

What is claimed is:

1. A sensor, comprising:
two electrodes having a space therebetween; and
a modulatable electrically conductive channel attached to the two electrodes, the
5 modulatable electrically conductive channel including a modified, partially double
stranded nucleic acid polymer electrically connected to the two electrodes and bridging
the space between the two electrodes, the modified, partially double stranded nucleic
acid polymer including:
two polynucleotide chains partially bonded together;
10 a gap in a first of the polynucleotide chains wherein nucleotides are
missing; and
a plurality of nucleotide bases of a second of the polynucleotide chains
exposed at the gap in the first of the polynucleotide chains.
- 15 2. The sensor as defined in claim 1, wherein the gap has a length ranging from
about 10 nm to about 50 nm.
3. The sensor as defined in any of claims 1 or 2, further comprising a
polymerase attached to the modified, partially double stranded nucleic acid polymer.
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4. The sensor as defined in any of claims 1 through 3, wherein:
i) linkers respectively attach each end of the first of the polynucleotide chains to a
respective one of the two electrodes; or
ii) linkers respectively attach each end of the second of the polynucleotide chains
25 to a respective one of the two electrodes; or
iii) both i and ii.
5. The sensor as defined in any of claims 1 through 4, wherein at least one of
the plurality of nucleotide bases exposed at the gap is a guanine base.

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6. The sensor as defined in any of claims 1 through 4, wherein each of the plurality of nucleotide bases exposed at the gap is a guanine base.

5 7. The sensor as defined in any of claims 1 through 6, further comprising a detector to detect a response from the modified, partially double stranded nucleic acid polymer when a switch strand, including a strand of nucleotides including bases complementary to at least some of the plurality of nucleotide bases exposed at the gap, associates with the at least some of the plurality of nucleotide bases at the gap.

10 8. The sensor as defined in any of claims 1 through 7, further comprising: a substrate supporting the two electrodes; and a polymerase attached to the substrate.

15 9. The sensor as defined in any of claims 1 through 8, further comprising a fluidic system to introduce a reagent to the modified, partially double stranded nucleic acid polymer.

20 10. The sensor as defined in claim 9 wherein the reagent includes labeled nucleotides, at least one of the labeled nucleotides including: a nucleotide; a linking molecule attached to a phosphate group of the nucleotide; and a switch strand attached to the linking molecule, the switch strand including a strand of nucleotides including bases complementary to at least some of the plurality of nucleotide bases exposed at the gap.

25 11. The sensor as defined in any of claims 1 through 10, further comprising a plurality of other modulatable electrically conductive channels attached to the two electrodes, each of the other modulatable electrically conductive channels including a respective modified, partially double stranded nucleic acid polymer electrically
30 connected to the two electrodes and bridging the space between the two electrodes.

12. The sensor as defined in any of claims 1 through 10 wherein, the modulatable electrically conductive channel exhibits:

a first conductance when the plurality of nucleotide bases are exposed at the gap; and

5 a second conductance that is different than the first conductance when at least some of the plurality of nucleotide bases at the gap are associated with complementary nucleotide bases.

13. A labeled nucleotide, comprising:

10 a nucleotide;

a linking molecule attached to a phosphate group of the nucleotide; and

a switch strand attached to the linking molecule, the switch strand including a strand of nucleotides including bases complementary to at least some of the plurality of nucleotide bases exposed at the gap of the sensor of any of claims 1 through 12.

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14. A kit, comprising:

an electronic component, including:

a support; and

two electrodes operatively disposed on the support and separated by a

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space; and

a polymeric solution, including:

a liquid carrier; and

a modified, partially double stranded nucleic acid polymer in the liquid carrier, the modified, partially double stranded nucleic acid polymer including:

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two polynucleotide chains partially bonded together and having opposed ends;

a linker attached to each of the opposed ends, each linker to attach to a respective one of the two electrodes;

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a gap in a first of the polynucleotide chains wherein nucleotides are missing; and

a plurality of nucleotide bases of a second of the polynucleotide chains exposed at the gap in the first of the polynucleotide chains; the modified, partially double stranded nucleic acid polymer to form a modulatable electrically conductive channel in the space between the two electrodes
5 when each linker attaches to the respective one of the two electrodes.

15. The kit as defined in claim 14, further comprising a reagent solution including labeled nucleotides, at least one of the labeled nucleotides including:
a nucleotide;
10 a linking molecule attached to a phosphate group of the nucleotide; and
a switch strand attached to the linking molecule, the switch strand including a strand of nucleotides including bases complementary to at least some of the plurality of nucleotide bases exposed at the gap.

15 16. The kit as defined in claim 15, wherein the bases in the switch strand are completely complementary to the plurality of nucleotide bases exposed at the gap.

17. The kit as defined in claim 15, wherein the switch strand further includes at least one nucleotide having a mismatched base that is non-complementary to a
20 corresponding one of the plurality of nucleotide bases exposed at the gap.

18. The kit as defined in claim 15, wherein the strand of nucleotides in the switch strand has at least one nucleotide fewer than the plurality of nucleotide bases exposed at the gap.

25 19. The kit as defined in claim 15, wherein the strand of nucleotides in the switch strand has a higher number of nucleotides than the plurality of nucleotide bases exposed at the gap, and wherein a portion of the switch strand forms a stem loop when associated at the gap.

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20. The kit as defined in claim 15, wherein:

the strand of nucleotides in the switch strand has a higher number of nucleotides than the plurality of nucleotide bases exposed at the gap;

a portion of the switch strand forms a stem loop when associated at the gap; and

5 an other portion of the switch strand is completely complementary to the plurality of nucleotide bases exposed at the gap or includes at least one nucleotide having a mismatched base that is non-complementary to a corresponding one of the plurality of nucleotide bases exposed at the gap.

10 21. A sensing system, comprising:

a flow cell; and

an electronic sensor integrated into the flow cell, the electronic sensor including:

two electrodes having a space therebetween;

a modulatable electrically conductive channel attached to the two

15 electrodes, the modulatable electrically conductive channel including a modified, partially double stranded nucleic acid polymer electrically connected to the two electrodes and bridging the space between the two electrodes, the modified, partially double stranded nucleic acid polymer including:

two polynucleotide chains partially bonded together;

20 a gap in a first of the polynucleotide chains wherein nucleotides are missing; and

a plurality of nucleotide bases of a second of the polynucleotide chains exposed at the gap in the first of the polynucleotide chains.

25 22. The sensing system as defined in claim 21, further comprising a reagent delivery system to selectively introduce a reagent to an input of the flow cell.

23. The sensing system as defined in claim 22, wherein the reagent is in a sample container, and the reagent includes labeled nucleotides, at least one of the

30 labeled nucleotides including:

a nucleotide;

a linking molecule attached to a phosphate group of the nucleotide; and
a switch strand attached to the linking molecule, the switch strand including a strand of nucleotides including bases complementary to at least some of the plurality of nucleotide bases exposed at the gap.

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24. The sensing system as defined in any of claims 21 through 23, further comprising a detector to detect a response from the electronic sensor.

25. The sensing system as defined in any of claims 21 through 24, further
10 comprising a polymerase anchored to the modified, partially double stranded nucleic acid polymer or a support of the electronic sensor.

26. A method, comprising:
introducing a template polynucleotide chain to an electronic sensor having a
15 polymerase tethered to i) a modulatable electrically conductive channel that bridges a space between, and is electrically connected to two electrodes or ii) a substrate supporting the two electrodes, the modulatable electrically conductive channel including a modified, partially double stranded nucleic acid polymer, which includes:
two polynucleotide chains partially bonded together;
20 a gap in a first of the polynucleotide chains wherein nucleotides are missing; and
a plurality of nucleotide bases of a second of the polynucleotide chains exposed at the gap in the first of the polynucleotide chains;
introducing reagents including labeled nucleotides to the electronic sensor,
25 whereby a nucleotide of one of the labeled nucleotides associates with the polymerase and a nucleotide-specific switch strand of the one of the labeled nucleotides associates with at least some of the plurality of nucleotide bases exposed at the gap; and
in response to the association at the gap, detecting a response of the electronic sensor.

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27. The method as defined in claim 26, further comprising:
associating the response of the electronic sensor with the associated nucleotide-specific switch strand; and
based on the associated nucleotide-specific switch strand, identifying the
5 nucleotide of the one of the labeled nucleotides.

28. The method as defined in any of claims 26 or 27, further comprising heating to disassociate the nucleotide-specific switch strand from the gap.