NANOELECTRIC DEVICES AND USE THEREOF

CROSS-REFERENCE

[0001] This application claims the benefit of U.S. Provisional Application No. 63/287,458 filed December 8, 2021 and U.S. Provisional Application No. 63/313,016 filed February 23, 2022, which are incorporated by reference in their entirety.

BACKGROUND

[0002] Biomolecule based information storage systems, *e.g.*, DNA-based, have a large storage capacity and stability over time. However, there is a need for scalable, automated, highly accurate and highly efficient systems for generating and reading biomolecules for information storage.

BRIEF SUMMARY

[0002a] In one aspect, provided herein is a method for single molecule sensing comprising: forming a ternary complex by contacting a molecular sensor with at least one charge modulator, wherein the ternary complex is bound to a charge sensor, and contacting the molecular sensor with the at least one charge modulator generates a change in current; measuring the change in current; correlating the change in current with a presence of the at least one charge modulator, thereby sensing a single molecule; and removing the ternary complex from the charge sensor.

[0002b] In another aspect, provided herein is a method for single molecule polynucleotide sequencing comprising: contacting a plurality of polynucleotides with at least one primer and at least one polymerase to form a plurality of ternary complexes, wherein the plurality of ternary complexes comprise a graphene binder; detecting one or more bases of the polynucleotides in real time, wherein detection occurs when the plurality of ternary complexes are bound to a graphene layer of a device, wherein the device is a chemically sensitive field effect transistor device or a CMOS device; and removing the ternary complexes from the graphene layer of the device.

[0003] Provided herein are devices and methods for detection of biomolecules.

[0004] Provided herein are methods for single molecule sensing comprising: (a) contacting a molecular sensor with at least one charge modulator, wherein contacting generates a change in current; (b) measuring the change in current; and (c) correlating the change in current with the presence or absence of the at least one charge modulator, thereby sensing the single molecule. Further provided are methods wherein the single molecule comprises a biomolecule. Further provided herein are methods wherein the biomolecule comprises a nucleic acid. Further provided herein are methods wherein the nucleic acid comprises DNA, RNA, or a mixture thereof. Further

provided herein are methods wherein the charge sensor comprises a graphene-enabled field effect transistor (GeFET) or CMOS device. Further provided herein are methods wherein the molecular sensor is in electrical communication with a charge sensor. Further provided herein are methods wherein the molecular sensor comprises a polymerase. Further provided herein are methods wherein the molecular sensor comprises an isothermal polymerase. Further provided herein are methods wherein the molecular sensor comprises Phi29 polymerase or variant thereof. Further provided herein are methods wherein the at least one charge modulator comprises a negative or positive charge. Further provided herein are methods wherein the at least one charge modulator comprises a charge modulating nucleotide (CMN). Further provided herein are methods wherein contacting comprising incorporating a CMN into a polynucleotide primer. Further provided herein are methods wherein the CMN comprises at least one modification relative to a canonical nucleotide. Further provided herein are methods wherein the modification comprises a modification to the base of the CMN. Further provided herein are methods wherein the modification comprises a