

Claims

1. 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
5 surface facing outward from said 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.
2. Sensor according to claim 1, wherein each electrode is provided with a non-conductive tube,
10 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 material comprises a plastic material, a flexible polymer or rubber.
- 15 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
20 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.
- 5 10. Sensor according to any one of the preceding claims, further comprising 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.
11. Sensor according to claim 10, wherein said sensor electronics is arranged within said sensor body or at a vehicle to which the sensor is mounted.
- 10 12. Sensor according to claim 10 or 11, wherein said sensor electronics further comprises a microcontroller for sampling a differential voltage over each electrode pair.
13. Sensor according to claim 12, 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
15 remote from said sensor.
14. Sensor according to any one of claims 10 to 13, further comprising a bias electrode arranged for setting a bias voltage for said sensor electronics.
15. Sensor according to claim 14, when dependent on claim 2 or 3, wherein said bias electrode is arranged at said single point of intersection.
- 20 16. Sensor according to claim 13, wherein said bias electrode is arranged outside of said sensor body, preferably at a center location in front of the sensor body.

17. Sensor according to any one of the preceding claims, wherein said sensor body comprises a plastic material and/or a composite material.
18. Sensor according to any one of the preceding claims, wherein said electrode surfaces comprise gold, carbon, platinum, titanium or stainless steel.
- 5 19. Sensor according to claim 17, 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.
20. 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
10 32 electrodes.
21. 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.
22. Sensor according to any one of the preceding claims, wherein said sensor body is hollow
15 and is provided with a plurality of holes in its outer surface.
23. 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
20 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.

24. System according to claim 23, wherein said sensor electronics is arranged within said sensor body or in said vehicle.
25. System according to claim 23 or 24, 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.
26. System according to claim 25, wherein said single point of intersection substantially corresponds to a geometrical center of said sensor body.
27. System according to any one of claims 22 to 26, wherein said sensor electronics further comprises a microcontroller for sampling a differential voltage over each electrode pair.
28. System according to claim 27, 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.
29. Sensor according to any one of claims 23 to 28, further comprising a bias electrode arranged for setting a bias voltage for said sensor electronics.
30. System according to claim 29 when dependent on claim 25 or 26, wherein said bias electrode is arranged at said single point of intersection.
31. System according to claim 29, wherein said bias electrode is arranged outside of said sensor body, preferably at a center location in front of the sensor body.

32. System according to any one of claims 23 to 31, wherein said sensor body comprises a plastic material and/or a composite material.
33. System according to any one of claims 23 to 32, wherein said sensor body is hollow and is provided with a plurality of holes in its outer surface.
- 5 34. 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
- 10 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.
- 15 35. Method according to claim 34, 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.
36. Method according to claim 35, wherein said single point of intersection substantially
- 20 corresponds to a geometrical center of said sensor body.
37. Method according to any one of claims 34 to 36, wherein said sensor body is formed by 3D printing.
38. Method according to any one of claims 34 to 36, wherein said sensor body is formed by molding or machining.

39. Method according to any one of claims 34 to 38, wherein said sensor body comprises a plastic material or a composite material.
40. Method according to any one of claims 34 to 38, 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.
41. Method according to claim 40, wherein said electrode surface is formed by plating gold or platinum onto a metal.
42. Method according to any one of claims 34 to 41, wherein said step of forming said plurality of electrodes comprises plating circuit boards with gold.
43. Method according to any one of claims 34 to 42, wherein said step of forming said plurality of electrodes comprises printing carbon onto gold plated circuit boards.
44. Method according to any one of claims 34 to 43, 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.
45. Method of performing electric field gradient measurements 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 22;
 - 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.
46. Method according to claim 45, wherein said sensor is maintained substantially fixed with respect to said vehicle.
47. Method according to claim 45 or 46, wherein said differential voltages are combined to form an electric field gradient vector at each of said plurality of sampling locations.

48. Method according to any one of claims 45 to 47, further comprising registering the position of each sampling location.