~~What is claimed is:~~Claims

1. A sensor, comprising:

two electrodes ~~having a space therebetween~~; and

~~a modulatable electrically conductive channel attached to the two 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;

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.~~;

further comprising a polymerase attached to the modified, partially double stranded nucleic acid polymer, and

a detector configured to detect a response from the modified, partially double stranded nucleic acid polymer when a nucleotide-specific switch strand, attached to a nucleotide to be detected via a linking molecule, is introduced to the sensor and associates with at least some of the plurality of nucleotide bases exposed at the gap, wherein the switch strand is selected to change the conductivity of the modified, partially double stranded nucleic acid polymer bridging the two electrodes, and includes a strand of nucleotides including bases complementary to the at least some of the plurality of nucleotide bases exposed at the gap.

2. A sensor, comprising:

two electrodes; and

a modified, partially double stranded nucleic acid polymer bridging the two electrodes, the modified, partially double stranded nucleic acid polymer including:

two polynucleotide chains partially bonded together;

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;

further comprising:

a substrate supporting the two electrodes; and

a polymerase attached to the substrate.

3. The sensor according to claim 2, further comprising a detector configured 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.

~~2~~4. The sensor as defined in any of claims 1-3, 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.~~

~~4~~5. The sensor as defined in any of claims 1 ~~through 3~~-4, 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 to a respective one of the two electrodes; or

iii) both i and ii.

~~5~~6. The sensor as defined in any of claims 1 ~~through 4~~-5, wherein at least one of the plurality of nucleotide bases exposed at the gap is a guanine base~~.~~

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

~~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.~~

~~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.~~

~~9~~7. The sensor as defined in any of claims 1 ~~through 8~~-6,
further comprising a fluidic system to introduce a reagent to the modified, partially double stranded nucleic acid polymer~~.~~;

~~10. The sensor as defined in claim 9~~ more preferably 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.

~~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 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~~

~~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~~8. A labeled nucleotide, comprising:

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~~ the previous clauses,

wherein the switch strand is selected to change the conductivity of the modified, partially double stranded nucleic acid polymer bridging the two electrodes of the sensor according to any of the previous claims, when the switch strand associates with at least some of the plurality of nucleotide bases exposed at the gap of the modified, partially double stranded nucleic acid polymer.

~~14~~9. A kit, comprising:

an electronic component, including:

a support; and

two electrodes operatively disposed on the support ~~and separated by a 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:

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;~~

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~~, wherein at least some of the plurality of nucleotide bases are configured to be able to associate with a switch strand having at least some nucleotide bases complementary to the plurality of nucleotide bases exposed at the gap;

wherein the modified, partially double stranded nucleic acid polymer ~~to form a modulatable electrically conductive channel in the space between the two electrodes when each linker attaches to the respective one of the two electrodes~~ is configured such that its conductivity changes when a switch strand associates at the gap;

and further comprising a polymerase attached to the modified, partially double stranded nucleic acid polymer.

~~15~~10. The kit as defined in claim ~~14~~9, further comprising a reagent solution including 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.

~~16~~11. The kit as defined in claim ~~15~~10, wherein the bases in the switch strand are completely complementary to the plurality of nucleotide bases exposed at the gap~~.~~; or

~~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 corresponding one of the plurality of nucleotide bases exposed at the gap~~.~~; or

~~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~~.~~; or

~~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~~.~~; or

~~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

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.

~~21~~12. A sensing system, comprising:

a flow cell; and

~~an electronic~~ a sensor according to any of claims 1-6, integrated into the flow cell~~, the electronic sensor including:~~

~~two electrodes having a space therebetween;~~

~~a modulatable electrically conductive channel attached to the two 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;~~

~~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~~.

~~22~~13. The sensing system as defined in claim ~~21~~12, 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~~, preferably wherein the reagent is in a sample container, ~~and~~ the reagent includ~~es~~ing 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~~.~~;

~~24. The sensing system as defined in any of claims 21 through 23,~~ more preferably 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 comprising a polymerase anchored to the modified, partially double stranded nucleic acid polymer or a support of the electronic sensor.~~

~~26~~14. A method, comprising:

introducing a template polynucleotide chain to an electronic sensor having a polymerase tethered to i) a ~~modulatable electrically conductive channel~~ modified, partially double stranded nucleic acid polymer 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~~ includ~~es~~ing:

two polynucleotide chains partially bonded together;

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, 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.

~~27~~15. The method as defined in claim ~~26~~14, 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 nucleotide of the one of the labeled nucleotides~~.~~, and

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