a pattern of magnetic gradients has been imposed is ready for the recording of an image through the imagewise, selective demagnetization of portions of a pattern.

The recording member 20 typically comprises a supporting base 10 on which there is coated a layer 12 of a magnetic recording material. The base 10 may be rigid or flexible, opaque or transparent. Magnetic recording layer 12 comprises fine, preferably acicular, particulate, single domain, hard magnetic matter dispersed in the polymeric binder of low or poor heat conductivity.

Desirably, the material capable of magnetization to the hard, magnetic state will be a particle size of 1 micrometer or under, although particles having a maximum dimension as large as 10 micrometers, such as the chromium dioxide particles described by Arthur, U.S. Patent 2,956,955 can be used. Such particles tend to agglomerate and frequently the individual unit dimensions of any one magnetizable area will have agglomerates in the range of up to about 10 μm . In recording and copying techniques the resolution is limited by the particle size. Accordingly, the smaller and more uniform the particle size of the material to be magnetized the better. Preferably, these particles should have a maximum dimension in the range of 0.1 to 5 micrometers and most especially, .1 to 2 micrometers. The particulate nature of the magnetic material also serves to limit the spread of the heat image by thermal diffusion, particularly when the particles are bound together and to the support with a binder of relatively low conductivity.

The hard magnetizable material must be capable of magnetization such that it exhibits an energy product $(BH)_{\text{max}}$ of .08—8.0 gauss oersteds 10^6 , a remanence B_r of 500 to 21,500 gauss, coercivity H_c of 40 to 6,000 oersteds and Curie point temperature below 1200°C , preferably in the range from 25 to 500°C . Desirably, the magnetiz-

able material should also have as high a saturation magnetization, i.e., flux as high as is possible consistent with the just recited desirable property range.

A particularly outstanding species of the magnetic component genus which can be used in making the recording member for use in the present invention is chromium dioxide (CrO_2). This material can be used in substantially pure form, or modified with one or more reactive elements. The term, chromium dioxide, as used in this application is specifically inclusive of the pure form and the modified forms. Suitable descriptions of both the process of preparation and the compositions which have the necessary properties will be found in the following illustrative list of issued U.S. patents: U.S.P. 2,956,955; U.S.P. 3,117,093; U.S.P. 3,074,778; U.S.P. 3,078,147; U.S.P. 3,278,263; U.S.P. 2,923,683; U.S.P. 2,923,684; U.S.P. 3,034,988; U.S.P. 3,068,176; U.S.P. 2,923,685. For pure CrO_2 the Curie temperature is near 119°C . This varies somewhat depending on the modifiers used in the synthesis of CrO_2 , but Curie temperatures in the range of 70°C to 170°C are easily obtainable with modified CrO_2 .

Chromium dioxide has a relatively low Curie temperature, and when in the desired particulate form has a relatively high coercivity and a relatively high remanence. Finely particulate chromium dioxide further absorbs light uniformly throughout the region of the visible spectrum, i.e., it is black to the exposing light.

Other magnetic materials which can be employed include α -iron carbide and $\alpha\text{-Fe}_2\text{O}_3$.

The imposition of a magnetic pattern may be obtained through any of the ways known in the art. Preferably, a generally rectangular shaped recording member 20 is moved by suitable drive means past the magnetic recording head 22 in the direction of arrow 24 (Figure 2A). As a result the pattern of magnetic lines 26 extending parallel to one side 30 of the recording member are developed thereon. These lines, of course, are not actually visible lines but represent magnetic field strength patterns as shown in Figure 1.

Under the influence of the recording head 22, the recording member is subjected to an alternating magnetic field which is uniform in the direction of side 30 but which, because the recording member travels under the head 22, varies along the direction of side 28, producing a series of magnetized sections 14, 14', 14'', etc. having alternate magnetic poles, or lines 16, 16', 16'' for maximum field intensity corresponding to the alternating magnetic field imposed by the recording head. Typical separation for the lines is 0.0635 mm, but such separation is a function of the frequency of the alternating field in the recording head and the speed of transition of the recording member past the recording head. The optimization of this separation is the subject matter of US-A-3,781,903 referred to above.

Once the magnetic member has cleared the recording head, it carries a pattern 26 of magnetic

lines 16, 16', 16'' between which extends a magnetic field 18. The process of creating such pattern is known as the premagnetization of the magnetic member.

A premagnetized magnetic member 20' may be exposed to an energy source to selectively image-wise raise the temperature of portions of the recording layer 12 to above its Curie point in order to selectively demagnetize such portions. This energy source 32 may be a high intensity lamp in close proximity to the recording layer. Imagewise selective heating may be accomplished by interposing an image carrying target having opaque and transparent sections to shield and expose the recording layer. However, a scanning, modulated laser beam could also be used to selectively raise the temperature of portions of the recording member to the desired level. For a recording layer comprising CrO_2 such temperature would be about 120°C .

Following exposure of the recording member, the now latent magnetic image is made visible through the application of a magnetic toner. Magnetic toners typically contain a magnetic pigment generally encapsulated in a fusible binder. The recording member 20 is driven past the toning or decorating station 34 where toner is applied over the full surface of the member carrying the latent image. Toner particles preferentially adhere to the still magnetized portions and are removed by use of an air stream 40 flowing over the surface of the recording member 20 through an air knife 36 connected to a suction source (not shown), through a pipe 38. The air knife comprises a lip 42 through which air carrying loose toner particles blowing over the surface of the recording member 20 is removed along the path indicated by arrows 40. Regardless of the original orientation of the premagnetization pattern of lines 26'' which consist of the lines remaining following exposure and the selective demagnetization, the premagnetization pattern must now be oriented in the present invention with respect to the air knife lip 42 so that the air flow over surface of the recording member 20 is along the lines 26'' rather than across.

When this orientation was selected and the air flow was along the premagnetization pattern, it was observed that in the reproduction of targets with patterns of groups of progressively finer lines oriented at 90° to each other and parallel to the recording member sides as well as groups of lines forming concentric circles showed a substantial decrease in moire patterns as compared to the same target reproduction when the air flow was perpendicular to the premagnetization pattern.

A wide variety of substrates for receiving the magnetic toner are useful in the present process, particularly those which are electrically conductive, e.g., metals as well as such surfaces as a dielectric containing a catalyst for electroless plating. Preferably the substrate is heated to an elevated temperature prior to the toner transfer step. The general process which forms the pre-

sent invention is an improvement to that disclosed in European Patent Application No. 79100892.3 (EP-A-4383).

To further illustrate the present invention the following examples are provided.

Examples 1 and 2

A Cirtrack (Reg. trademark) plate commercially available from E.I. du Pont de Nemours and Company, comprising a 0.0508 mm polyethylene-terephthalate film sheet on which there is coated a layer of CrO_2 magnetic material in a resin binder, of the type disclosed in US-A-3,929,658, was premagnetized using a recording head having a 0.0508 mm gap. The premagnetization frequency was adjusted to produce 15.75 poles or lines/mm. Premagnetization was obtained using a sine wave input to the head having sufficient magnitude to saturate the magnetic stratum.

Following premagnetization, the plate was cut in half. One half was then rotated 90° with respect to the other and taped back together to form a new plate having premagnetization patterns aligned perpendicular to each other. Two identical test targets were placed on the plate. Exposure occurred in a vacuum frame to insure intimate contact between target and plate. The exposure source was a xenon flash lamp of sufficient intensity to provide 100×10^{-3} joules/ cm^2 on the CrO_2 layer in the uncovered areas.

The targets comprised groups of lines separated by clear spaces, the lines and spaces having decreasing width in each group, as shown in the Table. The line patterns were in duplicate sets oriented at 90° to each other, generally parallel with the sides of the plate. In addition to the straight line patterns, patterns of semicircles were also included comprising lines having a width of 0.381 mm separated by clear spaces having a width of 2.540 mm.

TABLE

Line width (mm)	Clear space separation (mm)
0.1270	0.2286
0.1270	0.3048
0.2032	0.3302
0.2540	0.3810
0.9906	1.1430

Following exposure the plate was mounted on a printing drum which comprised a toner removal station in which a vacuum knife having a 1.5240 mm slot extending for 127 mm (the full width of the plate) was used to remove toner from the exposed areas. Vacuum of 44.45 mm of water was applied to the knife.

Since the two halves which comprise the plate were oriented at 90° to each other, the

premagnetization patterns were in one case parallel to the knife lip and in the other, perpendicular.

Following toning and toner removal from the exposed areas, the toned images were transferred onto preheated copper clad boards of the type used to make printed circuits. Evaluation of the transferred images showed that the plate whose premagnetization pattern was aligned perpendicular to the knife lip had all the circles substantially clear of any bridging by lingering toner particles in the clear spaces. All line patterns parallel to the knife lip were also clean; in the line patterns perpendicular to the knife lip, some bridging between lines was observed in the 0.1270 mm line separated by 0.3048 mm spaces with more bridging shown in the 0.1270 mm lines separated by 0.2286 mm spaces.

In the sample in which the premagnetization pattern was oriented parallel to the knife lip, the circles showed moire patterns due to bridging. Line patterns perpendicular to the knife lip showed bridging all the way up to patterns having 0.2540 mm line widths spaced at 0.3810 mm intervals, while line patterns parallel to the knife lip were substantially clear.

Claims

1. A process for obtaining high resolution of a magnetic toner image created on a recording member containing a pattern of parallel magnetic lines, by contact transferring the toner image from the recording member to a substrate surface and removing excess toner from the toned recording member prior to toner image transfer to the substrate surface by an air flow passing across the surface of the recording member, characterized in that the direction of the air flow is parallel to the magnetic line pattern in the recording member.

2. The process of claim 1 wherein the recording member is moving during application of the toner and the air flow is due to a vacuum knife, applied across the substrate in a traverse direction to the movement of the recording member.

3. The process of claim 2 wherein air flow is due to blowing air from an air knife positioned across the surface of the recording member.

4. The process of claim 1 wherein the substrate surface is electrically conductive.

5. The process of claim 4 wherein the substrate surface is copper.

Patentansprüche

1. Verfahren zur Erzielung einer hohen Auflösung eines magnetischen Tonerbildes, das auf einem Aufzeichnungsmaterial gebildet ist, welches ein Muster von parallelen magnetischen Linien enthält, durch Kontaktübertragung des Tonerbildes vom Aufzeichnungsmaterial auf eine Trägeroberfläche und Entfernung des überschüssigen Toners von dem getonten Aufzeichnungsmaterial durch einen Luftstrom,

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2. The process of claim 1 wherein the recording member is moving during application of the toner and the air flow is due to a vacuum knife, applied across the substrate in a traverse direction to the movement of the recording member.

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Patentansprüche

1. Verfahren zur Erzielung einer hohen Auflösung eines magnetischen Tonerbildes, das auf einem Aufzeichnungsmaterial gebildet ist, welches ein Muster von parallelen magnetischen Linien enthält, durch Kontaktübertragung des Tonerbildes vom Aufzeichnungsmaterial auf eine Trägoberfläche und Entfernung des überschüssigen Toners von dem getonten Aufzeichnungsmaterial durch einen Luftstrom,



der quer über die Oberfläche des Aufzeichnungsmaterials geleitet wird, bevor das Tonerbild auf die Trägeroberfläche übertragen wird, dadurch gekennzeichnet, dass die Richtung des Luftstromes parallel zu dem Muster der magnetischen Linien im Aufzeichnungsmaterial ist.

2. Verfahren nach Anspruch 1, bei dem das Aufzeichnungsmaterial während der Aufbringung des Toners bewegt wird und der Luftstrom durch ein Vakuummesser quer über den Träger in Querrichtung zur Bewegung des Aufzeichnungsmaterials veranlasst wird.

3. Verfahren nach Anspruch 2, bei dem die Luftströmung durch Blasluft aus einem Luftmesser veranlasst wird, das quer über die Oberfläche des Aufzeichnungsmaterials angeordnet ist.

4. Verfahren nach Anspruch 1, bei dem die Trägeroberfläche elektrisch leitend ist.

5. Verfahren nach Anspruch 4, bei dem die Trägeroberfläche Kupfer ist.

Revendications

1. Procédé pour obtenir une haute résolution d'une image de toner magnétique créée sur un

élément d'enregistrement contenant une configuration de lignes magnétiques parallèles, en transférant par contact l'image de toner de l'élément d'enregistrement à une surface de substrat et en enlevant l'excès de toner de l'élément d'enregistrement portant du toner, avant le transfert de l'image de toner à la surface du substrat, par un courant d'air passant le long de la surface de l'élément d'enregistrement, caractérisé par le fait que la direction du courant d'air est parallèle à la configuration de lignes magnétiques dans l'élément d'enregistrement.

2. Procédé selon la revendication 1, dans lequel l'élément d'enregistrement est en mouvement pendant l'application du toner et le courant d'air est dû à une lame de vide appliquée en travers du substrat dans une direction transversale au mouvement de l'élément d'enregistrement.

3. Procédé selon la revendication 2, dans lequel le courant d'air est dû à de l'air soufflé d'une lame d'air placée en travers de la surface de l'élément d'enregistrement.

4. Procédé selon la revendication 1, dans lequel la surface du substrat est conductrice de l'électricité.

5. Procédé selon la revendication 4, dans lequel la surface du substrat est du cuivre.

