

WHAT IS CLAIMED IS:

1. A nanopore sensor device for identifying nucleotides, comprising:
 - one or more cis wells;
 - one or more cis electrodes associated with the one or more cis wells;
 - a plurality of trans wells, each of the plurality of trans wells separated from the one or more cis wells by a lipid or solid-state membrane having a nanopore;
 - a plurality of field effect transistors (FETs), each of the plurality of FETs associated with one of the plurality of trans wells;
 - an electrical source configured to provide alternating current (AC) inputs between the one or more cis electrodes and the source terminals of the plurality of FETs; and
 - a controller operably coupled to the plurality of FETs, the controller configured to measure AC responses of the plurality of FETs, wherein the AC responses depend on the identities of the nucleotides within or near the nanopores.
2. The nanopore sensor device of Claim 1, wherein the controller is configured to measure changes of the amplitudes of the AC responses.
3. The nanopore sensor device of Claim 1, wherein the controller is configured to measure changes of the waveform shapes of the AC responses.
4. The nanopore sensor device of any of Claims 1-3, wherein the electrical source is configured to provide an AC voltage in a sinusoidal, rectangular, triangular, saw-tooth, or another suitable waveform alternating between a positive potential and a negative potential.
5. The nanopore sensor device of any of Claims 1-4, wherein ionic fluxes through the nanopores are modulated by: nucleotides passing through the nanopores, labels on nucleotides being incorporated to polynucleotides, or any combination thereof.
6. A method of identifying nucleotides, comprising:

providing a nanopore within a membrane separating a cis well and a trans well;

providing an AC input from an electrical source operably coupled to a cis electrode in the cis well and to the source terminal of a FET in the trans well; and

measuring an AC response from the FET, wherein the AC response depends on the identity of a nucleotide within or near the nanopore.

7. The method of Claim 6, wherein measuring the AC response comprises measuring a change of the amplitude of the AC response.

8. The method of Claim 6, wherein measuring the AC response comprises measuring a change of the waveform of the AC response.

9. The method of any of Claims 6-8, wherein providing the AC input comprises providing an AC voltage in a sinusoidal, rectangular, triangular, saw-tooth, or another suitable waveform alternating between a positive potential and a negative potential.

10. The method of any of Claims 6-9, wherein measuring the AC response comprises measuring a first response associated with a first nucleotide and a second response associated with a second nucleotide without waiting for a transient response to approach a steady-state response.

11. A sensor device for identifying nucleotides, comprising:

an electrode;

a FET;

a partially double-stranded nucleic acid polymer having one end operably coupled to the electrode and the other end operably coupled to the gate terminal of the FET;

an electrical source configured to provide an AC input between the electrode and the source terminal of the FET; and

a controller operably coupled to the FET, the controller configured to measure an AC response of the FET, wherein the AC response depends on the identity of a nucleotide interacting with the partially double-stranded nucleic acid polymer.

12. The sensor device of Claim 11, wherein the controller is configured to measure a change of the amplitude of the AC response.

13. The sensor device of Claim 11, wherein the controller is configured to measure a change of the waveform shape of the AC response.

14. The sensor device of any of Claims 11-13, wherein the electrical source is configured to provide an AC voltage in a sinusoidal, rectangular, triangular, saw-tooth, or another suitable waveform alternating between a positive potential and a negative potential.

15. The sensor device of any of Claims 11-14, wherein electrical conduction through the partially double-stranded nucleic acid polymer is modulated by a nucleic acid label on a nucleotide being incorporated to a polynucleotide, the nucleic acid label being partially complementary to the partially double-stranded nucleic acid polymer.