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(54) **SENSOR MANUFACTURE WITH DATA STORAGE**

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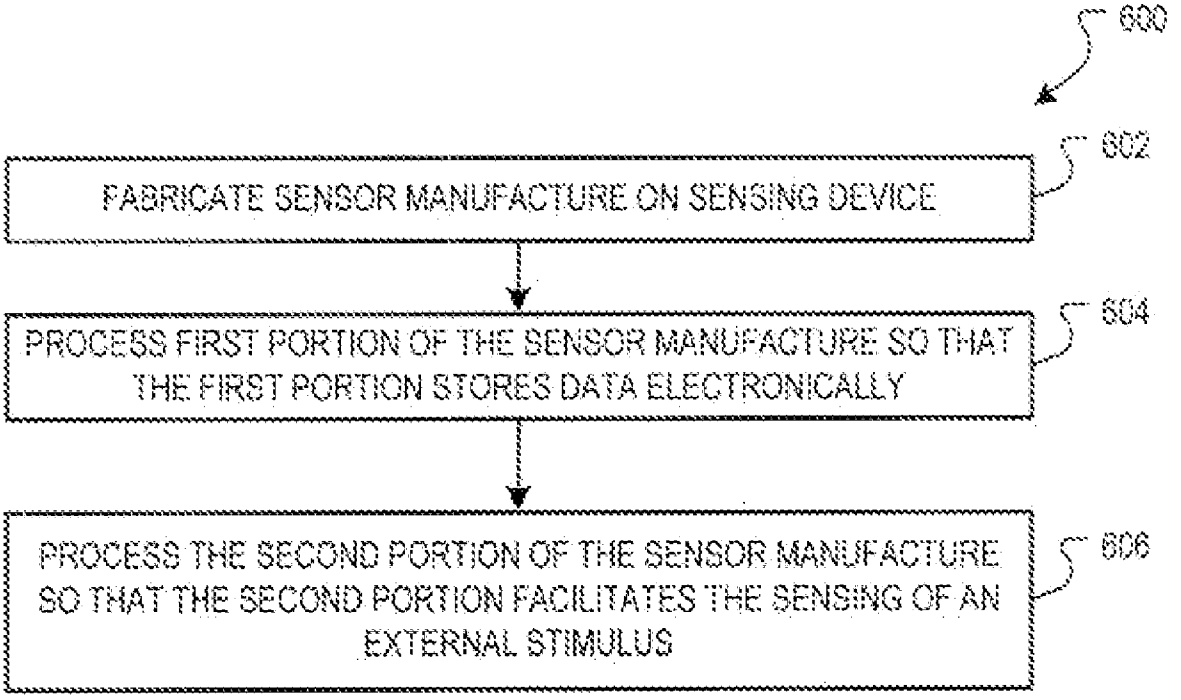
(57) **ABSTRACT**

A biometric sensing device includes a sensor manufacture for sensing a biometric stimulus. The sensor manufacture is also configured to persistently store data electronically, such as security data.



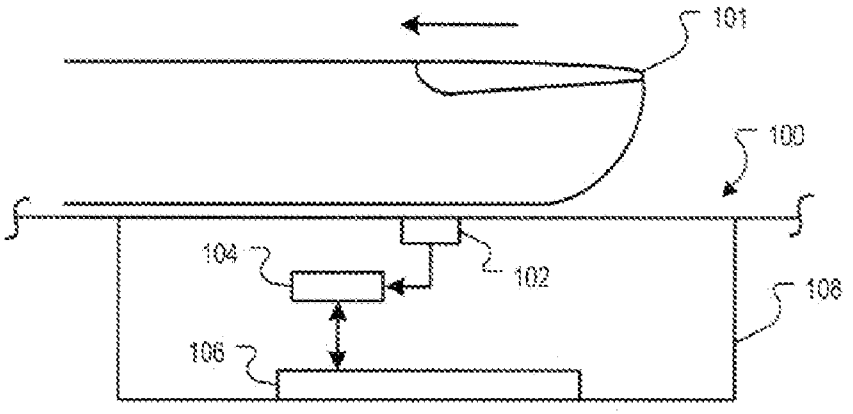


FIG. 1

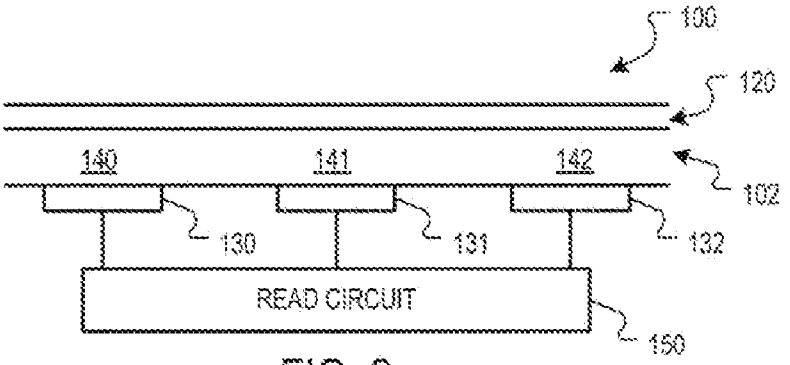


FIG. 2

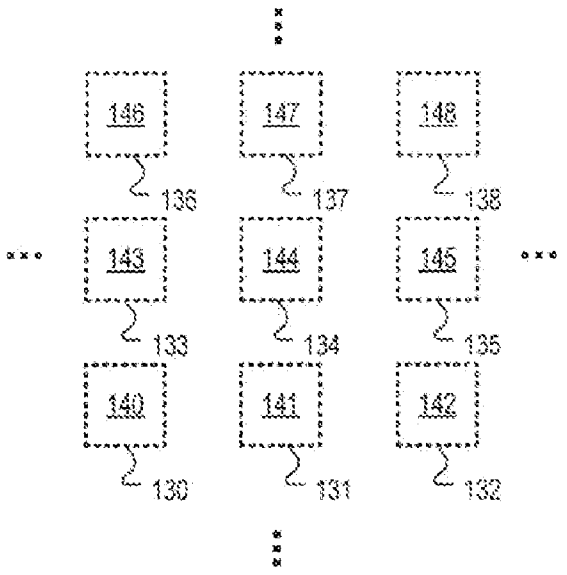


FIG. 3

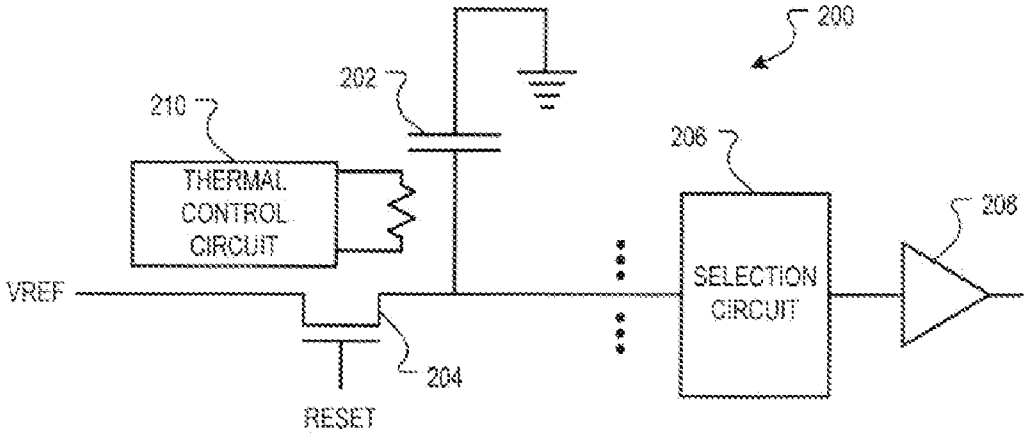


FIG. 4

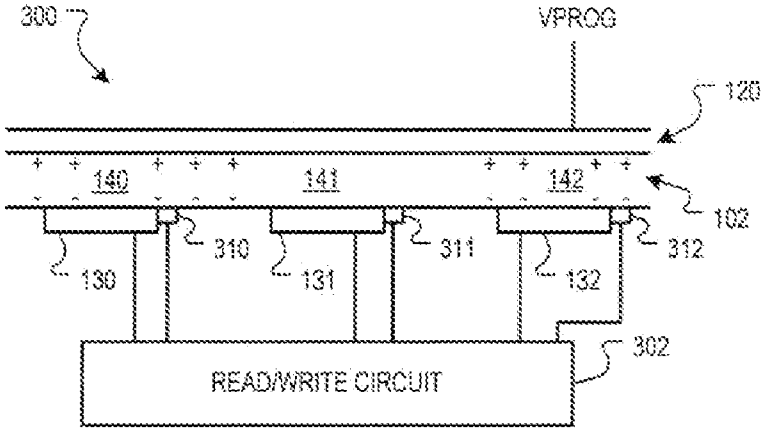


FIG. 5

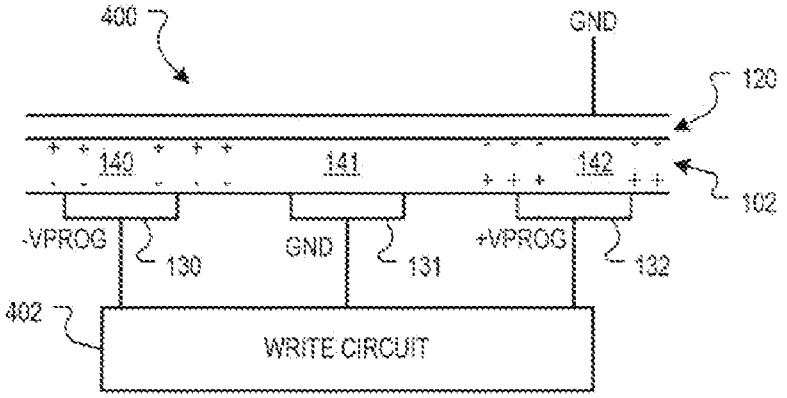


FIG. 6

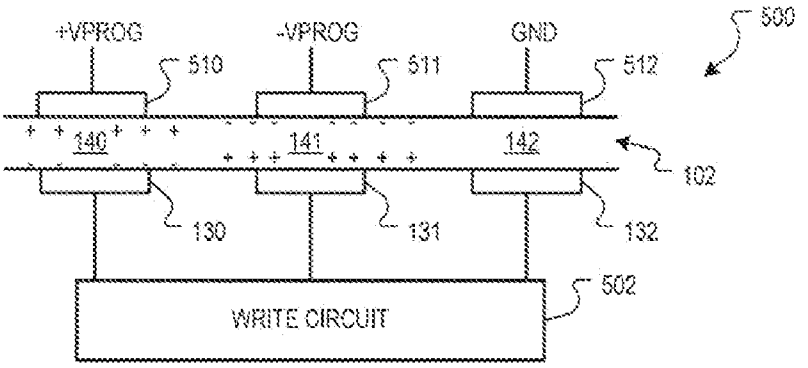


FIG. 7

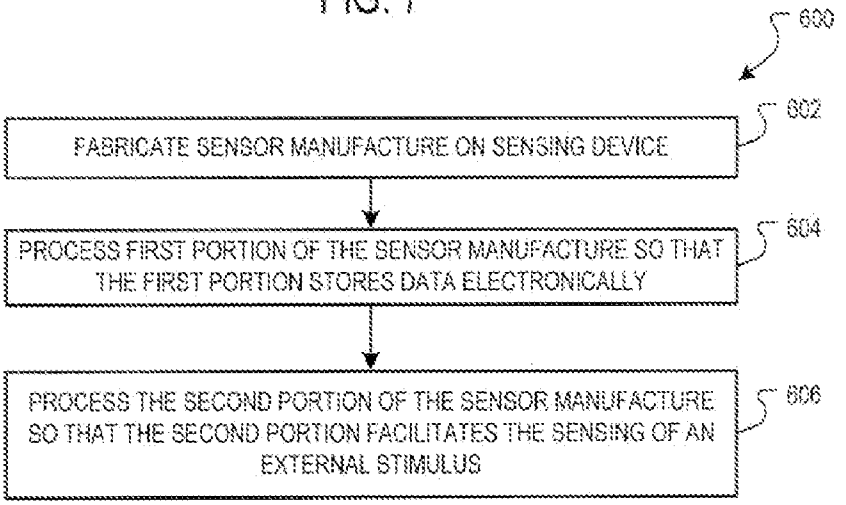


FIG. 8

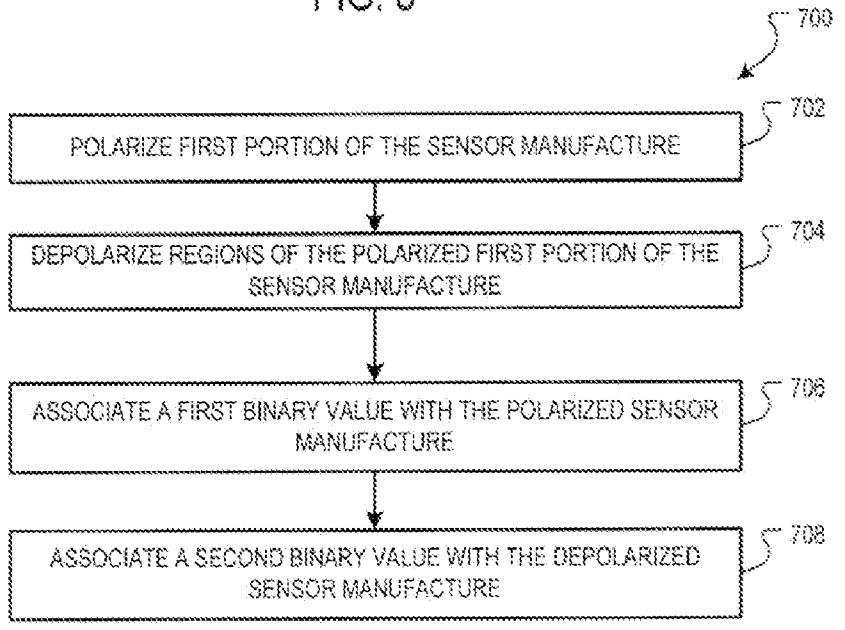


FIG. 9

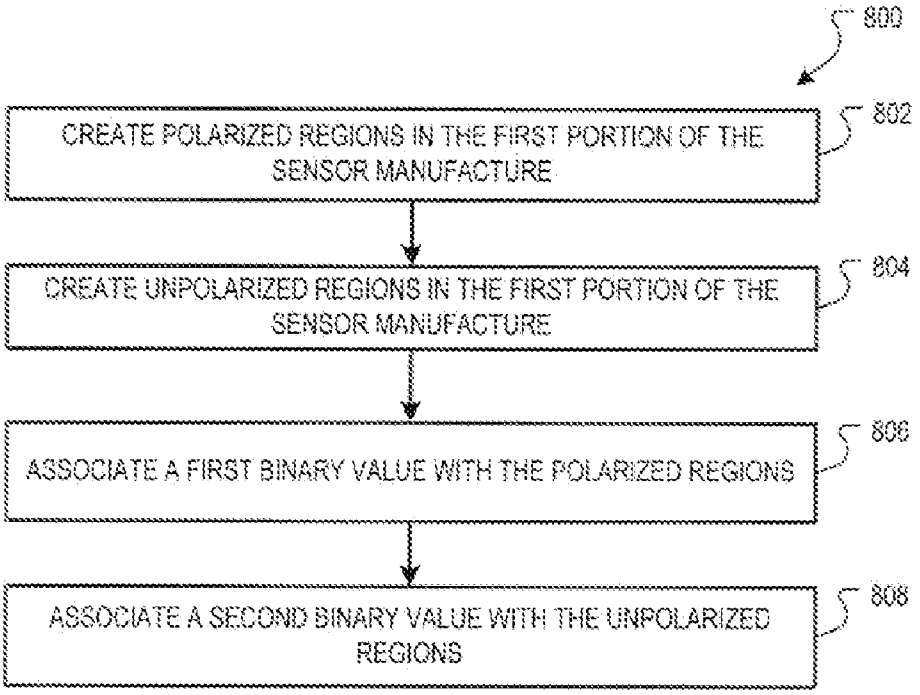


FIG. 10

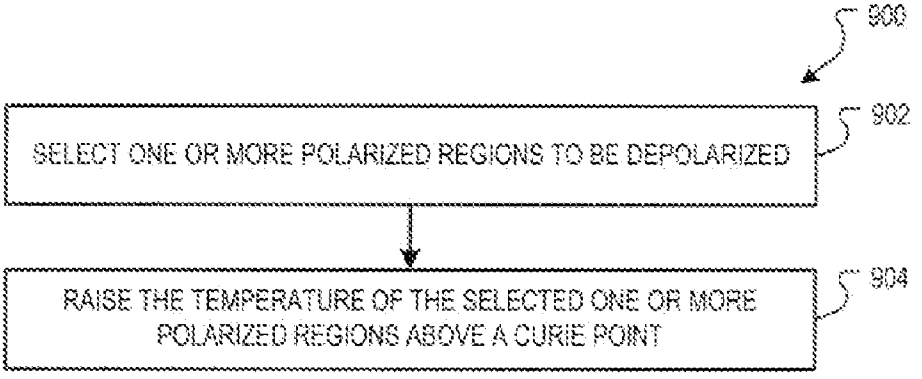


FIG. 11

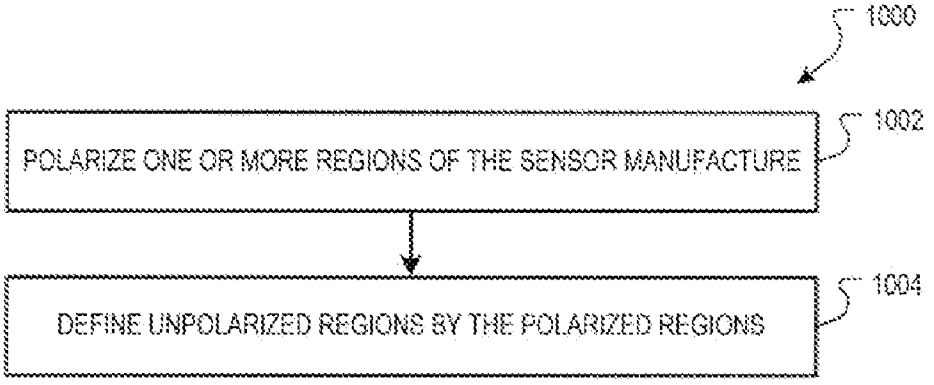


FIG. 12

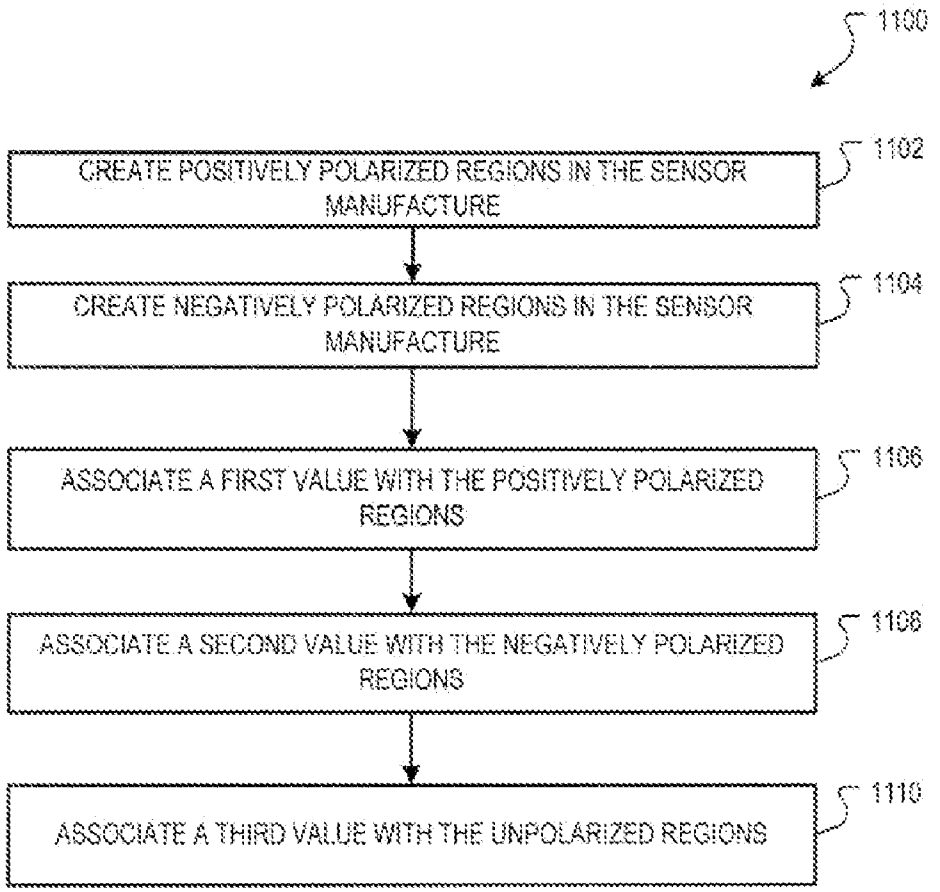

1100
CREATE POSITIVELY POLARIZED REGIONS IN THE SENSOR MANUFACTURE
1102
CREATE NEGATIVELY POLARIZED REGIONS IN THE SENSOR MANUFACTURE
1104
ASSOCIATE A FIRST VALUE WITH THE POSITIVELY POLARIZED REGIONS
1106
ASSOCIATE A SECOND VALUE WITH THE NEGATIVELY POLARIZED REGIONS
1108
ASSOCIATE A THIRD VALUE WITH THE UNPOLARIZED REGIONS
1110

FIG. 13

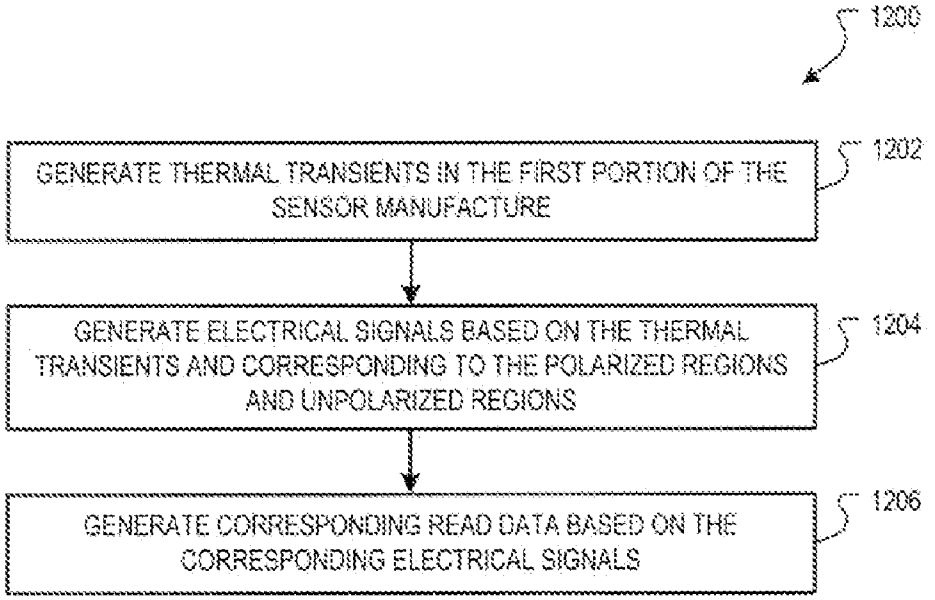

1200
GENERATE THERMAL TRANSIENTS IN THE FIRST PORTION OF THE SENSOR MANUFACTURE
1202
GENERATE ELECTRICAL SIGNALS BASED ON THE THERMAL TRANSIENTS AND CORRESPONDING TO THE POLARIZED REGIONS AND UNPOLARIZED REGIONS
1204
GENERATE CORRESPONDING READ DATA BASED ON THE CORRESPONDING ELECTRICAL SIGNALS
1206

FIG. 14

SENSOR MANUFACTURE WITH DATA STORAGE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This Application is related to application Ser. No. _____, entitled "Sensor Manufacture with Data Storage," filed on Mar. 6, 2007, the disclosure of which is incorporated herein by reference.

BACKGROUND

[0002] This disclosure relates to sensing devices.

[0003] Sensing devices can include sensor manufactures that can transduce one form of energy into another, e.g., charged coupled devices, piezoelectric materials, or pyroelectric materials. Such sensing devices can include basic control circuitry (e.g., e.g., amplifiers, analog-to-digital converters, input/output circuitry, and the like) on device (e.g., on-chip). The data output by the sensing device can be processed by a processing device in communication with the sensing device.

[0004] In particular applications, however, it may be desirable to store data in electronic form within the sensing device. For example, a manufacturer may desire to electrically store serial numbers for sensing devices within the sensing devices. Additionally, if the sensing devices are used in security applications, such as biometric sensing devices, for example, it maybe desirable to electrically store data to increase security. For example, it may be desirable to electrically store a private key in the sensing devices, or electrically store particular biometric information, such as fingerprint data for one or more persons, in the sensing devices.

SUMMARY

[0005] Disclosed herein in a sensor manufacture with data storage. The electrical properties of the sensor manufacture can be utilized to store data.

[0006] In an example implementation, a sensor manufacture can be fabricated on a sensing device. A first portion of the sensor manufacture can be processed so that the first portion of the sensor manufacture stores data electronically. A second portion of the sensor manufacture can be processed so that the second portion of the sensor manufacture facilitates the sensing of an external stimulus.

[0007] In another example implementation, a layer of sensor source material can be deposited on a sensing device. A first portion of the layer of sensor source material can be processed so that the first portion of the sensor source material stores data electronically.

[0008] In another example implementation, a first portion of a transducing material can be processed so that the first portion of the transducing material stores data electronically, and the transducing material can be configured to sense an external stimulus.

[0009] In another example implementation, a pyroelectric sensor manufacture is selectively polarized. A first portion of the pyroelectric sensor manufacture is selectively polarized so that the first portion of the pyroelectric sensor manufacture stores data electronically. A second portion of the pyroelectric sensor manufacture is selectively polarized so that the second portion of the sensor manufacture facilitates the sensing of a fingerprint.

[0010] Optional advantages and other advantages can be separately realized by the sensor manufacture with data storage. For example, separate on-chip memory requirements can be reduced. Additionally, data stored within the sensor manufacture can be less susceptible to compromise. For example, if the data are stored according to a polarization of the sensor manufacture, the data store region of the sensor manufacture may not be readily ascertainable by visual inspection or by other inspection means. Such example advantages, however, need not be realized in particular implementations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** is a block diagram of an example sensing device.

[0012] FIGS. **2** and **3** are block diagrams of example data elements defined within the example sensing device.

[0013] FIG. **4** is a block diagram of an example circuit for reading data stored in a sensor manufacture.

[0014] FIG. **5** is a block diagram of an example circuit for reading and storing data in a sensor manufacture.

[0015] FIG. **6** is a block diagram of example circuit for storing data in a sensor manufacture.

[0016] FIG. **7** is a block diagram of another example circuit for storing data in a sensor manufacture.

[0017] FIG. **8** is a flow diagram of an example process for storing data in a sensor manufacture.

[0018] FIG. **9** is a flow diagram of an example process for creating polarized and depolarized regions in a sensor manufacture.

[0019] FIG. **10** is a flow diagram of an example process for creating polarized and unpolarized regions in a sensor manufacture.

[0020] FIG. **11** is an example process for depolarizing a polarized region in a sensor manufacture.

[0021] FIG. **12** is an example process for defining depolarized regions in a sensor manufacture.

[0022] FIG. **13** is an example process for creating positively polarized regions and negatively polarized regions in a sensor manufacture.

[0023] FIG. **14** is a flow diagram of an example process for reading data stored in a sensor manufacture.

DETAILED DESCRIPTION

[0024] FIG. **1** is a block diagram of an example sensing device **100**. The example sensing device **100** can be a biometric sensing device configured to sense a biometric stimulus, such as the swiping of a finger **101** to read a corresponding fingerprint, for example. The sensing device **100** can implement a different type of sensor, however.

[0025] The sensing device **100** can include a sensor manufacture **102** coupled to a processing circuit **104** and an input/output circuit **106**. As the finger **101** is pressed and/or swiped on the sensor manufacture **102**, the sensor manufacture **102** generates electrical signals based on a characteristic of the fingerprint on the finger **101**. The source material of the sensor manufacture **102** can, for example, comprise a layer of polyvinylidene fluoride (PVDF), polyvinylidene fluoride, trifluoroethylene (PVDF-TrFE), polyvinylidene cyanide-vinyl acetate (PVDCN-VAc), or some other transducing material that can produce an electric charge in response to a physical stimulus, such as a biometric stimulus.

[0026] The electric signals output by the sensor manufacture **102** are processed by the processing circuit **104** and

output through the input/output circuit **106** as biometric data to a processing device, such as a microprocessor executing filtering and recognition algorithms. The example sensing device **100** can generate multiple instances per second of, for example, biometric data, with each instance corresponding to a partial image of a fingerprint. The multiple instances of biometric data can be processed by the processing device to detect overlapping data and generate a complete image of the fingerprint of the finger **101**.

[0027] In another implementation, the sensor manufacture **102** can be of such proportion to receive an entire fingerprint of the finger **101**. In this implementation, the finger **101** can be held stationary against the sensor manufacture **102** and an image of the entire fingerprint can be generated from a single instance of biometric data. Other biometric data collection techniques can also be used.

[0028] FIGS. **2** and **3** are block diagrams of example data elements defined within the sensor manufacture **102** of the example sensing device **100**. The sensor manufacture **102** can, for example, comprises a layer of pyroelectric material fabricated between an upper electrode **120** and a matrix array of lower electrodes as depicted by electrodes **130-138** in FIGS. **2** and **3**. Corresponding regions **140-148** are defined by each lower electrode **130-138** and the upper electrode **120**. In one implementation, the upper electrode **120** can comprises a single electrode fabricated atop the sensor manufacture **102**. In another implementation, the upper electrode **120** can comprises multiple electrodes fabricated atop the sensor manufacture **102**, e.g., row electrodes, or column electrodes, or a plurality of electrodes corresponding to the electrodes **130-138**.

[0029] As shown in FIG. **3**, the lower electrodes **130-138** can, for example, be arranged in rows and columns. The number of rows and columns can vary according to the particular implementation of the sensor device **100**. For example, the sensor manufacture **102** can comprise a relatively few number or rows and multiple columns and be configured to provide overlapping sections of biometric data during a finger swipe. Alternatively, the sensor manufacture **102** can comprise multiple rows and columns and be configured to provide a single instance of biometric data for an entire fingerprint. In one implementation, the sensor manufacture **102** can be approximately 1.2 centimeters in width and approximately 0.4 millimeters in length, and can comprise 8 rows of electrodes, with each row comprising 232 electrodes. Other configurations can also be used.

[0030] A processing circuit **104**, such as, for example, a read circuit **150**, can be connected to the lower electrodes **130-138**. In one implementation, the sensor manufacture **102** can be electrically configured to store data in one or more of the regions **140-148** by altering the electrical characteristic of the sensor manufacture **102**. For example, if the sensor manufacture **102** comprises a pyroelectric material, the sensor manufacture **102** can be polarized so that the pyroelectric material generates an electrical signal in response to a thermal transient. The data collected from regions **140-148** during a thermal transient can thus, for example, correspond to pixels. A portion of the sensor manufacture **102**, however, can be designated as a memory store. For example, the row defined by the regions **140-142** can be designated as a data store, and the rows defined by the regions **143-145** and **146-148** can be designated as rows of pixels. Thus, in the example sensor manufacture comprising 8 rows of 232 electrodes, the row defined by the regions **140-142** can comprise 232 data regions.

[0031] In one implementation, binary values can be associated with a polarization state of each data region. In an implementation, a polarized region can correspond to a binary value of 1, and an unpolarized region can correspond to a binary value of 0. In another implementation, the data regions can be positively polarized, negatively polarized, or unpolarized. Accordingly, in this implementation, a first data value can correspond to a positively polarized region, a second data value can correspond to a negatively polarized region, and a third data value can correspond to an unpolarized region. Other data schemes can also be used.

[0032] In an implementation, the data in the data regions can be encoded, for example, according to a reliability scheme (e.g., that includes error correction) or security scheme. For example, the data regions may be arranged according to groups of three and majority weighted for a data value, e.g., the data regions **140**, **141** and **142** can all be polarized in the same state and the data of each data region **140**, **141** and **142** can be compared to determine the data value stored in the data region group. Thus, if the data regions **140** and **141** correspond to a binary value of 1, and the data region **142** cannot be read or is corrupted, the data value of 1 can still be read from the group. The data stored in the groups of data regions or in the individual data regions can also be stored according to an encryption scheme, such as encryption by a symmetric or asymmetric encryption key. Other storage schemes can also be used.

[0033] In an implementation, the regions designated to store the data need not comprise contiguous data regions. For example, data regions can be defined in the sensor manufacture **102** in a systematic or quasi-random manner, e.g., if 232 data regions are to be defined in a sensor manufacture **102** comprising 1,856 regions, then the 232 data regions can be systematically or quasi-randomly distributed within the array of 1,856 regions to define a sensor manufacture **102** having 232 data regions and 1,624 pixels.

[0034] In an implementation, the regions designated to store data can also be insulated from an external stimulus. For example, if data are stored in the row defined by the regions **140-142**, then the row can be insulated from light, heat, or some other external stimulus to which the sensor manufacture **102** is sensitive.

[0035] In an implementation, a data region storing a particular value may also provide pixel data in response to an external stimulus. For example, the sensor manufacture **102** may comprise a material that is polarized to generate the electrical signals in response to an external stimulus. After the material is polarized, particular regions may be selected to store data. For example, regions **140-148** may be selected as a data store for eight bits and one parity bit, with polarized regions corresponding to a binary value of 1 and unpolarized regions corresponding to a binary value of 0. Several of the regions **140-148** may thus be depolarized to store the respective values of 1 and 0 in the regions **140-148**. Thereafter, the polarized regions of **140-148**, in addition to facilitating the storing of a data value, can also provide biometric data in response to an external stimulus. Because the unpolarized regions of **140-148** may not effectively provide biometric data in response to an external stimulus, the processing circuitry **104**, e.g., read circuit **150**, can be configure to treat the data output corresponding to the unpolarized regions as pixel

errors. In this implementation, the data stored in the regions **140-148** can, for example, be read before or after the occurrence of the external stimulus.

[0036] In another implementation, positively and negatively polarized data regions can be used to provide pixel data in response to an external stimulus. For example, the sensor manufacture **102** may comprise a material that is polarized to generate the electrical signals in response to an external stimulus. After the material is polarized, particular regions may be selected to store data. For example, regions **140-148** may be selected as a data store for eight bits and one parity bit, with positively polarized regions corresponding to a binary value of 1 and negatively polarized regions corresponding to a binary value of 0. Thus, the entire sensor manufacture **102** can be positively polarized, and then several of the regions **140-148** may thus be negatively polarized to store the respective 0 values. Thereafter, the positively polarized regions of **140-148**, in addition to facilitating the storing of a data value, can also provide biometric data in response to an external stimulus. Likewise, the negatively polarized regions of **140-148**, in addition to facilitating the storing of a data value, can also provide biometric data in response to an external stimulus. These signals of the negatively polarized regions can, for example, be inverted to match a corresponding response for a positively polarized region. The processing circuitry **104**, e.g., read circuit **150**, can be configured to process data corresponding to the negatively polarized regions in an inverted state during a sensing operation, and to process the data corresponding to the negatively polarized regions in a non-inverted state during a read operation. In this implementation, the data stored in the regions **140-148** can, for example, be read before or after the occurrence of the external stimulus.

[0037] Other storage and processing schemes can also be used. For example, a column can be configured to store data values; or data values may be stored along the peripheral column and the peripheral rows of the sensor manufacture **102**, etc.

[0038] FIG. **4** is a block diagram of an example circuit **200** for reading data stored in a sensor manufacture, such as the sensor manufacture **102**. The circuit **200** can, for example, be utilized to facilitate the reading of data stored in a pyroelectric sensor manufacture. A data region can be represented by a capacitor device **202**. In one example implementation, a first terminal of the capacitor device **202** can be sustained at a reference ground. For example, during a read operation of the sensor **100**, the upper electrode **120** can be sustained at a ground potential.

[0039] The second terminal of the capacitor device **202**, e.g., a lower electrode, such as electrode **130** of FIG. **2**, can be coupled to a gate **204** and a selection circuit **206**. During a read operation, the selection circuit **206** can select a particular data region for reading and couple the selected data region to an output amplifier **208**.

[0040] To initiate a read operation, a thermal control circuit **210** can generate a thermal transient within the data region. If the sensor manufacture **102** within the data region is polarized, the thermal transient will cause a charge to accumulate within the data region. Conversely, if the region is not polarized, the sensor manufacture **102** within the data region will not react to the thermal transient.

[0041] In one implementation, a RESET voltage can be applied to the lower electrode of the data region through the gate **204** to set the voltage of the data region to a known reference value, e.g., VREF. Thereafter, the voltage of the data region can change in response to the thermal transient applied by the thermal control circuit **210**. In one implementation, the voltage of the data region is measured after an integration time during the thermal transient, e.g., 1 millisecond.

[0042] For example, if data are stored within the sensor manufacture **102** by associating a polarized material with a binary value of 1 and an unpolarized material with a binary value of 0, then after the integration time the voltage across a polarized data region can be substantially VREF+VΔ, as the polarized sensor manufacture generates the addition voltage VΔ in response to the thermal transient. Likewise, the voltage across an unpolarized data region can be substantially VREF, as the unpolarized sensor manufacture will not react to the thermal transient.

[0043] In another implementation, the voltage of the data regions can be measured after an integration time after the thermal transient, e.g., 1 millisecond. In this implementation, the RESET voltage can be applied to the lower electrode of the data region through, the gate **204** to set the voltage of the data region to a known reference value, e.g., VREF, after the occurrence of the thermal transient. Thereafter, the data region experiences another thermal transient as it cools in response to the absence of thermal energy provided by the thermal control circuit **210**. Thus, after the integration time, the voltage across the polarized data region can be substantially VREF−VΔ, and the voltage across an unpolarized data region can be substantially VREF.

[0044] In another implementation, the data can be read after a first integration time during which the data regions are heated, and read again after a second integration time during which the data regions are cooling. The results of the reads can be combined for redundancy and to limit errors.

[0045] In another implementation, the data regions can be positively polarized, negatively polarized, or unpolarized, and corresponding data values can be associated with the positively polarized, negatively polarized and unpolarized regions. In this implementation, the voltage across a positively polarized data region, after an integration time can be substantially VREF+VΔ; across a negatively polarized region, substantially VREF−VΔ; and across an unpolarized region, substantially VREF. In this implementation, corresponding data values can be associated with the positively polarized, negatively polarized and unpolarized regions. In another implementation, a first binary value can be associated with, a positively polarized region, a second binary value can be associated with a negatively polarized region, and the unpolarized region can be ignored, or can be representative of other data, e.g., a data value indicating the beginning or the end of a data, block, or a multi-digit binary value, e.g., "00," "01," "10," or "11", for example.

[0046] FIG. **5** is a block diagram of an example circuit **300** for reading and storing data in a sensor manufacture **102**. In the example circuit **300** of FIG. **5**, the data regions can be either polarized or unpolarized, and corresponding binary values can be associated with the polarized and unpolarized regions.

[0047] In one implementation, a read/write circuit **302** can be connected to the lower electrodes, e.g., lower electrodes **130-132**. The read/write circuit **302** can, for example, implement the circuit **200** of FIG. **4** to perform read operations. Other read circuits, however, can also be used.

[0048] For processing a writing operation, the read/write circuit **302** can, for example, apply a reference potential, e.g.,

a ground voltage, to the lower electrodes **130-132** that correspond to the data regions **140-142** in which data are to be stored. A program voltage VPROG can, for example, be applied to the upper electrode **120**. In an implementation in which the sensor manufacture comprises a pyroelectric layer, the program voltage VPROG can be a voltage that causes the sensor manufacture to polarize when referenced from the reference voltage. The program voltage VPROG can, for example, be applied by connecting a probe to the upper electrode **120**, or by coupling the voltage to the upper electrode **120** through a switch, or by some other connection or coupling.

[0049] In one implementation, after the sensor manufacture **102** is polarized, the program voltage VPROG is removed and the read/write circuit **302** can, for example, thermally excite one or more data regions above a Curie temperature of the sensor manufacture **102**. Upon exceeding the Curie point, the heated region of the sensor manufacture **102** depolarizes. As shown in FIG. **5**, in one implementation, each electrode **130**, **131** and **132** has an associated heating element **310**, **311** and **312**, and each heating element **310**, **311** and **312** may be individually activated. For example, the heating element **311** was activated to heat the data region **141** above the Curie temperature of the sensor manufacture **102**, causing the sensor manufacture **102** to depolarize. According, the three data regions **140-141** can, for example, be read by the read/write circuit **302** to retrieve binary data such as 101 or 010, depending on the association of binary values to the polarization states.

[0050] In another implementation, selected resistive elements can be activated while the program voltage VPROG is applied to the top electrode **120**. In this implementation, selected data regions of the sensor manufacture **102** are precluded from becoming polarized during the application of VPROG to the top electrode **120**.

[0051] In one implementation, the heating elements **310-312** can comprise a resistive material. In an implementation, the heating elements **310-312** are proximate to corresponding electrodes **130-132** and thus proximate to corresponding data regions **140-142**. Other configurations can also be used. For example, a heating element can be circumferentially disposed around the perimeter of a corresponding lower electrode, or can be located on a corresponding electrode. In another implementation, the heating elements **310-312** can be disposed near the top of the sensor manufacture **102**, such as on the top layer of the sensor manufacture **102** or on the upper electrode **120**.

[0052] In one implementation, the thermal control circuit **210** of the read circuit **200** of FIG. **4** can also be used to implement the heating elements **310-312**. In one implementation, the thermal control circuit **210** can apply a first (e.g., short) current pulse or voltage pulse to the heating elements during a read operation, and provide a second (e.g., long) current pulse or voltage pulse during a write operation. In one implementation, the durations are such that the first (e.g., short) duration does not cause the data region to reach the Curie temperature, and the second (e.g., long) duration causes the data region to exceed the Curie temperature and thus depolarize.

[0053] In another implementation, the thermal control circuit **210** can apply a low current pulse or low voltage pulse to the heating elements during a read operation, and provide a high current pulse or a high voltage pulse during a write operation. The magnitudes are such that the low pulse does not cause the data region to reach the Curie temperature, and the high pulse causes the data region to exceed the Curie temperature and thus depolarize.

[0054] Other thermal control circuits **210** can also be used. For example, separate heating elements and control circuits can be used for read operations and write operations.

[0055] The magnitude of the program voltage VPROG can, for example, depend on the thickness of the sensor manufacture **102** layer. For example, if the sensor manufacture **102** comprises a pyroelectric material having a layer thickness of substantially three micrometers, a voltage of about 280 V can be applied across the sensor manufacture **102** layer to polarize the layer.

[0056] FIG. **6** is a block diagram of example circuit **400** for storing data in a sensor manufacture **102**. In this implementation, the data regions can be positively polarized, negatively polarized, or unpolarized, and corresponding data values can be associated with the positively polarized, negatively polarized and unpolarized regions. In another implementation, a first binary value can be associated with a positively polarized region, a second binary value can be associated with a negatively polarized region, and the unpolarized region can be ignored, or can be representative of other data, e.g., a data value indicating the beginning or the end of a data block, or a multi-digit binary value, e.g., "00," "01," "10," or "11", for example.

[0057] In one implementation, a write circuit **402** can be connected to the lower electrodes, e.g., lower electrodes **130-132**. For processing a writing operation, a reference potential can be applied to the upper electrode **102**, and the write circuit **402** can, for example, selectively apply a program voltage VPROG or a reference voltage to the lower electrodes **130-132**. In an implementation in which the sensor manufacture comprises a pyroelectric layer, the program voltage VPROG can be a voltage that causes the sensor manufacture **102** to polarize when referenced from the reference voltage. As shown in FIG. **6**, the voltages of −VPROG, GND, and +VPROG are applied to the electrodes **130-132**, which, in turn, causes the data region **140** to be become positively polarized and the data region **142** to be become negatively polarized. The data region **141**, however, remains unpolarized as the potential across the data region **141** is substantially 0 volts.

[0058] In another implementation, the write circuit **402** can be configured to provide a single program voltage, e.g., +VPROG. In this example implementation, the sensor manufacture **102** can be either in a common polarized state or an unpolarized state, which can, for example, correspond to binary values.

[0059] FIG. **7** is a block diagram of another example circuit **500** for storing data in a sensor manufacture **102**. In this implementation, the data regions can be positively polarized, negatively polarized, or unpolarized, and corresponding data values can be associated with the positively polarized, negatively polarized and unpolarized regions. In another implementation, a first binary value can be associated with a positively polarized region, a second binary value can be associated with a negatively polarized region, and the unpolarized region can be ignored, or can be representative of other data, e.g., a data value indicating the beginning or the end of a data block, or a multi-digit binary value, e.g., "00," "01," "10," or "11", for example.

[0060] The example circuit **500** includes top electrodes, e.g., electrodes **510**, **511** and 232 disposed on the top surface

of the sensor manufacture **102**. In one implementation, the top electrodes can comprise electrode rows extending the width of the sensor manufacture **102**, e.g., if the sensor device **102** has 8 rows and 232 electrodes columns, then there are 8 separate top electrodes. In another implementation, the top electrodes can comprise electrode columns extending the length of the sensor manufacture **102**, e.g., if the sensor device **100** has 8 rows and 232 electrodes columns, then there are 232 separate top electrodes. In another implementation, the top electrodes can comprise corresponding electrodes for each data region, e.g., if the sensor device **102** has 8 rows and 232 electrodes columns, then there are 1,856 separate top electrodes.

[0061] For processing a writing operation, a write circuit **502** can, for example, apply a reference potential, e.g., a ground voltage, to the lower electrodes **130-132** that correspond to the data regions **140-142** in which data are to be stored. Program voltages of VPROG or −VPROG can, for example, be applied to the upper electrodes **510-512**. In an implementation in which the sensor manufacture **102** comprises a pyroelectric layer, the program voltages can be a voltage that causes the sensor manufacture **102** to polarize when referenced from the reference voltage. The program voltage can, for example, be applied by connecting a probe or probes to the upper electrodes **510-512**, or by coupling the voltages to the upper electrode **510-512** through a switch network, or by some other connection or coupling.

[0062] As shown in FIG. **7**, the program voltages of +VPROG, −VPROG and the reference voltage GND are applied to the electrodes **510-512**, which, in turn, causes the data region **140** to be become positively polarized and the data region **141** to be become negatively polarized. The data region **142**, however, remains unpolarized as the potential across the data region **141** is substantially 0 volts.

[0063] In another implementation, a single program voltage, e.g., +VPROG, can be applied to the top electrodes **510-512**. In this example implementation, the sensor manufacture **102** can be either in a common polarized state or an unpolarized state, which can, for example, correspond to binary values.

[0064] Other example circuits can also be used to store data in the sensor manufacture **102**. In another implementation, for example, the circuits **400** and **500** of FIGS. **6** and **7** cart include heating elements to depolarize data regions or preclude polarization of data regions as described with respect to FIG. **4**. For example, positively and negatively polarized regions can be selectively depolarized after programming. The heating elements, e.g., elements **310-312**, can be proximate to the lower electrodes **130-132** of FIGS. **6** and **7**, or can be proximate to the top electrode **120** of FIG. **6** or the top electrodes **510-512** of FIG. **7**. Other circuit configurations can also be used. By thus conditioning the sensor manufacture **102** as described above, data can be stored electronically in the source material of the sensor manufacture **102**.

[0065] FIG. **8** is a flow diagram of an example process **600** for storing data in a sensor manufacture. The process **600** can, for example, be implemented in the sensor device **100** and in one or more of the example implementations described above.

[0066] Stage **602** fabricates a sensor manufacture on a sensing device. For example, the sensor device **100** can be fabricated with the sensor manufacture **102** as shown in FIG. **1**.

[0067] Stage **604** processes the first portion of the sensor manufacture so that the first portion stores data electronically. For example, the sensor manufacture **102** can undergo polarization processing by one of the example circuits **300**, **400** or **500** as described above.

[0068] Stage **606** processes the second portion of the sensor manufacture so that the second portion facilities the sensing of an external stimulus. For example, the sensor manufacture **102** can be polarized so that the sensor manufacture generates an electrical signal in response to a stimulus, such as a thermal transient caused by a biometric stimulus.

[0069] FIG. **9** is a flow diagram of an example process **700** for creating polarized and depolarized regions in a sensor manufacture. The process **700** can, for example, be implemented in the sensor device **100** and in one or more of the example implementations described above.

[0070] Stage **702** polarizes the first portion of the sensor manufacture. For example, the sensor manufacture **102** can undergo polarization processing by one of the example circuits **300**, **400** or **500** as described above.

[0071] Stage **704** depolarizes the regions of the polarized first portion of the sensor manufacture. For example, the sensor manufacture **102** can undergo depolarization processing by one of the example circuits **300**, **400** or **500** as described above.

[0072] Stage **706** associates a first binary value with the polarized sensor manufacture, and stage **708** associates a second binary value with the depolarized sensor manufacture. For example, the processing circuit **104** of FIG. **1** can be configured to associate a voltage received from the amplifier **208** and corresponding to an unpolarized data region with the binary value of 1, and to associate a voltage received from the amplifier **208** and corresponding to a polarized data region with the binary value of 0.

[0073] FIG. **10** is a flow diagram of an example process **800** for creating polarized and unpolarized regions in a sensor manufacture. The process **800** can, for example, be implemented in the sensor device **100** and in one or more of the example implementations described above.

[0074] Stage **802** creates polarized regions in the first portion of the sensor manufacture. For example, the sensor manufacture **102** can undergo polarization processing by one of the example circuits **300**, **400** or **500** as described above to create polarized regions in the sensor manufacture **102**.

[0075] Stage **804** creates unpolarized regions in the first portion of the sensor manufacture. For example, the sensor manufacture **102** can undergo depolarization processing by one of the example circuits **300**, **400** or **500** as described above to depolarize a polarized region. In another implementation, regions of an unpolarized sensor manufacture **102** can be selectively polarized, which, in turn, creates unpolarized regions that are defined by the polarized regions.

[0076] Stage **806** associates a first binary value with the polarized regions, and stage **808** associates a second binary value with the unpolarized regions. For example, the processing circuit **104** of FIG. **1** can be configured to associate a voltage received from the amplifier **208** and corresponding to an unpolarized data region with the binary value of 0, and to associate a voltage received from the amplifier **208** and corresponding to a polarized data region with the binary value of 1.

[0077] FIG. **11** is a flow diagram of an example process **900** for depolarizing a polarized region in a sensor manufacture. The process **900** can, for example, be implemented in the sensor device **100** and in one or more of the example implementations described above.

[0078] Stage **902** selects one or more polarized regions to be depolarized. For example, a polarized region in a sensor manufacture **102** can be selected by the thermal control circuit **210**, or by the write circuits **302**, **402**, and **502** of FIGS. **4-6**, to be depolarized.

[0079] Stage **904** raises the temperature of the selected one or more polarized regions above a Curie point. For example, a current pulse or voltage pulse can be applied to a heating element to raise the temperature of a polarized region above a Curie temperature of the sensor manufacture **102**.

[0080] FIG. **12** is a flow diagram of an example process **1000** for defining depolarized regions in a sensor manufacture. The process **1000** can, for example, be implemented in the sensor device **100** and in one or more of the example implementations described above.

[0081] Stage **1002** polarizes one or more regions of the sensor manufacture. For example, the sensor manufacture **102** can undergo polarization processing by one of the example circuits **400** or **500** as described above to create polarized regions in the sensor manufacture **102**.

[0082] Stags **1004** defines unpolarized regions by the polarized regions. For example, regions of the sensor manufacture **102** that are polarized in FIGS. **6** and **7** can define unpolarized regions, such as polarized regions **140** and **142** defining region **141** as an unpolarized region.

[0083] FIG. **13** is a flow diagram of an example process **1100** for creating positively polarized regions and negatively polarized regions in a sensor manufacture. The process **1100** can, for example, be implemented in the sensor device **100** and in one or more of the example implementations described above.

[0084] Stage **1102** creates positively polarized regions in the sensor manufacture. For example, the sensor manufacture **102** can undergo polarization processing by one of the example circuits **400** or **500** as described above to create positively polarized regions in the sensor manufacture **102**.

[0085] Stage **1104** creates negatively polarized regions in the sensor manufacture. For example, the sensor manufacture **102** can undergo polarization processing by one of the example circuits **400** or **500** as described above to create negatively polarized regions in the sensor manufacture **102**.

[0086] Stage **1106** associates a first value with the positively polarized regions. For example, the processing circuit **104** of FIG. **1** can be configured to associate a voltage received from the amplifier **208** and corresponding to positively polarized data region with a first data value.

[0087] Stage **1108** associates a second value with the negatively polarized regions. For example, the processing circuit **104** of FIG. **1** can be configured to associate a voltage received from the amplifier **208** and corresponding to negatively polarized data region with a second data value.

[0088] Stage **1110** associates a third value with the unpolarized regions. For example, the processing circuit **104** of FIG. **1** can be configured to associate a voltage received from the amplifier **208** and corresponding to an unpolarized data region with a third data value.

[0089] FIG. **14** is a flow diagram of an example process **1200** for reading data stored in a sensor manufacture. The process **1200** can, for example, be implemented in the sensor device **100** and in the example circuit **200** of FIG. **4**.

[0090] Stage **1202** generates thermal transients in the first portion of the sensor manufacture. For example, the thermal control circuit **210** can generate a thermal transient in the data region represented by the capacitive device **202**.

[0091] Stage **1204** generates electrical signals based on the thermal transients and corresponding to the polarized regions and unpolarized regions. For example, the data region represented by the capacitive device **202** can charge or discharge in response to the thermal transient generated by the thermal control circuit **210**.

[0092] Stage **1206** generates corresponding read data based on the corresponding electrical signals. For example, the signal output by the amplifier **208** can be processed into a data signal by the processing circuit **104**.

[0093] Any type of data can be persistently stored in the sensor manufacture **102**. For example, the sensor manufacture **102** can be programmed to store a sensor device **100** serial number; and/or a private encryption key to protect against fraud; and/or one or more data sets relating to pre-authorized users, e.g., fingerprint data for cleared individuals; and/or calibration data relating to a sensor parameter, such a temperature; etc.

[0094] This written description sets forth the best mode of the invention and provides examples to describe the invention and to enable a person of ordinary skill in the art to make and use the invention. This written description does not limit the invention to the precise terms set forth. Thus, while the invention has been described in detail with reference to the examples set forth above, those of ordinary skill in the art may effect alterations, modifications and variations to the examples without departing from the scope of the invention.

What is claimed is:

1. A method, comprising:

fabricating a sensor manufacture on a sensing device;

processing a first portion of the sensor manufacture so that the first portion of the sensor manufacture stores data electronically; and

processing a second portion of the sensor manufacture so that the second portion of the sensor manufacture facilitates the sensing of an external stimulus.

2. The method of claim **1**, wherein:

fabricating a sensor manufacture on a sensing device comprises fabricating a pyroelectric layer on the sensing device.

3. The method of claim **2**, wherein:

processing the first portion of the sensor manufacture comprises:

polarizing the first portion of the sensor manufacture; and

depolarizing regions of the polarized first portion of the sensor manufacture.

4. The method of claim **3**, comprising:

associating a first binary value with the polarized sensor manufacture; and

associating a second binary value with the depolarized sensor manufacture.

5. The method of claim **2**, wherein:

processing the first portion of the sensor manufacture comprises:

creating polarized regions in the first portion of the sensor manufacture; and

creating unpolarized regions in the first portion of the sensor manufacture.

6. The method of claim **5**, comprising:

associating a first binary value with the polarized regions; and

associating a second binary value with the unpolarized regions.

7. The method of claim 5, wherein:
creating unpolarized regions in the first portion of the sensor manufacture comprises:
selecting one or more polarized regions to be depolarized: and
raising the temperature of the selected one or more polarized regions above a Curie point of the sensor manufacture.
8. The method of claim 5, wherein:
creating unpolarized regions in the first portion of the sensor manufacture comprises:
polarizing one or more regions of the sensor manufacture; and
defining the unpolarized regions by the polarized regions.
9. The method of claim 5, further comprising:
generating a thermal transient in the first portion of the sensor manufacture;
generating electrical signals based on the thermal transient and corresponding to the polarized regions and the unpolarized regions; and
generating corresponding read data based on the corresponding electrical signals.
10. The method of claim 9, wherein:
the thermal transient comprises at least one of a heating transient and a cooling transient.
11. The method of claim 2, wherein:
processing the first portion of the sensor manufacture comprises:
creating positively polarized regions in the first portion of the sensor manufacture; and
creating negatively polarized regions in the first portion of the sensor manufacture.
12. The method of claim 11, further comprising:
associating a first data value with a positively polarized region;
associating a second data value with a negatively polarized region; and
associating a third data value with an unpolarized region.
13. The method of claim 2, further comprising:
storing security data in the first portion of the sensor manufacture.
14. The method of claim 1, wherein:
the external stimulus comprises a biometric stimulus.
15. The method of any one of claims 1, 4, 9 and 12, wherein:
the external stimulus comprises a finger print swipe.
16. The method of claim 1, wherein:
the second portion of the sensor manufacture includes a portion of the first portion of the sensor manufacture.
17. The method of claim 1, wherein:
the sensor manufacture comprises polyvinylidene fluoride.
18. A method, comprising:
depositing a layer of sensor source material on a sensing device; and
conditioning a first portion of the layer of sensor source material so that the first portion of the sensor source material stores data electronically.
19. The method of claim 18, comprising:
conditioning a second portion of the layer of sensor source material so that the second portion of the layer of sensor source material transduces an external stimulus into electrical signals.
20. The method of claim 18, wherein:
conditioning a first portion of the layer of sensor source material comprises:
polarizing the first portion of the layer of sensor source material; and
depolarizing regions of the polarized first portion of the layer of sensor source material.
21. The method of claim 20, comprising:
associating a first binary value with the polarized layer of sensor source material; and
associating a second binary value with the depolarized layer of sensor source material.
22. The method of claim 18, wherein:
conditioning the first portion of the layer of sensor source material comprises:
creating polarized regions in the first portion of the layer of sensor source material; and
creating unpolarized regions in the first portion of the layer of sensor source material.
23. The method of claim 22, comprising:
associating a first binary value with the polarized regions; and
associating a second binary value with the unpolarized regions.
24. The method of claim 22, wherein:
creating unpolarized regions in the first portion of the layer of sensor source material comprises:
selecting one or more polarized regions to be depolarized; and
raising the temperature of the selected one or more polarized regions above a Curie point of the layer of sensor source material.
25. The method of claim 22, wherein:
creating unpolarized regions in the first portion of the layer of sensor source material comprises:
polarizing one or more regions of the layer of sensor source material; and
defining the unpolarized regions by the polarized regions.
26. The method of claim 22, further comprising:
generating a thermal transient in the first portion of the layer of sensor source material;
generating electrical signals based on the thermal transient and corresponding to the polarized regions and the unpolarized regions; and
generating corresponding read data based on the corresponding electrical signals.
27. The method of claim 18, wherein:
conditioning the first portion of the layer of sensor source material comprises:
creating positively polarized regions in the first portion of the layer of sensor source material; and
creating negatively polarized regions in the first portion of the layer of sensor source material.
28. The method of claim 18, further comprising:
storing security data in the first portion of the layer of sensor source material.
29. The method of claim 19, wherein:
the external stimulus comprises a fingerprint swipe.
30. The method of any one of claims 21, 22 and 27, wherein:
the sensor manufacture comprises polyvinylidene fluoride.
31. The method of claim 19, wherein;
the second portion of the sensor manufacture includes a portion of the first portion of the sensor manufacture.

32. A method comprising;

processing a first portion of a transducing material so that the first portion of the transducing material stores data electronically;

wherein the transducing material is configured to sense an external stimulus.

33. The method of claim **32**, wherein:

processing a first portion of the transducing material so that the first portion of the transducing material stores data electronically comprises:

creating polarized regions in the first portion of the transducing material.

34. The method of claim **33**, comprising:

associating a first binary value with polarized transducing material; and

associating a second binary value with unpolarized transducing material.

35. The method of claim **33**, comprising:

selecting one or more polarized regions to be depolarized; and

raising a temperature of the selected one or more polarized regions above a Curie point of the transducing material to create unpolarized regions from the selected or more polarized regions.

36. The method of claim **33**, wherein:

unpolarized regions are defined by proximate polarized regions.

37. The method of claim **33**, wherein:

creating polarized regions in the first portion of the transducing material comprises:

creating positively polarized regions in the first portion of the transducing material; and

creating negatively polarized regions in the first portion of the transducing material.

38. A method of storing data in a fingerprint sensor, comprising:

fabricating a pyroelectric sensor manufacture on a sensing device;

selectively polarizing a first portion of the pyroelectric sensor manufacture so that the first portion of the pyroelectric sensor manufacture stores data electronically; and

polarizing a second portion of the pyroelectric sensor manufacture so that the second portion of the sensor manufacture facilitates the sensing of a fingerprint.

39. The method of claim **38**, wherein:

selectively polarizing a first portion of the pyroelectric sensor manufacture so that the first portion of the pyroelectric sensor manufacture stores data electronically comprises:

creating polarized regions in the first portion of the pyroelectric sensor manufacture;

creating unpolarized regions in the first portion of the pyroelectric sensor manufacture;

associating a first binary value with the polarized regions; and

associating a second binary value with the unpolarized regions.

40. The method of claim **39**, wherein:

selectively polarizing a first portion of the pyroelectric sensor manufacture so that the first portion of the pyroelectric sensor manufacture stores data electronically comprises:

creating positively polarized regions in the first portion of the pyroelectric sensor manufacture;

creating negatively polarized regions in the first portion of the pyroelectric sensor manufacture;

associating a first binary value with the positively polarized regions; and

associating a second binary value with the negatively polarized regions.

41. The method of claim **40**, wherein:

the second portion of the pyroelectric sensor manufacture comprises the first portion of the pyroelectric sensor manufacture; and

fingerprint data generated by the negatively polarized regions of the pyroelectric sensor manufacture are inverted.

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