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WRITER FOR HUMAN-READABLE EXTREMELY HIGH DENSITY PERMANENT DATA STORAGE

Abstract

A writing device is provided which includes one or more emitters disposed over a tape. The writing device further includes a controller. The controller controls the emitters and instructs the emitters to write one or more pixels of information on the tape.

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Background/Summary

PRIORITY CLAIM [0001] This application claims the priority and benefit of U.S. Provisional Patent Application No. 63/554,677 filed on Feb. 16, 2024, which is incorporated by reference in its entirety.

BACKGROUND

[0002] The story of humanity has been recorded in many forms since the earliest humans walked the planet Earth. Our current understanding of history tells us that early humans lacked meaningful ways to create formal records. Histories of people and places were taught by spoken word from one generation of people to the next. These histories are largely lost now for many reasons. Oral traditions relied on at least one member of a group memorizing the oral tradition, without error, and teaching it to another person in a later generation. Such traditions relied on the survival of particular people to be passed on from one generation to another. These traditions also required that a person transmit the oral tradition to another without error. And further, these traditions required that the oral tradition be shared with a subsequent generation. Any break in the generational chain led to a complete loss of the oral history of the group.

[0003] Over time, language developed such that thoughts and spoken words could be expressed in a written form. Sumerian cuneiform is currently the oldest known written language, which is a series of wedge shaped marks carved into clay tablets. Egyptian hieroglyphs were also an ancient form of written language, which was both carved into various media, such as stones and wood, but was also painted and written on stones, papyrus, and painted, carved, or cast into metal. History knows about these languages and writing systems because some examples of written cuneiform and hieroglyphs survived through time to today. Ancient peoples realized that written language was a far better way to record their stories and history than passing histories from one generation to the next orally. With the advent of written language, oral histories were, in some cases, transcribed into written histories that could endure longer than their human carriers would live.

[0004] For thousands of years, humans relied on written texts to write their histories though methods other than carving, casting, and painting were developed. For example, new writing surfaces were invented, such as parchment and paper which were far easier to store than stone tablets. Many of the histories written on stone tablets were transcribed into a new format on paper or parchment to continue the history of people. In other words, as the storage medium for written language transformed from clay and stone to parchment and paper, written language was easier to store for many civilizations. Libraries were created to care for and maintain these records to maintain all of the histories that could be maintained.

[0005] Paper and parchment, in ancient times, were expensive commodities. Frequently, only one version of a book or a history was created and maintained in a library or a personal collection. Further, and unfortunately, paper and parchment are far less durable than stone. Fires and floods through years upon years of history destroyed many libraries and many histories that were the only ones of their kind, resulting in histories that were lost forever. While many parchment and paper books and histories did survive, many have been edited, mis-translated, mis-transcribed, or incorrectly interpreted for various reasons, including negligence, intentional changes, incompetence, and in some cases malevolence during re-transcription due to aging of the parchment and paper books. Other books and histories were censored for their content, in many cases. In either case, information in these documents was lost.

[0006] With the invention of the printing press, books became much easier to print in quantity which increased the likelihood of survival for many books. And, until very recently, printed books were how humans stored their histories and stories. When the transistor was invented, digital storage became a reality. Digital storage solved many of the storage issues for information. Instead of needing great buildings to house paper and parchment, a single memory storage could maintain more information than ever was stored in those great buildings and made that information accessible to anyone who desired access to it. Digital storage on magnetic tapes and disks, optical storage discs, semiconductor storage, and solid state storage media require little physical space to store high volumes of information.

[0007] Digital storage was as transformative to information storage as paper and parchment were to clay tablets. Digital storage has made information of any kind simple to obtain through the Internet, which was not possible even 50 years ago. More written information is generated now than has ever been generated in the history of humanity. While digital storage has had a massive effect on humanity, digital storage is still limited. For example, information stored in digital storage devices, are encoded, and stored in a manner that is virtually incomprehensible to all but the most technologically savvy of human beings, if that information could be obtained by those human beings at all. The weakness of digital storage is that digital storage requires machines to pull the stored information and provide it to a human being in a human-readable format. A human being cannot simply read information contained on an optical disc or a magnetic disk without a machine that is programmed to transfer different elements of the optical disc or magnetic disk into a human-readable form. For this reason, more than the simple storage of digital information is necessary to maintain digital information. The machines programmed to read digital information must also be maintained to provide a meaningful storage of information that can last through time. Digital information within a device that cannot access power or is somehow damaged, may be unrecoverable.

[0008] For this reason, there is a need to write information in a physically small footprint or package while also maintaining the information in a human readable form. To solve this need, a new type of writing technique is needed to write information on a new storage device in a human-readable form.

[0009] It is therefore one object of this disclosure to provide writing device to write on storage media on a microscopic level and in a human readable format. It is further an object of this disclosure to provide a writing device to write on a storage device which contains storage media that is both human readable, readily replicated, and easily stored.

SUMMARY OF THE DISCLOSURE

[0010] Disclosed herein a writing device for writing on a non-magnetic or optical tape. The writing device includes one or more emitters disposed over a tape. The writing device further includes a controller which controls the one or more emitters. The one or more emitters are configured to write one or more pixels of information on the tape.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Non-limiting and non-exhaustive implementations of the disclosure are described with reference to the following figures, wherein like reference numerals refer to like parts throughout the various views unless otherwise specified. The advantages of the disclosure will become better understood with regard to the following description and accompanying drawings where:

[0012] FIG. **1** illustrates a prior art atomic microscopy tip.

[0013] FIG. **2** illustrates a field-emissive emitter.

[0014] FIG. **3** illustrates a writing device incorporating a plurality of emitters.

[0015] FIG. **4** illustrates a storage device after being written on by the atomic microscopy tip.

[0016] FIG. **5** illustrates a controller for the writing device.

DETAILED DESCRIPTION

[0017] In the following description of the disclosure, reference is made to the accompanying drawings, which form a part hereof, and which are shown by way of illustration-specific implementations in which the disclosure may be practiced. It is understood that other implementations may be utilized, and structural changes may be made without departing from the scope of the disclosure.

[0018] In the following description, for purposes of explanation and not limitation, specific techniques and embodiments are set forth, such as particular techniques and configurations, in order to provide a thorough understanding of the device disclosed herein. While the techniques and embodiments will primarily be described in context with the accompanying drawings, those skilled in the art will further appreciate that the techniques and embodiments may also be practiced in other similar devices.

[0019] Reference will now be made in detail to the exemplary embodiments, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used throughout the drawings to refer to the same or like parts. It is further noted that elements disclosed with respect to particular embodiments are not restricted to only those embodiments in which they are described. For example, an element described in reference to one embodiment or figure may be alternatively included in another embodiment or figure regardless of whether or not those elements are shown or described in another embodiment or figure. In other words, elements in the figures may be interchangeable between various embodiments disclosed herein, whether shown or not.

[0020] FIG. **1** illustrates a prior art atomic microscopy tip **100**. Tip **100** is a conventional atomic force microscopy (“AFM”) or atomic tunneling microscope (“ATM” tip. Tip **100** is typically formed with a silicon, silicon nitride, or polycrystalline tungsten structure to form a cantilever **105**, a pyramidal or conical tip **110** which ends at a vertex **115**. Tip **100** is fashioned to produce a high intensity e-beam or another extremely high-resolution energy beam in an AFM microscope or in an ATM microscope to scan a sample on a microscopic level.

[0021] FIG. **2** illustrates a field-emissive emitter **200**, arranged in an array **205** as a field emission display (“FED”) and having a plurality of individual microtips, **210**A, **210**B, **210**C, **210**D, **210**E, **210**F, **210**G, and **210**H. Microtips **210**A-**210**H may further be fashioned of silicon, silicon nitride, tungsten polycrystalline structures, metals, metal alloys, or any other material known in the art. Microtips **210**A-**210**H may be arranged on an electrically resistive layer **215** in an organized pattern, as will be discussed below. Electrically resistive layer **215** may be formed with any material that does not conduct electricity, which can include materials such as rubber, glass, plastics, crystal structures, or any other non-conductive material known in the art. Resistive layer **215** may be disposed on a cathode conductor layer **220** which may be an electrically conductive material for transferring electrical energy to or from microtips **210**A-**210**H, depending on a type of scanning operation being performed at any particular time, using any of a scanning electron microscope (“SEM”), tunneling electron microscope (“TEM”), focused ion beam (“FIB”), positron emission tomography (“PET”), or an AFM/ATM device. Cathode conductor layer **225** may further be disposed on a glass layer **225**, such that cathode layer **220** is insulated between resistive layer **215** and glass layer **225**.

[0022] Array **205** is illustrated as having 8 microtips, microtips **210**A-**210**H. However, neither this disclosure nor FIG. **2** is intended to limit the number of microtips used in array **205**. While it is preferable that the number of microtips implemented in array **205** have an even number, it is not required for operation of array **205**. As shown in FIG. **2**, microtips **210**A-**210**H are arranged in columns **230**A-**230**D and rows **235**A-**235**B. For example, column **230**A includes microtip **210**A and microtip **210**B. Column **230**B includes microtip **210**C and microtip **210**D. Column **230**C includes microtip **210**E and microtip **210**F. Column **230**D includes microtip **210**G and microtip **210**H. Similarly, and for example, row **235**A may include microtip **210**A, microtip **210**C, microtip **210**E, and microtip **210**G. Row **235**B, may include microtip **210**B, microtip **210**D, microtip **210**F, and microtip **210**H. Microtips **210**A-**210**H may be so organized in any number to be associated with a particular row and column. In this manner, each one of the plurality of microtips **210**A-**210**H may be individually excited to cause the one of the plurality of microtips **210**A-**210**H to emit energy to write on a storage device.

[0023] FIG. **3** illustrates a writing device **300**. As shown in FIG. **3**, writing device **300** is illustrated as using multiple emitters, emitter **305**A, emitter **305**B, and emitter **305**C. Any number of emitters is possible, although FIG. **3** illustrates three emitters, emitter **305**A, emitter **305**B, and emitter **305**C. It is also noted, however, that a single emitter, such as emitter **305**A could be implemented in writing device **300**, and incorporating field-emissive emitter **200**, shown in FIG. **2**. Each of emitters **305**A-**305**C may emit an energy beam **310**A-**310**C. A type of energy beam **310**A-**310**C may depend on a type of emitter **305**A-**305**C associated with a particular type of microscope device, such as SEM, TEM, FIB, PET, AFM, or ATM. Each emitter **305**A-**305**C may be focused and configured to write on a storage device **315**. Further, each emitter **305**A-**305**C may be directed by controller **320** to write information in a certain part of storage device **315**, as will be described below.

[0024] With respect to FIGS. **2** and **3**, an e-beam, a high-resolution energy beam, or an AFM/AFM microtip, such as microtips **210**A-**210**H, emitted by one or more of emitters **305**A-**305**C may write on a recording layer **410** of a storage device **315**. Storage device **315** may be implemented as a ½″ tape, which are commonly available in devices including a cassette, a VHS cassette, an 8-Track cassette, a reel to reel tape, or others. While these tapes are intended to be used for magnetic data storage, writing device **300** is non-magnetic and does not rely on the tapes in these devices being magnetic.

[0025] Writing device **300** may emit an energy beam from one or a plurality of beam emitters **305**A-**305**C or cause energy to be emitted from field-emissive emitter **200**. Each one of emitters **305**A-**305**C, and each one of microtips **210**A-**210**H may be individually controllable in terms of energy intensity (for emitters **305**A-**305**C) or for penetration (for microtips **210**A-**210**H) In this manner, each one of emitters **305**A-**305**C or microtips **210**A-**210**H may individually write at least part of one pixel on a recording layer **410** of a storage device. The pixels may be implemented in variable sizes in the storage device or may be uniform, facilitating halftone processes which have historically been used in printing black and white newspaper pictures. Beam emitters **305**A-**305**C or field-emissive emitter **200** may be sized to be as wide as a tape in a storage device. For example, beam emitters **305-305**C may write at a width of one half of an inch on a one half inch tape storage device. Likewise, field-emissive emitter **200** may incorporate microtips **210**A-**210**H to have a width of one half of an inch to write on a one half inch tape storage device. The application of an energy beam **310**A-**310**C directly or via field-emissive emitter **200** may form permanent alterations in the recording layer **410** of tape **400** in storage device **315**. The permanent alterations in the recording layer **410** of tape **400** in storage device **315** may further be permanent alterations in physical or optical properties of the recording layer **410** of tape **400** in storage device **315**.

[0026] Beam emitters **305**A-**305**C and/or field-emissive emitter **200** may be manufactured by manufacturing processes frequently used with the manufacturing of semiconductors. In this manner, assuming a character size of 100 nm for a written character, an array of 125,000 emitters or microtips may write across a width of tape **400** in storage device **315** in 1 nm increments. The resolution of these characters is set in 1 nm increments (e.g., pixels), giving a pixel resolution of 1 nm in an X-Y plane of storage device **315**. Tape **400** in storage device **315** may be advanced by 1 nm to write a next set of pixels across a width of tape **400** in storage device **315**. A standard “linear tape open” (“LTO”) storage device includes approximately 960 meters of tape. At a character size of 100 nm, a single LTO storage device could store up to 6.583×10.sup.13 characters, which is approximately equivalent to the contents of the United States Library of Congress. At a write speed of 1 row of pixels each 10 microseconds (10 μs), a full row of 68.57 million characters could be written across tape **400** of storage device **315** every 100 milliseconds (100 ms). Writing an entire LTO storage device would take 27 hours. However, using an array of 125,000 emitters or tips to write across tape **400** of storage device **315**, would increase the speed of writing by 125,000 times to approximately 0.7776 seconds.

[0027] Further, while each character having a size of 100 nm is too small for the human eye to see, microscopy techniques allow for the contents of tape **400** to be displayed through a lens or a screen associated with the microscopy device. In this manner, text may be written onto storage device **315** using plain language text (in any language) such that, when magnified, the written text may be read and understood by any person who is fluent in the written language.

[0028] FIG. **4** illustrates storage device **315** with information contained within storage device **315**. Storage device **315** may be implemented as a magnetic, non-magnetic, or optical tape **400**, having a plurality of layers. Tape **400** includes a lubricant layer **405** which may be optional, a recording layer **410**, an optional adhesion promotion layer **415**, and a mylar substrate layer **420**. Lubricant layer **405** may be disposed on recording layer **115** to provide mechanical lubrication for a magnetic encoding/decoding device. While storage device **315** does not use a magnetic encoding/decoding device, LTO tapes, may be implemented with lubrication layer **405**. However, in a preferable embodiment, a tape **400**, specific to storage device **315** without a lubricant layer **405** may be used. Lubrication layer **405** may have a thickness of approximately 25 nanometers (25 nm) give or take a manufacturing tolerance of 5%. Lubricant layer **405** may be disposed on recording layer **410**. Recording layer **410** may be non-magnetic and implemented using non-magnetic and highly ductile metals such as gold, silver, copper, other metals such as nickel, chrome, aluminum, and others known in the art, metal alloys or certain types of plastics and films. Recording layer **410** may have a thickness of approximately 50 nanometers (50 nm), give or take a manufacturing tolerance of 5%. recording layer **410** may be disposed on an adhesion promotion layer **415** or directly on plastic layer **420**. Plastic layer **420** may be constructed from plastics including polyethylene terephthalate (“PET”-known as Mylar® in the relevant industries), poly-dimethyl siloxane, and other similar plastics known in the art. Adhesion promotion layer **415** may be optional and included in situations where recording layer **410** requires adhesive promotion to bond with PET layer **420** via adhesion promotion layer **415**. PET layer **420** may have a thickness of approximately 5.2 micrometers to 8.9 micrometers (5.2 μm-8.9 μm) and serve as the structural substrate for tape **400** of storage device **315**.

[0029] As shown in FIG. **4**, a plurality of markings have been permanently altered by writing device **300** to encode four individual characters **430**A, **430**B, **430**C, and **430**D in tape **400**. Each one of characters **430**A-**430**D may have a total size as small as 100 nanometers (100 nm) and may comprise one hundred 1 nanometer (1 nm) pixels. Alternatively, each character could be written larger, up to 1 micrometer (1 μm) with 10 nanometer (10 nm) pixels. Character size may vary in a range between 100 nanometers (100 nm) and 1 millimeter (1 mm). Pixel size may vary in a range between 1 nanometer (1 nm) pixels and 1 micrometer (1 μm) pixels. Each pixel may be altered by one or more beam emitter, such as emitters **305**A-**305**C, shown in FIG. **3** or by one or more microtip, such as microtip **210**A-**210**H, shown in FIG. **2**. Characters **430**A-**430**D may be representative of characters, which include Latin characters, Chinese characters, Japanese characters, Korean characters, Cyrillic characters, Arabic characters, or any other characters which are part of a written human language, or any other characters intended to convey meaning.

[0030] Once characters **430**A-**430**D are inscribed within recording layer **410**, they may be read by humans using optical magnification. The use of optical magnification is considered to still be “human-readable” for the purposes of this disclosure. While advanced microscopes, such as a scanning electron microscope (“SEM”), a transmission electron microscope (“TEM”), or an electronic optical microscope may be easier to use for reading characters **430**A-**430**D in recording layer **410**, simple optical magnification may also be sufficient to read characters **430**A-**430**D in recording layer **410**, rendering characters **430**A-**430**D “human-readable” without reliance on a particular machine which may not exist in the future. It is anticipated that storage device could be human-readable for 1000 years or more.

[0031] Simple optical magnification techniques render characters **430**A-**430**D intelligible whether advanced microscope technology is available in the future or not. Further, while storage device **315** would maintain usefulness for an amount of time similar to an optical disc, the information inscribed in storage device **315** is stored in an analog human-readable fashion that does not require a specific machine.

[0032] FIG. **5** illustrates a controller **320** for writing device **300**, shown in FIG. **3**. Controller **320** may receive informational input **500** from another device. For example, a series of books may be provided as informational input **500** in a digital form. Property records may be provided as informational input **500** in a digital form. Any type of information may be extracted from an analog form into a digital form to be written into storage device **315**, shown in FIG. **4**. Once informational input **500** is received by controller **320**, controller **320** may, by processor **520**, perform various operations on informational input **500** to prepare the data for writing onto storage device **315**. For example, a parser **505** may break large sections of informational input **505** data into smaller sections for the purpose of applying physical space parameters of storage device **315**. Parser **505** may determine that writing data representative of a newspaper article on a one half inch tape, such as tape **400** shown in FIG. **4**, is to arrange the writing in horizontally in a certain number of rows and a certain number of columns. As an example, a 1000 word newspaper article may be written as approximately 5000 characters with a size of 1 nm arranged in one row per word along a width (one half inch, for example) of tape **400**. In this manner, parser **505** may determine how to arrange the written data on tape **400** for writing.

[0033] Once informational input **505** is parsed by parser **505**, compiler **510** may determine which characters are to be printed on a particular portion of tape **400**. For example, complier **510** may recognize each letter of each word in each row and generate instructions for which characters to write in a particular row of tape **400**.

[0034] Once the characters for each word are identified by compiler **510**, processor **520** may perform a pixelate operation **515**. Pixelate operation may be performed in a manner to transform the characters compiled by compiler **510** into a plurality of pixels. For example, a character having a size of 100 nanometers may include one hundred one nanometer pixels from top to bottom. Some of those pixels may be written or not written depending on the character and how the character is located within the 100 nanometer space on tape **400** in a pseudo “dot-matrix” fashion. Pixels associated with each character in each word in each row may be identified by processor **520**.

[0035] Once pixels have been determined, processor **520** may determine a number of available beam emitters **305**A-**305**C or microtips **210**A-**210**H to write each pixel on tape **400**. Processor **520** may execute instructions which cause each one of beam emitters **305***n* (as shown in FIG. **5**—though beam emitters **305***n* could also be considered as microtips **210**A-**210**H depending on the type of beam used) to write an assigned pixel on tape **400**. As each beam emitter **305***n* or microtip **210**A-**210**H writes each pixel, a character is created on tape **400** which creates a word of the exemplary news article on each row of tape **400**. A beam emitter **305** or microtip **210**A-**210**H may write part of a pixel or a full pixel, depending on how a character is intended to be written on tape **400**. For example, certain halftone processes may be used to create a black and white character or write a black and white picture out of a certain arrangement of pixels.

[0036] Other arrangements could be made, depending on how parser **505** parses informational input **500**. For example, a series of newspaper articles may be best written horizontally along a length of tape **400**. For example, every newspaper article written by a particular newspaper between 1900 and 2000 may be written on tape **400** and parser **500** may determine that the articles may be written on tape **400** horizontally across a length of a tape in a first row while every newspaper article from another newspaper written between 1900 and 2000 may be written across a length of a tape in a second row. In this example, compiler **510** may determine the characters needed in each row, which may be then pixelated by processor **510**. Processor **520** may execute instructions to cause beam emitters **305***n* or microtips **210**A-**210**H to write each pixel in each column (the width of each character—100 nm) across a length of tape **400** such that each column is written effectively simultaneously by beam emitters **305**_n_ or microtips **210**A-**210**H. Once a first column of characters is written by beam emitters **305**_n_ or microtips **210**A-**210**H, tape **400** may be advanced by 100 nanometers to a second column of characters to continue writing characters and words in each row.

[0037] These examples are only for the purpose of explanation and are not limiting to specific arrangements of characters or words or writing techniques. These examples are illustrative of various ways controller **320** may cause writing to be performed on tape **400**.

[0038] Although specific implementations of the disclosure have been described and illustrated, the disclosure is not to be limited to the specific forms or arrangements of parts so described and illustrated. The scope of the disclosure is to be defined by the claims appended hereto, any future claims submitted here and in different applications, and their equivalents.

Claims

1. A writing device, the device comprising: one or more emitters disposed over a tape; a controller controlling the one or more emitters and configured to write one or more pixels of information on the tape.

2. The writing device of claim 1, wherein the one or more emitters emits an energy beam into the tape.

3. The writing device of claim 1, wherein the one or more emitters comprises one or more microtips.

4. The writing device of claim 3, wherein the microtips are disposed on a resistive layer.

5. The writing device of claim 4, wherein the resistive layer is disposed on a cathode conductor layer.

6. The writing device of claim 5, wherein the cathode conductor layer is disposed on a glass layer.

7. The writing device of claim 6, wherein the one or more microtips are arranged in rows and columns across one of the one or more emitters and wherein the controller controls each individual one of the one or more emitters.

8. The writing device of claim 1, wherein the controller includes a processor which performs parsing, compiling, and pixelating operations on informational input provided to the controller.

9. The writing device of claim 1, wherein the tape includes a recording layer.

10. The writing device of claim 9, wherein the recording layer is permanently altered by the writing device.

11. The writing device of claim 10, wherein the permanent alternation forms one or more pixels in the recording layer of the tape.

12. The writing device of claim 11, wherein the one or more pixels create one or more characters in the recording layer of the tape.

13. The writing device of claim 9, wherein the tape includes an adhesion promotion layer.

14. The writing device of claim 9, wherein the tape includes a lubricant layer.

15. The writing device of claim 9, wherein the tape includes a substrate layer.

16. The writing device of claim 15, wherein the substrate layer is a plastic layer.

17. The writing device of claim 1, wherein the one or more pixels have a resolution in the range of between 1 nanometer and 1 micrometer.

18. The writing device of claim 17, wherein the one or more pixels are arranged to make a character with a height of between 100 nanometers and 1 millimeter.

19. The writing device of claim 17, wherein the resolution of a character written by the writing device is in a range between 100 nanometers and 1 millimeter.

20. The writing device of claim 1, wherein the tape is disposed in a storage device and is a non-magnetic tape.