

CLAIMS

What is claimed is:

- 5 1. A system for controlling translocation of a target molecule through a nanopore, comprising:
- a sensing membrane deposited onto a substrate, wherein the sensing membrane includes a single nanopore formed therein;
- one or more spacers disposed onto an exposed top surface of the sensing
10 membrane;
- a filter membrane disposed over the one or more spacers and onto the top surface of the sensing membrane, whereby the sensing membrane, the one or more spacers and the filter membrane form a sensing structure and wherein the filter membrane includes a plurality of nanopores formed therein;
- 15 wherein the filter membrane is separated from the sensing membrane by a distance on the order of contour length of the target molecule and the average size of a nanopore in the plurality of nanopores formed in the filter membrane is less than twice the radius of gyration of the target molecule;
- two chambers configured to host a fluid and fluidly coupled to each other by a
20 fluidic channel, wherein the sensing structure is disposed into fluidic channel and thereby prevents the fluid from passing between the two chambers except through the nanopores formed therein; and
- two electrodes electrically coupled to a voltage source and configured to apply an electrical potential across the sensing structure, such that one electrode is placed into
25 each of the two chambers.
2. The system of claim 1 wherein the filter membrane is configured to exhibit electrical resistance lower than the electrical resistance exhibited by the sensing membrane.
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3. The system of claim 1 wherein filter membrane and the sensing membrane define a space between them such that volume of the space between the filter membrane and the sensing membrane is less than a thousand times the volume of the target molecule when the target molecule is in coiled form in a free solution.

4. The system of claim 1 wherein the sensing membrane is comprised on a dielectric material.

5. The system of claim 1 wherein the sensing membrane is comprised on a two-dimensional material.

6. The system of claim 1 wherein the one or more spacers are configured to separate the filter membrane from the sensing membrane by a distance and sized such that the distance is less than contour length of the target molecule.

7. The system of claim 8 wherein the plurality of nanopores formed in the filter membrane with an average nearest neighbor distance between any two nanopores such that two times the distance between the filter membrane and the sensing membrane plus the average nearest neighbor distance between any two nanopores is greater than contour length of the target molecule.

8. The system of claim 1 wherein the plurality of nanopores formed in the filter membrane with an average nearest neighbor distance between any two nanopores such that the average nearest neighbor distance between any two nanopores is less than radius of gyration of the target molecule when the target molecule is in a free solution.

9. The system of claim 1 wherein the filter membrane is configured to exhibit electrical resistance and the sensing membrane is configured to exhibit an electrical resistance such that quotient of the electrical resistance exhibited by the filter membrane divided by the electrical resistance exhibited by the sensing membrane is less than 0.01.

10. A sensing structure for controlling translocation of a target molecule through a nanopore, comprising:

a sensing membrane with a single nanopore formed therein;

one or more spacers disposed onto a surface of the sensing membrane; and

5 a filter membrane disposed over the one or more spacers and onto the surface of the sensing membrane, wherein the filter membrane includes a plurality of nanopores formed therein and the one or spacers are sized such that the filter membrane is separated from the sensing membrane by a distance on the order of contour length of the target molecule and the average size of a nanopore in the plurality of nanopores formed
10 in the filter membrane is less than twice the radius of gyration of the target molecule.

11. The sensing structure of claim 10 wherein the filter membrane is configured to exhibit electrical resistance lower than the electrical resistance exhibited by the sensing membrane.

12. The sensing structure of claim 10 wherein filter membrane and the sensing membrane define a space between them such that volume of the space between the filter membrane and the sensing membrane is less than a thousand times less the volume of the target molecule when the target molecule is in coiled form in a free solution.

13. The sensing structure of claim 10 wherein the plurality of nanopores formed in the filter membrane with an average nearest neighbor distance between any two nanopores such that two times the distance between the filter membrane and the sensing membrane plus the average nearest neighbor distance between any two nanopores is
25 greater than contour length of the target molecule.

14. The sensing structure of claim 10 wherein the plurality of nanopores formed in the filter membrane with an average nearest neighbor distance between any two nanopores such that the average nearest neighbor distance between any two nanopores
30 is less than radius of gyration of the target molecule when the target molecule is in a free solution.

15. The sensing structure of claim 10 wherein the filter membrane is configured to exhibit electrical resistance and the sensing membrane is configured to exhibit an electrical resistance such that quotient of the electrical resistance exhibited by the filter membrane divided by the electrical resistance exhibited by the sensing membrane is less than 0.01.

16. A method for controlling translocation of a target polymer through a sensing membrane having a single nanopore formed therein, comprising:

positioning a sensing structure in a fluidic channel, the sensing structure having a filter membrane disposed onto a sensing membrane, where the filter membrane includes a plurality of nanopores formed therein and the filter membrane is separated by one or more spacers from the sensing membrane, wherein the filter membrane is separated from the sensing membrane by a distance on the order of contour length of the target molecule and the average size of a nanopore in the plurality of nanopores formed in the filter membrane is less than twice the radius of gyration of the target molecule;

driving a target polymer through the nanopore in the sensing structure by applying an electric potential across the sensing structure; and

measuring passage time of the target polymer through the nanopore in the sensing membrane, where a distance separating the filter membrane from the sensing membrane is less than contour length of the target molecule.

17. The method of claim 16 wherein plurality of nanopores in the filter membrane are formed with an average nearest neighbor distance between any two nanopores such that two times the distance between the filter membrane and the sensing membrane plus the average nearest neighbor distance between any two nanopores is greater than contour length of the target molecule.

18. A method for controlling translocation of a target polymer through a sensing membrane having a single nanopore formed therein, comprising:

positioning a sensing structure in a fluidic channel, the sensing structure having a filter membrane disposed onto a sensing membrane, where the filter membrane includes a plurality of nanopores formed therein and the filter membrane is separated by one or more spacers from the sensing membrane,

wherein the filter membrane is separated from the sensing membrane by a distance on the order of contour length of the target molecule and the average size of a nanopore in the plurality of nanopores formed in the filter membrane is less than twice the radius of gyration of the target molecule;

5 driving a target polymer through the nanopore in the sensing structure by applying an electric potential across the sensing structure; and

measuring passage time of the target polymer through the nanopore in the sensing membrane, where the plurality of nanopores formed in the filter membrane with an average nearest neighbor distance between any two
10 nanopores such that the average nearest neighbor distance between any two nanopores is less than radius of gyration of the target molecule when the target molecule is in a free solution.

19. A method for controlling translocation of a target polymer into a sensing
15 structure of a nanodevice, where the sensing structure includes a filter membrane having a plurality of nanopores and a sensing membrane having a single sensing nanopore formed therein, wherein the filter membrane is separated from the sensing membrane by a distance on the order of contour length of the target molecule and the average size of a nanopore in the plurality of nanopores formed in the filter membrane is less than twice the radius
20 of gyration of the target molecule, comprising:

driving a target polymer through the sensing nanopore in the sensing structure and into a cavity formed between the filter membrane and the sensing membrane, where the target polymer is driven by applying an electric potential across the sensing structure;

trapping the target polymer in the cavity, where distance separating the filter
25 membrane from the sensing membrane is larger than capture radius of the target polymer; and

ejecting the target polymer from the cavity in the sensing structure by reversing the electric potential applied across the sensing structure.