impossible to determine their positions in respect of each other and of anatomical landmarks.

Due to their flexibility thin oblong microelectrodes cannot be implanted by inserting them into soft tissue in the absence of a support making them sufficiently rigid for this purpose, they are even more difficult to implant in a desired disposition in respect of a selected target in the brain like a nerve cell. The targeted disposition of a set of such microelectrodes therefore requires measures not readily available in the art, such as avoiding them damaging a blood vessel and to spread them out in the tissue in a desired manner.

ASPECTS OF THE INVENTION

A primary aspect of the present invention is to provide a microelectrode that does not damage blood vessels during implantation by insertion into soft tissue and/or during its disposition in non-static soft tissue or, at least, to provide a microelectrode of which the risk of damage is substantially reduced. The soft tissue concerned is primarily nervous tissue, in particular brain or spinal cord tissue, but also endocrine tissue such as tissue of the pituitary, pineal, thyroid, parathyroid, and adrenal glands, testes and ovaries tissue, and pancreatic islets of Langerhans tissue.

Another primary aspect of the present invention is to provide a microelectrode that minimizes cell damage.

Another aspect of the present invention is to provide a set of such microelectrodes.

Still another aspect of the present invention is to provide a means for determining the position of a microelectrode pertaining to a set of implanted microelectrodes in respect of any other microelectrode and/or an anatomical landmark like a particular nerve cell or a nucleus.

A further aspect of the present invention is to provide a set of such microelectrodes of which each electrode can be identified *in situ* upon insertion.

A still further aspect of the invention is to provide a method of manufacture of the microelectrode of the invention and of a set comprising two or more microelectrodes of the invention.

Additional aspects of the present invention will become apparent from the study of the following summary of the invention, the description of preferred embodiments thereof, and the appended claims.

SUMMARY OF THE INVENTION

The microelectrode of the invention is of such kind that it only can be disposed in soft tissue by means of a rigid support. In this application the combination of microelectrode and rigid support is termed proto-microelectrode. Upon implantation the rigid support is removed by dissolution in body fluid and the microelectrode of the invention is formed *in situ*.

Soft tissue according to the invention is, in particular, nervous tissue such as brain tissue, spinal cord tissue, dorsal root ganglia and peripheral nerves but includes also body fluid and membranes enclosing such tissue.

According to the present invention, there is provided a microelectrode for implantation into soft tissue, in particular nervous tissue, comprising an oblong electrode body of an electrically conducting material having a proximal end and a distal end, wherein the electrode body is covered by a layer of first insulating material except for at an annular contact section thereof disposed between a distal section extending from the distal end in a proximal direction and a proximal section extending from the annular section to the proximal end, the layer of insulating material on the distal terminal section extending distally of the distal end of the electrode body so as to fully enclose the distal end to form a blunt distal bulge or wherein the layer of first insulating material on the distal terminal section is covered or substituted by a layer of second insulating material forming the bulge. The bulge has a radial

The Claims defining the Invention are as follows:

1. A microelectrode for implantation into soft tissue, optionally nervous or endocrine tissue, comprising an oblong electrode body of electrically conducting material having a proximal end and a distal end, the body comprising insulated distal and proximal sections extending from the distal and proximal ends, the distal section optionally comprising a bulb at its distal end; wherein the distal and proximal sections are separated by an annular section, wherein the proximal section is covered by a layer of first insulating material and wherein the electrode comprises a blunt distal terminal bulge formed by one of:

a) a layer of first insulating material on the distal section;

b) a layer of first insulating material on the distal section covered or fully or partly substituted by a layer of a second insulating material; or

c) a layer on the bulb, the layer comprising one or more of first insulating material and second insulating material;

wherein the bulge has a radial extension substantially greater than that of the proximal section covered by the layer of first insulating material.

2. The microelectrode of claim 1, wherein the electrode body is:

a) rotationally symmetric;

b) flexible;

c) rotationally symmetric and flexible; or

d) flexible and curved and of a shape so as to be of rotationally symmetric form in a straight conformation.

3. The microelectrode of claim 2, wherein a distal face of the distal bulge is substantially hemispherical or hemi-elliptic or of paraboloid or hyperboloid form, and wherein the distal bulge

comprises a circular or elliptic base facing in a proximal direction centred on the axis of rotational symmetry.

4. The microelectrode of any one of claims 1 to 3, wherein said radial extension is greater by 50 % or more, or by 100 % or more, or by 1000 % or more than the radial extension of the layer of first insulating material on the proximal section.

5. The microelectrode of any one of claims 1 to 4, wherein the axial length ratio of the distal section to the proximal section is 1:5 or more, 1:10 or more, 1:20 or more, or 1:50 or more.

6. The microelectrode of any one of claims 1 to 5, wherein the axial length of the annular section is 10 % or less, or 5 % or 2 % or 1 % or less of the length of the electrode body.

7. The microelectrode of any one of claims 1 to 6, wherein a layer of insulating material on the distal section is of a material different from that on the proximal section.

8. The microelectrode of claim 7, wherein a material capable of swelling in contact with aqueous body fluid is disposed on a layer, the layer comprising one or more of first and second insulating material covering the bulge, wherein the material capable of swelling optionally has a Bloom strength of from 200 to 300 or more, or from 200 to 350, or about 300.

9. The microelectrode of claim 8, wherein swelling at body temperature and upon reaching equilibrium is by a factor of 2, or by a factor of 5, or by a factor of 10 or more.

10. The microelectrode of any one of claims 7 to 9, wherein an insulating material disposed on the distal section is resilient.

11. The microelectrode of claim 10, wherein the resilient material comprises closed gas-filled cells.

12. The microelectrode of any one of claims 1 to 11, attached or attachable to a flexible insulated electrical conductor, wherein the attachment is to the electrode body at or near the proximal end thereof in an electrically conducting manner.

13. The microelectrode of any one of claims 1 to 12, wherein the electrode body is of a metal or comprises a metal.

14. The microelectrode of any one of claims 1 to 12, wherein the electrode body is of an electrically conducting polymer or comprises such polymer.

15. A proto-microelectrode comprising or consisting of the microelectrode of any one of claims 1 to 14 and a biocompatible solid support material, wherein the support material is rigid and dissolvable in body fluid.

16. The proto-microelectrode of claim 15, wherein the support material consists of or comprises:

a) carbohydrate;
b) protein; or
c) carbohydrate and protein; and
d) optionally comprises a pharmacologically active agent selected from the group consisting of coagulant, anticoagulant, antibiotic, osmotic pressure adjusting agent, anti-inflammatory agent, nutrient, factor stimulating growth, factor stimulating cell differentiation, hormone.

17. The proto-microelectrode of claim 15 or 16, wherein the support material encloses the microelectrode partially or fully.

18. The proto-microelectrode of any one of claims 15 to 17, wherein the support material is rigid.

19. A set of axially aligned proto-microelectrodes of any one of claims 15 to 18 sharing said support material.

20. The set of claim 19, wherein the proto-microelectrodes are disposed in parallel or in a mode fanning out in a distal direction.

21. The set of claim 19, wherein a microelectrode comprises one or more additional subsections of second insulating material of a radial extension substantially greater than that of the insulating layer on the proximal section, wherein said subsections are comprised by:

a) the distal section;

b) the proximal section; or

c) the distal section and the proximal section.

22. The set of claim 21, wherein said subsections are separated by intermediate sections of smaller radial extension.

23. The set of claim 19 or claim 20, comprising an expandable material capable of swelling in body fluid disposed between two or more microelectrodes in the proximity of their distal ends, wherein the dissolution rate of material capable of swelling is lower than the dissolution rate of the support material and wherein said material capable of swelling has a Bloom strength of from about 80 to 200, or from about 100 to 150.

24. The set of any one of claims 19 to 23, wherein a distal bulge of insulating material is of non-spherical form.

25. The set of claim 24, wherein the distal bulge of non-spherical form is oblong and is axially disposed in such a manner so as to slant radially outwardly in respect of an axis of rotational symmetry of the layer.

26. The set of any one of claims 20 to 25, wherein two or more subsections of substantially greater diameter than that of the insulating layer on the proximal section differ in their radial extension.

27. The set of any one of claims 19 to 26, wherein said two or more microelectrodes differ in the composition of insulating material forming:

a) their distal bulges;

b) one or more of said subsections; or

c) their distal bulges and one or more of said subsections;

so as to allow identification of individual microelectrodes implanted in nervous tissue by radiative means.

28. The set of any one of claims 19 to 27, comprising microelectrodes of different length.

29. The proto-microelectrode of any one of claims 15 to 18 or the set of proto-microelectrodes of any one of claims 19 to 28 comprising a friction reducing coat on the support material.

30. Use of the microelectrode of any one of claims 1 to 14, the proto-microelectrode of any one of claims 15 to 18, and the set of proto-microelectrodes of any one of claims 19 to 28 in an *in vitro* method comprising electrical stimulation of *in vitro* cells, optionally *in vitro* nerve cells, and in an *in vitro* method comprising monitoring the electrical activity of such cells.