

CLAIMS

What is claimed is:

1. A bioelectronic device comprising:
a first electrode and a second electrode separated by a gap; and
a protein attached to the first and second electrodes via a linker;
wherein the electrical surface potential of the first and second electrodes at zero bias is from about 250 mV to about 400 mV on the normal hydrogen electrode scale.
2. The device of claim 1, wherein conductance of the protein is maximized when the surface potential of the first and second electrodes at zero bias is from about 250 mV to about 400 mV.
3. The device of claim 1 or claim 2, wherein the surface potential of the first and second electrodes at zero bias is from about 250 mV to about 350 mV.
4. The device of any of claims 1 to 3, wherein the first and second electrodes are comprised of a metal or metals that impart a surface potential from about 250 mV to about 400 mV at zero bias.
5. The device of any of claims 1 to 4, wherein at least one of the first and second electrodes comprises a different metal as that of the other electrode.
6. The device of any of claims 1 to 5, wherein at least one of the first and second electrodes comprises gold or an alloy thereof.
7. The device of any of claims 1 to 6, wherein both the first and second electrodes comprise gold or an alloy thereof.
8. The device of any of claims 1 to 6, wherein the first electrode comprises gold or an alloy thereof and the second electrode comprises a different metal or an alloy thereof.

9. The device of claim 8, wherein the second electrode comprises palladium or an alloy thereof.
10. The device of claim 8, wherein the second electrode comprises platinum or an alloy thereof.
11. The device of any of claims 1 to 10, wherein the device comprises a reference electrode, and wherein the surface potential of the first and second electrodes is maintained at about 250 mV to about 400 mV due to a bias applied between the reference electrode and at least one of the first or second electrode.
12. The device of claim 11, wherein the reference electrode comprises a third electrode immersed in an electrolyte solution and in contact with the first and second electrodes.
13. The device of any of claims 1 to 12, wherein the gap has a width of about 1.0 nm to about 20.0 nm.
14. The device of any of claims 1 to 13, wherein the first and second electrodes are separated by a dielectric layer.
15. The device of any of claims 1 to 14, wherein the protein is a non-redox protein.
16. The device of claim 15, wherein the protein is selected from the group consisting of a polymerase, a nuclease, a proteasome, a glycopeptidase, a glycosidase, a kinase and an endonuclease.
17. The device of any of claims 1 to 16, wherein the linker is attached to an inactive region of the protein.
18. The device of any of claims 1 to 17, wherein the linker comprises a covalent chemical bond.
19. The device of any of claims 1 to 18, wherein the protein is biotinylated.

20. The device of any of claims 1 to 19, wherein the linker comprises thio-streptavidin.
21. The device of any of claims 1 to 20, wherein the protein and the first and second electrodes are biotinylated, and wherein the linker comprises a streptavidin molecule comprising at least two biotin binding sites.
22. A system for direct electrical measurement of protein activity, the system comprising:
- (a) the bioelectronic device of any of claims 1 to 21;
 - (b) a means for introducing an analyte capable of interacting with the protein;
 - (c) a means for applying a voltage bias between the first and second electrodes that is 100mV or less; and
 - (d) a means for monitoring fluctuations that occur as the chemical entity interacts with the protein.
23. An array comprising a plurality of the bioelectronic devices of claims 1 to 21.
24. The array of claim 23, wherein the array comprises:
- (a) a means for introducing an analyte capable of interacting with the protein;
 - (b) a means for applying a voltage bias between the first and second electrodes that is 100mV or less; and
 - (c) a means for monitoring fluctuations that occur as the chemical entity interacts with the protein.
25. A method for direct electrical measurement of protein activity, the method comprising
- (a) introducing an analyte capable of interacting with the protein to any of the devices of claims 1 to 21;
 - (b) applying a voltage bias between the first and second electrodes that is 100mV or less; and
 - (c) observing fluctuations in current between the first and second electrodes that occur when the analyte interacts with the protein.
26. The method of claim 25, wherein the analyte is a biopolymer selected from the group consisting of a DNA molecule, an RNA molecule, a peptide, a polypeptide, or a glycan.