

WHAT IS CLAIMED IS:

1. A dielectrophoretic (DEP) sensor, comprising:
a graphene electrode adjacent a channel for confining a target particle in a liquid;
a surface probe attached to a surface of the graphene electrode, the surface probe having a selective reaction with the target particle; and
a voltage source electrically connected to the graphene electrode and configured to apply a voltage to the graphene electrode to cause DEP trapping of the target particle at the graphene electrode.
2. The DEP sensor of claim 1, wherein the surface probe and target particle are a complimentary pairs selected from the group consisting of molecules, proteins, aptamers, antibodies, lipids, vesicles, cell-derived particles, functionalized nanoparticles and whole cells.
3. The DEP sensor of claim 1 or 2, wherein the graphene electrode comprises a plurality of strips.
4. The DEP sensor of claim 3, wherein the strips are parallel to each other.
5. The DEP sensor of any one of the preceding claims, further comprising a second electrode overlapping with the graphene electrode and electrically connected with the voltage source.
6. The DEP sensor of claim 5, further comprising a source meter in electrical communication with the graphene electrode and the second electrode.
7. The DEP sensor of any one of the preceding claims, wherein the DEP sensor is a resistance-based sensor.

8. The DEP sensor of any one of the preceding claims, wherein the DEP sensor is a capacitance based sensor.
9. A readout method for a dielectrophoretic (DEP) sensor comprising a graphene electrode with a surface probe attached to a surface of the graphene electrode, the surface probe having a selective reaction with a target particle, the readout method comprising:
 - applying an AC excitation to the graphene electrode sufficient to dielectrophoretically attract the target particle toward the graphene electrode; and
 - applying a measurement signal to the graphene electrode, the measurement signal being sufficient to readout a response from the DEP sensor indicative of a presence of the target particle.
10. The readout method of claim 9, wherein the measurement signal is a DC signal.
11. The readout method of claim 9 or 10, wherein the measurement signal is an AC signal.
12. The readout method of any one of claims 9-11, wherein an amplitude of the AC excitation is larger than an amplitude of the measurement signal.
13. The readout method of any one of claims 9-12, wherein the readout is based on a change of capacitance measured by the sensor.
14. The readout method of any one of claims 9-12, wherein the readout is based on a change of current measured by the sensor.
15. The readout method of any one of claims 9-14, wherein the surface probe and target particle are a complimentary pairs selected from the group consisting of

molecules, proteins, aptamers, antibodies, lipids, vesicles, cell-derived particles, functionalized nanoparticles and whole cells.