Claims

1. An electric field gradient sensor, comprising:
   - a sensor body having an outer surface; and
   - a plurality of electrodes distributed over said outer surface, each electrode having an electrode surface facing outward from said outer surface;

   wherein said plurality of electrodes are arranged forming a plurality of electrode pairs, each electrode pair comprising a first electrode and a second electrode located on opposite sides of said sensor body, wherein the electric field gradient sensor further comprises sensor electronics for measuring a voltage over each of said electrode pairs, said sensor electronics comprising electrical contacts to each of said plurality of electrodes, and wherein the electric field gradient sensor further comprises a bias electrode arranged for setting a bias voltage for said sensor electronics.

2. Sensor according to claim 1, wherein each electrode is provided with a non-conductive tube, a first end of said tube enclosing said electrode.

3. Sensor according to claim 2, wherein said non-conductive tubes extend in a substantially radial direction outwards from said sensor body.

4. Sensor according to claim 2 or 3, wherein said non-conductive tube comprises a plastic material, a flexible polymer or rubber.

5. Sensor according to any one of the preceding claims, wherein for each electrode pair an interconnecting line is formed interconnecting the first electrode and the second electrode, and wherein said electrodes are distributed over said surface such that said interconnecting lines intersect at one single point of intersection.

6. Sensor according to claim 5, wherein said single point of intersection substantially corresponds to a geometrical center of said sensor body.

7. Sensor according to any one of the preceding claims, wherein said sensor body has a substantially spherical shape.

8. Sensor according to any one of the preceding claims, wherein said sensor body has an oblate spheroid shape or a prolate spheroid shape.

9. Sensor according to any one of the preceding claims, wherein said sensor body has a substantially cylindrical shape.

10. Sensor according to claim 1, wherein said sensor electronics is arranged within said sensor body or at a vehicle to which the sensor is mounted.

11. Sensor according to claim 1 or 10, wherein said sensor electronics further comprises a microcontroller for sampling a differential voltage over each electrode pair.

12. Sensor according to claim 11, wherein said sensor electronics further comprises one or more of the following: amplifiers for amplifying measured voltages, a power source, and a communication unit for communicating said measured voltages to a receiver arranged remote from said sensor.

13. Sensor according to claim 1, when dependent on claim 5 or 6, wherein said bias electrode is arranged at said single point of intersection.

14. Sensor according to claim 12, wherein said bias electrode is arranged outside of said sensor body, preferably at a center location in front of the sensor body.

15. Sensor according to any one of the preceding claims, wherein said sensor body comprises a plastic material and/or a composite material.

16. Sensor according to any one of the preceding claims, wherein said electrode surfaces comprise gold, carbon, platinum, titanium or stainless steel.

17. Sensor according to claim 15, wherein said electrodes are formed by gold plated circuit boards, gold plated circuit boards printed with carbon; or by metal plated with gold or platinum.

18. Sensor according to any one of the preceding claims, wherein said plurality of electrodes comprises between 6 to 40 electrodes, preferably between 20 to 34, more preferably 24 or 32 electrodes.

19. Sensor according to any one of the preceding claims, further comprising a mounting component coupled to said sensor body for mounting said sensor to a vehicle, in particular to an unmanned underwater vehicle.

20. Sensor according to any one of the preceding claims, wherein said sensor body is hollow and is provided with a plurality of holes in the outer surface.

21. System for measuring an electric field gradient at a structure located in an electrically conductive medium, the system comprising:

- an electric field gradient sensor comprising a sensor body having an outer surface and a plurality of electrodes distributed over said surface, each electrode having an electrode surface facing outward from said surface;
- an unmanned underwater vehicle, wherein the electrical field gradient sensor is mounted to the unmanned underwater vehicle; and
- sensor electronics for measuring a voltage over each of said electrode pairs, said sensor electronics comprising electrical contacts to each of said plurality of electrodes;

wherein said plurality of electrodes are arranged forming a plurality of electrode pairs, each electrode pair comprising a first electrode and a second electrode located on opposite sides of said sensor body, and

wherein the system further comprises a bias electrode arranged for setting a bias voltage for said sensor electronics.

22. System according to claim 21, wherein said sensor electronics is arranged within said sensor body or in said vehicle.

23. System according to claim 21 or 22, wherein for each electrode pair an interconnecting line is formed interconnecting the first electrode and the second electrode, and wherein said electrodes are distributed over said surface such that said interconnecting lines intersect at one single point of intersection.

24. System according to claim 23, wherein said single point of intersection substantially corresponds to a geometrical center of said sensor body.

25. System according to any one of claims 21 to 24, wherein said sensor electronics further comprises a microcontroller for sampling a differential voltage over each electrode pair.

26. System according to claim 25, wherein said sensor electronics further comprises one or more of the following: amplifiers for amplifying measured voltages, a power source, and a communication unit for communicating said measured voltages to a receiver arranged remote from said sensor.

27. System according to claim 21 when dependent on claim 23 or 24, wherein said bias electrode is arranged at said single point of intersection.

28. System according to claim 21, wherein said bias electrode is arranged outside of said sensor body, preferably at a center location in front of the sensor body.

29. System according to any one of claims 21 to 28, wherein said sensor body comprises a plastic material and/or a composite material.

30. System according to any one of claims 21 to 29, wherein said sensor body is hollow and is provided with a plurality of holes in the outer surface.

31. Method for manufacturing an electric field gradient sensor, comprising the steps of:
    - providing sensor electronics;
    - forming a sensor body around said sensor electronics, said sensor body having an outer surface; and
    - forming a plurality of electrodes distributed over said surface, each electrode having an electrode surface facing outward from said surface and being electrically connected to said sensor electronics;

    wherein said plurality of electrodes are arranged such as to form a plurality of electrode pairs, each electrode pair comprising a first electrode and a second electrode located on opposite sides of said sensor body, and

    wherein the method further comprises arranging a bias electrode for setting a bias voltage for said sensor electronics.

32. Method according to claim 31, wherein for each electrode pair an interconnecting line is formed interconnecting the first electrode and the second electrode, and wherein said electrodes are distributed over said surface such that said interconnecting lines intersect at one single point of intersection.

33. Method according to claim 32, wherein said single point of intersection substantially corresponds to a geometrical center of said sensor body.

34. Method according to any one of claims 31 to 33, wherein said sensor body is formed by 3D printing.

35. Method according to any one of claims 31 to 33, wherein said sensor body is formed by molding or machining.

36. Method according to any one of claims 31 to 35, wherein said sensor body comprises a plastic material or a composite material.

37. Method according to any one of claims 31 to 35, wherein said step of forming said plurality of electrodes comprises providing electrodes having the outward facing electrode surface comprising gold, carbon, platinum, titanium or stainless steel.

38. Method according to claim 37, wherein said electrode surface is formed by plating gold or platinum onto a metal.

39. Method according to any one of claims 31 to 38, wherein said step of forming said plurality of electrodes comprises plating circuit boards with gold.

40. Method according to any one of claims 31 to 39, wherein said step of forming said plurality of electrodes comprises printing carbon onto gold plated circuit boards.

41. Method according to any one of claims 31 to 40, further comprising attaching a non-conducting tube to each of said electrodes such that a first end of said tube encloses said electrode, said tube extending radially outwards from said sensor body.

42. Method of performing electric field gradient measurements in the vicinity of a structure located in an electrically conducting medium, comprising the steps of:

- providing an electric field gradient sensor according to any one of claims 1 to 20;
- mounting said sensor to an unmanned underwater vehicle; and
- moving said vehicle along at least a part of said structure, while sampling differential voltages over said electrode pairs of said sensor at a plurality of sampling locations.

43. Method according to claim 42, wherein said sensor is maintained substantially fixed with respect to said vehicle.

44. Method according to claim 42 or 43, wherein said differential voltages are combined to form an electric field gradient vector at each of said plurality of sampling locations.

45. Method according to any one of claims 42 to 44, further comprising registering the position of each sampling location.