

AN INFORMATION OUTPUT DEVICE AND  
A METHOD FOR MANUFACTURING THE SAME

**Cross-Reference To Related Application**

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[0001] This application claims the benefit of priority of Singapore patent application No. 201108787-1, filed 28 November 2011, the content of it being hereby incorporated by reference in its entirety for all purposes.

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**Technical Field**

[0002] Various embodiments relate to an information output device and a method for manufacturing the information output device.

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**Background**

[0003] Conventional consumer packaging, for example for electronics and food and beverage, use passive graphics and texts. For such a packaging, the information conveyed by the packaging remains the same throughout the life of the packaging.

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**Summary**

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[0004] According to an embodiment, an information output device is provided. The information output device may include a substrate, a printed output device arranged on the substrate, the printed output device being configured for outputting information, and a power supply configured to supply power to the printed output device.

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[0005] According to an embodiment, a method for manufacturing an information output device is provided. The method may include providing a substrate, printing an output device on the substrate, the printed output device being configured for outputting information, and providing a power supply, the power supply being configured to supply power to the printed output device.

[0006] According to an embodiment, an information output device is provided. The information output device may include a plurality of substrates, a plurality of printed output devices, wherein each printed output device is arranged on a respective substrate of the plurality of substrates, and wherein each printed output device is configured for outputting information, a coupling structure configured to couple the plurality of substrates to each other, and a power supply configured to supply power to each printed output device.

[0007] According to an embodiment, a method for manufacturing an information output device is provided. The method may include providing a plurality of substrates, printing a respective output device on a respective substrate of the plurality of substrates, the respective printed output device being configured for outputting information, forming a coupling structure configured to couple the plurality of substrates to each other, and providing a power supply, the power supply being configured to supply power to each respective printed output device.

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### **Brief Description of the Drawings**

[0008] In the drawings, like reference characters generally refer to like parts throughout the different views. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. In the following description, various embodiments of the invention are described with reference to the following drawings, in which:

[0009] FIG. 1A shows a schematic block diagram of an information output device, according to various embodiments.

25 [0010] FIG. 1B shows a flow chart illustrating a method for manufacturing an information output device, according to various embodiments.

[0011] FIG. 1C shows a schematic block diagram of an information output device, according to various embodiments.

30 [0012] FIG. 1D shows a flow chart illustrating a method for manufacturing an information output device, according to various embodiments.

[0013] FIG. 2 shows a schematic perspective view of an information output device, according to various embodiments.

[0014] FIG. 3 shows a schematic cross sectional view of an information output device, according to various embodiments.

5 [0015] FIG. 4 shows a schematic block diagram representative of an information output device, according to various embodiments.

[0016] FIG. 5 shows a flow chart illustrating a method for manufacturing an information output device, according to various embodiments.

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### **Detailed Description**

[0017] The following detailed description refers to the accompanying drawings that show, by way of illustration, specific details and embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention. Other embodiments may be utilized and structural, logical, and electrical changes may be made without departing from the scope of the invention. The various embodiments are not necessarily mutually exclusive, as some embodiments can be combined with one or more other embodiments to form new embodiments.

15 20 [0018] Embodiments described in the context of one of the methods or devices are analogously valid for the other method or device. Similarly, embodiments described in the context of a method are analogously valid for a device, and vice versa.

[0019] Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other embodiments. Features that are described in the context of an embodiment may correspondingly be applicable to the other embodiments, even if not explicitly described in these other embodiments. Furthermore, additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or similar feature in the other embodiments.

[0020] In the context of various embodiments, the articles “a”, “an” and “the” as used with regard to a feature or element includes a reference to one or more of the features or elements.

5 [0021] In the context of various embodiments, the phrase “at least substantially” may include “exactly” and a reasonable variance.

[0022] In the context of various embodiments, the term “about” as applied to a numeric value encompasses the exact value and a reasonable variance.

[0023] As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

10 [0024] As used herein, the phrase of the form of “at least one of A or B” may include A or B or both A and B. Correspondingly, the phrase of the form of “at least one of A or B or C”, or including further listed items, may include any and all combinations of one or more of the associated listed items.

[0025] Various embodiments may provide one or more intelligent printed media.

15 [0026] Various embodiments may relate to a fully printed device or a hybrid printed device, and a method for forming the same. The printed device may integrate operably coupled active or functional devices or components, with printed visuals. By the term “fully printed device”, it is meant that the all the functional devices are printed functional devices. In addition, the term “fully printed” when applied to a functional device may  
20 mean that the entire functional device or all parts of the functional device are printed. By the term “hybrid printed device”, it is meant that one or more of the functional devices are printed functional devices. In addition, the term “hybrid printed” when applied to a functional device may mean that one or some parts of the functional device may be printed.

25 [0027] Various embodiments may provide a fully printed or hybrid device or product (e.g. an information output device) integrating operably coupled active or functional devices such as one or more interactive displays with a circuit including multiple functional devices selected from a group consisting of energy storage devices, energy harvesting devices, sensors, switches, capacitors, resistors, inductors, and conducting  
30 traces, etc. For example, the fully or hybrid printed product may be an integrated display including a light emitting film and graphics overlay, with integrated energy storage such

as a battery, an integrated energy harvesting device such as a photovoltaic cell or component, and an integrated sensor. Each functional device (e.g. a power supply, an energy storage device, an energy harvesting device, a sensor, a switch, a processing circuit) may be a fully printed functional device or a hybrid printed functional device. In addition or alternatively, each functional device may be in an arranged form or an assembled form, and which may be provided in the information output device.

[0028] Various embodiments of the printed device may be employed in various applications including interactive consumer packaging, for example interactive consumer packaging for electronic devices and interactive consumer packaging for food and beverage, as well as interactive printed media.

[0029] In order that the invention may be readily understood and put into practical effect, particular embodiments will now be described by way of examples and not limitations, and with reference to the figures.

[0030] FIG. 1A shows a schematic block diagram of an information output device 100, according to various embodiments. The information output device 100 includes a substrate 102, a printed output device 104 arranged on the substrate 102, the printed output device 104 being configured for outputting information, and a power supply 106 configured to supply power to the printed output device 104. In FIG. 1A, the line represented as 108 is illustrated to show the relationship between the substrate 102, the printed output device 104, and the power supply 106, which may include electrical coupling and/or mechanical coupling.

[0031] In other words, the information output device 100 is a device that outputs or conveys information to a user. The device 100 may have a substrate 102 on which the printed output device 104 may be arranged. For example, the printed output device 104 may be printed, using printing technology, on or onto the substrate 102. The power supply 106 supplies power to the printed output device 104, which outputs or conveys information. In various embodiments, the power supply 106 is coupled to the printed output device 104.

[0032] In various embodiments, the printed output device 104 and the power supply 106 may be integrated with each other and/or with the substrate 102. In other words, the printed output device 104 and the power supply 106 may be integral to the device 100.

[0033] In various embodiments, the power supply 106 may include or may be a printed power supply arranged on the substrate 102. For example, the power supply 106 may be printed, using printing technology, on or onto the substrate 102. Therefore, the device 100 may have a single substrate 102 on which the printed output device 104 and the power supply 106 may be printed.

[0034] The information output device 100 may further include a sensor, wherein the printed output device 104 is configured to output the information in response to a signal received from the sensor. The sensor may be arranged on the same substrate 102 as that of the printed output device 104. The sensor may be integrated with the printed output device 104 and/or the power supply 106 and/or with the substrate 102. The sensor may be integral to the device 100. In various embodiments, the sensor may be coupled to the printed output device 104.

[0035] The sensor may include or may be a printed sensor arranged on the substrate 102. For example, the sensor may be printed, using printing technology, on or onto the substrate 102. Therefore, the printed output device 104 and the sensor may be printed on the substrate 102. In various embodiments, the device 100 may have a single substrate 102 on which the printed output device 104, the power supply 106 and the sensor may be printed.

[0036] The sensor may sense or detect an input signal, for example an external stimulus, and may generate an output signal based on the input signal. The output signal may be provided to the printed output device 104 which may then output the information in response to the output signal of the sensor. As non-limiting examples, the printed output device 104 may provide the information when the output signal is received from the sensor, or may provide the relevant information corresponding to the type of output signal received, or may change/alter the information outputted by the printed output device 104 in response to the output signal received, including for example changing the form or format of the information and/or the brightness of the information.

[0037] In various embodiments, the sensor may include at least one of a light sensor or a touch sensor. The light sensor may, for example, detect a change in ambient light intensity so that the printed output device 104 may output the information in a suitable manner, for example increasing the brightness of the information when the ambient light

intensity is low, and conversely, decreasing the brightness of the information when the ambient light intensity is high.

[0038] The touch sensor may, for example, provide a signal for activating the information output device 100 when a user touches the device 100, and the printed output device 104 may then output the information. The printed output device 104 may also change the information outputted in response to a touch by the user. In various embodiments, the touch sensor may include at least one of a resistive touch sensor or a conductive touch sensor or an inductive touch sensor.

[0039] In various embodiments, the power supply 106 may include or may be an energy storage device. The energy storage device stores the energy to be provided to the printed output device 104. The energy storage device may include at least one of a capacitor or a supercapacitor or a battery. The energy storage device may be rechargeable. In a non-limiting example, the energy storage device may be rechargeable via a mains power supply. The energy storage device may also be referred to as a power storage device. In the context of various embodiments, the energy storage device may include or may be a printed energy storage device. The printed energy storage device may be printed on the substrate 102.

[0040] In various embodiments, the printed power supply 106 may include or may be an energy harvesting device. The energy harvesting device may receive one form of energy and converts the energy into another form of energy. For example, the energy harvesting device may convert ambient energy into electrical energy. The energy harvesting device may supply energy which is derived from external sources (for example, solar power, kinetic energy, etc.). The energy harvesting device may include at least one of a photovoltaic cell or a piezoelectric material. The energy harvesting device may also be referred to as a power harvesting device. In various embodiments, the energy harvesting device may also store the energy that is generated. In the context of various embodiments, the energy harvesting device may include or may be a printed energy harvesting device. The printed energy harvesting device may be printed on the substrate 102.

[0041] In various embodiments, the power supply 106 may include at least one of an energy storage device or an energy harvesting device. In embodiments where the power

supply 106 includes an energy storage device and an energy harvesting device, the energy storage device and the energy harvesting device may be coupled to each other. The energy storage device may store the energy harvested by the energy harvesting device.

5 [0042] In various embodiments, the printed output device 104 may include or may be a visual output device. The visual output device may display information, for example in the form of graphics and/or images and/or videos and/or visual perceptions and/or texts.

[0043] In various embodiments, the visual output device may include or may be an interactive visual output device. For example, the visual output device may output information in response to an interaction with a user, for example via touch or a signal  
10 generated by the user received by the interactive visual output device.

[0044] In various embodiments, the visual output device may include a light emitting film. The light emitting film may include an organic material or an inorganic material.

[0045] In various embodiments, the visual output device may include or may be a display, for example a display screen.

15 [0046] In various embodiments, the printed output device 104 may include or may be an acoustic output device. The acoustic output device may output information, for example in the form of an audio signal or sound.

[0047] In various embodiments, the acoustic output device may include or may be a speaker.

20 [0048] In various embodiments, the printed output device 104 may include at least one of a visual output device or an acoustic output device. In various embodiments, the printed output device 104 may be embedded.

[0049] In various embodiments, the substrate 102 may be at least substantially planar or flat. In various embodiments, the substrate 102 may be deformable.

25 [0050] In various embodiments, the substrate 102 may have a thickness of between about 100  $\mu\text{m}$  and about 10 mm, for example between about 100  $\mu\text{m}$  and about 5 mm, between about 100  $\mu\text{m}$  and about 1 mm, between about 100  $\mu\text{m}$  and about 500  $\mu\text{m}$ , between about 100  $\mu\text{m}$  and about 200  $\mu\text{m}$ , between about 500  $\mu\text{m}$  and about 5 mm or between about 1 mm and about 2 mm.

30 [0051] In various embodiments, the substrate 102 may have a length of between about 100 mm and about 10 m, for example between about 100 mm and about 5 m, between

about 100 mm and about 1 m, between about 100 mm and about 500 mm, between about 100 mm and about 200 mm, between about 500 mm and about 10 m, between about 500 mm and about 1 m or between about 1 m and about 3 m.

5 [0052] In various embodiments, the substrate 102 may have a width of between about 100 mm and about 10 m, for example between about 100 mm and about 5 m, between about 100 mm and about 1 m, between about 100 mm and about 500 mm, between about 100 mm and about 200 mm, between about 500 mm and about 10 m, between about 500 mm and about 1 m or between about 1 m and about 3 m.

10 [0053] In various embodiments, the substrate 102 may be of any suitable shape, including but not limited to a square, a rectangle, a circle, an ellipse or a polygon.

[0054] In various embodiments, the substrate 102 may be made of a material including but not limited to a plastic, a polymer, a paper, leather, a suitable packaging material or any other suitable material. In various embodiments, the substrate 102 may be made of a deformable material.

15 [0055] In various embodiments, the printed output device 104 and the power supply 106 may be arranged or printed on a same side of the substrate 102 or on different sides (e.g. opposite sides) of the substrate 102. In various embodiments, the sensor may be arranged or printed on a same side of the substrate 102 or on a different side of the substrate 102, relative to one or both of the printed output device 104 and the power supply 106. In  
20 various embodiments, the energy storage device and the energy harvesting device may be arranged or printed on a same side of the substrate 102 or on different sides of the substrate 102, relative to each other and/or relative to the printed output device 104. In various embodiments, where two or more functional devices are arranged on the same side of the substrate 102, some or all of the functional devices may be arranged or printed  
25 on the same layer and/or on different layers relative to one another.

[0056] In various embodiments, the information output device 100 may further include a processing circuit configured to communicate with the printed output device 104 for outputting the information. In various embodiments, the processing circuit may be arranged on the substrate 102. In various embodiments, the processing circuit may be a  
30 printed circuit arranged on the substrate 102, for example the processing circuit may be printed on the substrate 102. The processing circuit may provide one or more signals to

the printed output device 104. As a non-limiting example, the processing circuit may provide an activation signal to the printed output device 104 to begin outputting information. In various embodiments, the processing circuit is coupled to the printed output device 104.

5 [0057] In addition, the processing circuit may be coupled to at least one of the power supply 106 and/or the sensor. As a non-limiting example, the processing circuit may receive a signal from the sensor and then provide one or more signals to the printed output device 104 in response to the signal received from the sensor. In addition, the processing circuit may process the signal received from the sensor, for example sampling  
10 and/or filtering and/or amplifying the signal. Furthermore, the processing circuit may also provide a switching function and/or an amplifying function for controlling the power supplied by the power supply 106 to the printed output device 104.

[0058] In various embodiments, the information output device 100 may further include a switch or a switching circuit. The switching circuit may be a printed switching circuit. In  
15 various embodiments, the switching circuit may be printed on the substrate 102. The switching circuit may be part of the processing circuit.

[0059] In various embodiments, the information output device 100 may further include at least one of a printed graphic or a printed image or a printed text. The printed graphic and/or the printed image and/or a printed text may be printed on the substrate 102. The  
20 printed graphic and/or the printed image and/or a printed text may be passive.

[0060] In the context of various embodiments, the information output device 100 may be, but not limited to, a consumer packaging (e.g. for electronic devices, for food and beverage), a printed medium, a page of a book, a poster (e.g. a roll-up poster), a floating banner or a wall paper. The information output device 100 may be used for interactive  
25 applications, including for the applications mentioned above.

[0061] In the context of various embodiments, one or more of the functional devices, including but not limited to the power supply 106, the energy storage device, the energy harvesting device, the sensor, the switching circuit, or the processing circuit may be a fully printed functional device or a hybrid printed functional device. In addition or  
30 alternatively, one or more of the functional devices may be in an arranged form or an assembled form, and provided in the information output device 100.

[0062] In the context of various embodiments, it should be appreciated that one or more of the functional devices (e.g. the printed output device 104, the power supply 106 (e.g. the energy storage device and/or the energy harvesting device), the sensor, etc. may be integrated. By the term “integrated”, it is meant that the functional device is formed or provided or printed as part of the information output device 100, for example formed or arranged or printed on the substrate 102. Therefore, the functional device may be integral to the information output device 100. As such, external devices, for example a battery, need not be necessarily provided or connected to the information output device 100, for operation of the information output device 100.

[0063] In the context of various embodiments, a “circuit” may be understood as any kind of a logic implementing entity, which may be special purpose circuitry or a processor executing software stored in a memory, firmware, or any combination thereof. Thus, in an embodiment, a “circuit” may be a hard-wired logic circuit or a programmable logic circuit such as a programmable processor, e.g. a microprocessor (e.g. a Complex Instruction Set Computer (CISC) processor or a Reduced Instruction Set Computer (RISC) processor). A “circuit” may also be a processor executing software, e.g. any kind of computer program, e.g. a computer program using a virtual machine code such as e.g. Java. Any other kind of implementation of the respective functions which will be described in more detail below may also be understood as a ‘circuit’ in accordance with an alternative embodiment.

[0064] In the context of various embodiments, the information output device 100 may include a memory which is for example used in the processing carried out by the information output device 100. A memory used in the embodiments may be a volatile memory, for example a DRAM (Dynamic Random Access Memory) or a non-volatile memory, for example a PROM (Programmable Read Only Memory), an EPROM (Erasable PROM), EEPROM (Electrically Erasable PROM), or a flash memory, e.g., a floating gate memory, a charge trapping memory, an MRAM (Magnetoresistive Random Access Memory) or a PCRAM (Phase Change Random Access Memory). In various embodiments, the memory may be provided as part of the processing circuit.

[0065] FIG. 1B shows a flow chart 120 illustrating a method for manufacturing an information output device, according to various embodiments.

[0066] At 122, a substrate is provided.

[0067] At 124, an output device is printed on the substrate. The printed output device is configured for outputting information.

[0068] At 126, a power supply is provided. The power supply is configured to supply  
5 power to the printed output device.

[0069] In various embodiments, at 126, the power supply may be printed on the substrate.

[0070] In various embodiments, a sensor may be provided. The printed output device may be configured to output the information in response to a signal received from the  
10 sensor. In various embodiments, the sensor may be printed on the substrate.

[0071] In various embodiments, at 126, an energy storage device may be provided. In various embodiments, the energy storage device may be printed on the substrate.

[0072] In various embodiments, at 126, an energy harvesting device may be provided. In various embodiments, the energy harvesting device may be printed on the substrate.

[0073] In the method of various embodiments, it should be appreciated that one or more  
15 features or components or functional devices, including the associated arrangements, as described in the context of the information output device 100 may be formed or provided or printed.

[0074] FIG. 1C shows a schematic block diagram of an information output device 140,  
20 according to various embodiments. The information output device 140 includes a plurality of substrates 142, a plurality of printed output devices 144, wherein each printed output device 144 is arranged on a respective substrate 142 of the plurality of substrates 142, and wherein each printed output device 144 is configured for outputting information, a coupling structure 146 configured to couple the plurality of substrates 142  
25 to each other, and a power supply 148 configured to supply power to each printed output device 144. In FIG. 1C, the line represented as 150 is illustrated to show the relationship between the plurality of substrates 142, the plurality of printed output devices 144, the coupling structure 146 and the power supply 148, which may include electrical coupling and/or mechanical coupling.

[0075] Therefore, the information output device 140 includes a plurality of  
30 substrates 142, where each printed output device 144 may be printed on a separate or

individual substrate 142. Each substrate 142 may include one or more printed output devices 144. Each printed output device 144 may output the same information, or one or more printed output devices 144 may output the same information, or one or more other printed output devices 144 may output different information. Each printed output  
5 device 144 may also output different information.

[0076] The coupling structure 146 may be a printed coupling structure. The coupling structure 146 may be in an arranged form or an assembled form. The coupling structure 146 may be a single structure configured to couple the plurality of substrates 142 to each other. The coupling structure 146 may be arranged on a side or  
10 periphery region of each substrate 142. The coupling structure 146 may allow the plurality of substrates 142 to be arranged in a stack arrangement, one over the other. The coupling structure 146 may allow a substrate 142 to be displaced angularly relative to one or more other substrates 142. In various embodiments, the coupling structure 146 may also be a support structure.

15 [0077] In various embodiments, the power supply 148 may be arranged or formed on at least one of the coupling structure 146 or one of the plurality of substrates. In various embodiments, the power supply 148 may be arranged on the coupling structure 146 and/or each or any one or some of the substrates 142.

[0078] In various embodiments, the power supply 148 may be a printed power supply.

20 [0079] In various embodiments, the power supply 148 may include at least one of an energy storage device or an energy harvesting device. In various embodiments, the energy storage device may be a printed energy storage device. In various embodiments, the energy harvesting device may be a printed energy harvesting device.

[0080] In various embodiments, an energy storage device and/or an energy harvesting  
25 device may be arranged or printed on each substrate 142. In various embodiments, an energy storage device and/or an energy harvesting device may be arranged or printed on the coupling structure 146. In various embodiments, one or more of the plurality of printed output devices 144, for example on different substrates 142, may share a common energy storage device and/or a common energy harvesting device. In various  
30 embodiments, the common energy storage device and/or the common energy harvesting device may be arranged on the coupling structure 146. In various embodiments, one or

more features or components or functional devices, including the associated arrangements, as described in the context of the information output device 100 may be provided in the information output device 140. However, it should be appreciated that various changes in form and detail may be possible. For example, a sensor (e.g. a printed sensor) may be provided on each substrate 142, or on one or more substrates 142. In various embodiments, a common sensor may be provided, for example on the coupling structure 146.

[0081] In various embodiments, the information output device 140 may be a book or may function as a book, where each substrate 142 may be a page of the book. The coupling structure 146 may act as a binder for binding or coupling the separate substrates (pages) 142 together to form the book. Each substrate (page) 142 may be flipped over, about the coupling structure 146, so that any preceding or succeeding page may be shown to a user.

[0082] In various embodiments, where a page 142 is open and viewable by a user, the page 142 may be activated or powered on, for example by the power supply 148, for outputting information, while pages that are not open and/or non-viewable by the user may not be activated or powered on. This may minimize power consumption.

[0083] FIG. 1D shows a flow chart 160 illustrating a method for manufacturing an information output device, according to various embodiments.

[0084] At 162, a plurality of substrates are provided.

[0085] At 164, a respective output device is printed on a respective substrate of the plurality of substrates. The respective printed output device is configured for outputting information.

[0086] At 166, a coupling structure configured to couple the plurality of substrates to each other is formed.

[0087] At 168, a power supply is provided. The power supply is configured to supply power to each respective printed output device.

[0088] In various embodiments, at 168, the power supply may be provided on at least one of the coupling structure or one of the plurality of substrates. In various embodiments, at 168, the power supply may be provided on the coupling structure and/or each or any one or some of the substrates.

[0089] In various embodiments, at 168, the power supply may be printed on at least one of the coupling structure or one of the plurality of substrates.

[0090] In the method of various embodiments, it should be appreciated that one or more features or components of functional devices, including the associated arrangements, as described in the context of the information output device 100 may be formed or provided or printed.

[0091] In the context of various embodiments, the term “information” may include any one of or any combination of a text, a picture, a graphic, an image, a video, a visual perceptions, a visual signal, a sound, and an audio signal.

[0092] In the context of various embodiments, the term “coupled” may include electrical coupling and/or mechanical coupling. In the context of various embodiments, the term “coupled” may include a direct coupling and an indirect coupling. For example, two devices being coupled together may mean that there is a direct coupling path between the two devices and/or there is an indirect coupling path between the two devices, e.g. via one or more intervening devices.

[0093] In the context of various embodiments, the terms “printed”, “printing” and the like, with regard to a device, mean that the device is formed or fabricated by means of a printing process. In various embodiments, the printing process may include but not limited to screen printing, flexography, gravure, offset lithography and inkjet. In the context of various embodiments, the terms “printed”, “printing” and the like, with regard to a device or functional device, may mean a fully printed device or a hybrid printed device.

[0094] The printing process may be carried out layer by layer, where a functional device may be printed on a single layer or through a number of layers, where the number of layers may define the thickness of the device. In addition, different functional devices may be printed on the same layer or on different layers or planes. Furthermore, there may be an overlap between any two devices on at least one of the layers.

[0095] The printing process offers a low cost manufacturing process, as well as allowing bulk manufacturing.

[0096] In the context of various embodiments, the functional devices may be formed or printed using one or more materials including but not limited to a light emitting phosphor,

a conductor, a transparent conductor, a dielectric, a semiconductor, a photovoltaic material, an optoelectronic material, etc.

5 [0097] In the context of various embodiments, it should be appreciated that, other than the printed output device (e.g. 104, 144), any functional device or element may be fully printed or hybrid printed or in an arranged form or an assembled form.

[0098] FIG. 2 shows a schematic perspective view of an information output device 200, according to various embodiments. The information output device 200 includes a plurality of individual information output devices 202. Each information output device 202 may be a printed device or article. The plurality of information output devices 202 may be coupled together to form a compound device or product, i.e. the information output device 200.

15 [0099] In various embodiments, each information output device 202 may be a page or sheet of a book, and the compound product (i.e. the information output device 200) may be a book with multiple ones of the information output device 202 coupled together via a printed support 214, which may also serve as a coupling device or structure for the multiple information output devices 202.

[0100] In various embodiments, the information output device 202 includes at least one integrated light film, at least one integrated graphics overlay, at least one integrated electronic circuit (or processing circuit), at least one integrated energy storage device (e.g. a battery), and at least one integrated energy harvesting device (e.g. a photovoltaic cell). One or more or each of the integrated light film, the integrated graphics overlay, the integrated electronic circuit, the integrated energy storage device, the integrated energy harvesting device may be printed. The integrated graphics overlay may be passive graphics.

25 [0101] The integrated light film and the integrated graphics overlap may be referred to as an output device and as represented by 204 in FIG. 2, which may be an integrated illuminated / animated display with graphics 204. In FIG.2, there is shown an integrated electronic circuit (or processing circuit) 206, an integrated energy storage device (e.g. a battery) 208, an integrated energy harvesting device (e.g. a photovoltaic cell) 210, and an integrated switch/sensor 212, where one or more of these may be printed. There is also shown a printed support or coupler 214 for coupling together the plurality of information

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output devices 202. As shown in FIG. 2, the integrated electronic circuit 206 and the integrated energy storage device 208 may be provided on or with the printed support 214.

[0102] FIG. 3 shows a schematic cross sectional view of an information output device 300, according to various embodiments. The information output device 300 may be the individual information output device 202 of FIG. 2. The information output device 300 may be a fully printed or hybrid integrated functional article.

[0103] The information output device 300 includes a substrate 302, an integrated illuminated / animated display with graphics 304, an integrated photovoltaic cell 306, and an integrated switch / sensor 307, arranged or printed on one side or surface (e.g. top surface) 308 of the substrate 302. The information output device 300 further includes an integrated battery 310 arranged or printed on an opposite side or surface (e.g. bottom surface) 312 of the substrate 302. The information output device 300 may further include electronics or an electronic circuit 314. The electronics 314 may be provided or printed on the substrate 302, for example on the top surface 308 and/or the bottom surface 312, or away from the substrate 302 and electrically coupled by an electrical conductor (e.g. a wire), as represented by 316, to the functional devices on the substrate 302, including the integrated illuminated / animated display with graphics 304, the integrated photovoltaic cell 306, the integrated switch / sensor 307 and the integrated battery 310. While not shown, there may be electrical or conducting traces on the substrate 302, for example on the top surface 308 and/or the bottom surface 312, for electrical coupling among the various functional devices on the substrate 302 as well as with the electronics 314.

[0104] In various embodiments, some of the functional devices may be printed on a substrate such that the functional devices lie on the same layer or plane relative to the substrate. In various embodiments, at least one of the functional devices may be provided on a different layer during the printing process. In various embodiments, at least one of the functional devices may be provided on a different side of the substrate, for example as illustrated in FIG. 3 where the integrated battery 310 is printed on the side 312 of the substrate 302 opposing the side 308 bearing the other printed functional devices.

[0105] In various embodiments, optionally, some or all of the electronics (e.g. 314) operably coupled to the functional printed devices (e.g. 304, 306, 307, 310) may be

provided away from the substrate (e.g. 302). Optionally, this may include having the electronics (e.g. 314) provided in or on a support or a coupler/coupling structure.

[0106] In various embodiments where the fully printed or hybrid integrated device or article is a book or other portable medium suitable for displaying or outputting  
5 information, for example in the form of one or more of data, text, graphics, or videos, etc., the electronics may be provided where the spine (e.g. coupling structure) of the book is located, for example, to one side of the fully printed or hybrid integrated functional article, in a size and shape suitable for easy handling by a user.

[0107] FIG. 4 shows a schematic block diagram representative of an information output  
10 device 400, according to various embodiments. The information output device 400 may be representative of the information output device 200 (FIG. 2), 202 (FIG. 2), 300 (FIG. 3). As illustrated in FIG. 4, a photovoltaic cell 402 may be operably coupled to a battery 404, which may be operably coupled to electronics or a processing circuit 406 that may be configured to receive one or more inputs from a sensor 408. The electronics 406  
15 may also be operably coupled to a display (output device) 410 that may be configured to provide or change visually perceptible visuals, graphics, or text, in response to the input received from the sensor 408. Each of, or one or more of the photovoltaic cell 402, the battery 404, the electronics 406, the sensor 408 or the display 410 may be a printed functional device and/or integrated with the information output device 400.

20 [0108] FIG. 5 shows a flow chart 500 illustrating a method for manufacturing an information output device, according to various embodiments.

[0109] At 502, printed graphics are provided. The printed graphics may be passive graphics.

[0110] At 504, a printed display is provided.

25 [0111] At 506, a printed sensor is provided.

[0112] At 508, a printed battery is provided.

[0113] At 510, a printed photovoltaic cell is provided.

[0114] At 512, an electronic circuit or a processing circuit may be provided. In addition,  
30 at 512, electronics integration may be carried out to electrically couple the printed display, the printed sensor, the printed battery, the printed photovoltaic cell and the processing circuit to each other.

[0115] At 514, a lamination process may be carried out. For example, this may include forming a protective cover.

[0116] In various embodiments, the printed graphics, the printed display, the printed sensor, the printed battery, and the printed photovoltaic cell may be printed on a single  
5 substrate. In various embodiments, the processing circuit may be provided on the same substrate or away from the substrate. The processing circuit may be a printed circuit.

[0117] It should be appreciated that the printed graphics, the printed display, the printed sensor, the printed battery, and the printed photovoltaic cell may be printed in any order.

[0118] The method, having the steps of 502 to 514 may form an information output  
10 device (e.g. an intelligent printed medium). The intelligent printed medium may for example be employed as a page of a book. In various embodiments, the steps of 502 to 514 may be repeated to form a plurality of such book pages. As such, for example, at 516, printed book pages may be provided. The printed book pages may be subjected to a lamination process at 514. Therefore, intelligent printed media may be formed. In various  
15 embodiments, the printed book pages may be coupled together using a coupling structure to form a book.

[0119] While the invention has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and  
20 scope of the invention as defined by the appended claims. The scope of the invention is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.

## CLAIMS

1. An information output device comprising:  
a substrate;  
5 a printed output device arranged on the substrate, the printed output device being configured for outputting information; and  
a power supply configured to supply power to the printed output device.
2. The information output device as claimed in claim 1, wherein the power supply  
10 comprises a printed power supply arranged on the substrate.
3. The information output device as claimed in claim 1 or 2, further comprising a sensor, wherein the printed output device is configured to output the information in response to a signal received from the sensor.  
15
4. The information output device as claimed in claim 3, wherein the sensor comprises a printed sensor arranged on the substrate.
5. The information output device as claimed in any one of claims 1 to 4, wherein the  
20 power supply comprises an energy storage device.
6. The information output device as claimed in any one of claims 1 to 5, wherein the power supply comprises an energy harvesting device.
- 25 7. The information output device as claimed in any one of claims 1 to 6, wherein the printed output device comprises a visual output device.
8. The information output device as claimed in any one of claims 1 to 7, wherein the  
30 printed output device comprises an acoustic output device.

9. The information output device as claimed in any one of claims 1 to 8, wherein the substrate is at least substantially planar.

10. The information output device as claimed in any one of claims 1 to 9, further  
5 comprising a processing circuit configured to communicate with the printed output device for outputting the information.

11. A method for manufacturing an information output device, the method comprising:

10 providing a substrate;  
printing an output device on the substrate, the printed output device being configured for outputting information; and  
providing a power supply, the power supply being configured to supply power to the printed output device.

15 12. The method as claimed in claim 11, wherein providing a power supply comprises printing the power supply on the substrate.

13. The method as claimed in claim 11 or 12, further comprising providing a sensor,  
20 wherein the printed output device is configured to output the information in response to a signal received from the sensor.

14. The method as claimed in claim 13, wherein providing a sensor comprises printing the sensor on the substrate.

25 15. An information output device, the device comprising:  
a plurality of substrates;  
a plurality of printed output devices, wherein each printed output device is arranged on a respective substrate of the plurality of substrates, and wherein each printed  
30 output device is configured for outputting information;

a coupling structure configured to couple the plurality of substrates to each other;  
and

a power supply configured to supply power to each printed output device.

5 16. The information output device as claimed in claim 15, wherein the power supply is arranged on at least one of the coupling structure or one of the plurality of substrates.

17. The information output device as claimed in claim 15 or 16, wherein the power supply is a printed power supply.

10

18. A method for manufacturing an information output device, the method comprising:

providing a plurality of substrates;

15 printing a respective output device on a respective substrate of the plurality of substrates, the respective printed output device being configured for outputting information;

forming a coupling structure configured to couple the plurality of substrates to each other; and

20 providing a power supply, the power supply being configured to supply power to each respective printed output device.

19. The method as claimed in claim 18, wherein providing a power supply comprises providing the power supply on at least one of the coupling structure or one of the plurality of substrates.

25

20. The method as claimed in claim 18 or 19, wherein providing a power supply comprises printing the power supply on at least one of the coupling structure or one of the plurality of substrates.