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Datasheet for the decision of 24 February 2015

Case Number: T 1286/11 - 3.4.02

Application Number: 04251670.8

Publication Number: 1464953

IPC: G01N27/414, G01N33/487

Language of the proceedings: EN

Title of invention:
Biosensor comprising an organic field effect transistor and method for the fabrication of the sensor

Applicant:
Alcatel-Lucent USA Inc.

Relevant legal provisions:
EPC 1973 Art. 56

Keyword:
Inventive step - (yes)

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Case Number: T 1286/11 - 3.4.02

D E C I S I O N
of Technical Board of Appeal 3.4.02
of 24 February 2015

Appellant: (Applicant)	Alcatel-Lucent USA Inc. 600-700 Mountain Avenue Murray Hill, NJ 07974 (US)
Representative:	MERH-IP Matias Erny Reichl Hoffmann Paul-Heyse-Strasse 29 80336 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 20 January 2011 refusing European patent application No. 04251670.8 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	B. Müller
Members:	H. von Gronau
	F. J. Narganes-Quijano

Summary of Facts and Submissions

I. The appeal of the applicant is directed against the decision of the examining division to refuse the European patent application No. 04251670.8. The examining division refused the application in particular on the ground that the independent claims 1 and 6 then on file did not involve an inventive step.

II. With the statement setting out the grounds of appeal the appellant filed two sets of claims amended according to a main and an auxiliary request, and requested that the decision of the examining division be set aside and a patent be granted. As a precaution, the appellant subsequently requested oral proceedings in the event that the board intended to refuse the present appeal.

III. In reply to a telephone consultation with the rapporteur of the Board, the appellant filed with the letter dated 2 February 2015 a set of amended claims 1 to 13 and amended pages 1 to 5 of the description replacing the corresponding application documents of the main request on file.

IV. The independent claims 1 and 10 of the set of claims of the main request read as follows:

"1. A biosensor system for the detection of biological target molecules, comprising:

an organic field effect transistor (100), including:

a transistor channel (110) having a semiconductive film (115) comprising organic molecules (120), said channel (100) also having probe molecules (125), wherein:

said probe molecules (125) are coupled to an outer surface (130) of said semiconductive film (115),

said film (115) has an interior substantially free of said probe molecules (125),

said organic molecules (120) are hydrophobic and said probe molecules (125) are hydrophilic, and

said probe molecules (125) are selected from the group consisting of: single stranded DNA; RNA; aptamers; and proteins."

"10. A method of fabricating an organic field effect transistor (200) for the detection of biological target molecules, comprising:

forming a transistor channel (210) including:

forming a semiconductive film (215) comprising organic molecules (220) between a source (270) and drain (275); and

coupling a probe molecule (225) to an outer surface (230) of said semiconductive film (215), said semiconductive film (215) having an interior substantially free of said probe molecule (225), wherein

said organic molecules (220) are hydrophobic and said probe molecules (225) are hydrophilic, and

said probe molecules (225) are selected from the group consisting of: single stranded DNA; RNA; aptamers; and proteins."

V. The set of claims of the main request also includes dependent claims 2 to 9 and 11 to 13 referring back to claims 1 and 10, respectively.

VI. The following documents cited by the examining division are relevant for the present decision:

D1: US 2002/0167003

D4: Abstract of JP 10260156 published in "Patent Abstracts of Japan".

Reasons for the Decision

1. Main request - Novelty (Article 54 EPC 1973)

1.1 Lack of novelty was not an issue in the contested decision.

2. Main request - Inventive Step (Article 56 EPC 1973)

2.1 The examining division regarded the document D1 as closest prior art document. This document discloses a biosensor system for the detection of biological target molecules ("*biological sensor*", cf. the title and figure 3 together with the corresponding description), comprising:
an organic field effect transistor, including:
a transistor channel having a semiconductive film comprising organic molecules 200 ("*These qualities are primarily accomplished through an organic self-assembled monolayer exposed to the atmosphere. The monolayer is used in the sensor transistor as the active semiconductor layer in which the conducting channel is formed*", cf. paragraph [0011]), said channel also having probe molecules ("*The chemical specificity and strength of interaction of the monolayer may be selectively tuned by varying the chemical or sensing end group of the organic molecules comprising the monolayer*", cf. paragraph [0011]; therefore the organic molecules also serve as probe molecules).

In the disclosure of document D1 the self-assembling molecule 200 (cf. figure 2A) comprises an end group 206 coupled to the gate insulator, an organic hydrophobic conjugated segment 204 (phenyl-acetylene, cf. paragraph [0039]), and a hydrophilic sensing end group 202 (nitrite or halide groups, cf. paragraph [0038]). However, contrary to the finding of the examining division in its decision, a self-assembling molecule that contains both hydrophobic and hydrophilic groups - i.e. a so-called amphiphilic or amphipathic molecule - cannot be considered to be constituted by two distinct molecules having different hydroaffinity properties within the meaning of the claimed invention which requires that the hydrophilic probe molecules are coupled to the outer surface of a semiconductive film comprising the hydrophobic organic molecules.

2.2 It follows from the considerations above that the subject-matter of claim 1 differs from the disclosure of document D1 in that

said channel has probe molecules in addition to the organic molecules and said probe molecules are coupled to an outer surface of said semiconductive film comprising the organic molecules,

said film has an interior substantially free of said probe molecules,

said organic molecules are hydrophobic and said probe molecules are hydrophilic, and

said probe molecules are selected from the group consisting of: single stranded DNA; RNA; aptamers; and proteins.

2.3 These distinguishing features provide the effect of facilitating the formation of a uniform closely packed crystalline or polycrystalline film of the organic molecules having an interior substantially free of, if

not completely void of, the probe molecules. This is advantageous for the charge transfer in the film and the sensitivity of the sensor transistor (cf. page 6, line 18 to page 7, line 21 of the description of the present application). This is particularly relevant for probe molecules comprising nucleic acid or amino acid sequences, such as DNA or proteins, which impede the formation of ordered semiconductive films composed of the functionalized organic polymers (cf. page 6, lines 7 to 17 of the description).

2.4 Therefore, in view of the disclosure of document D1, the person skilled in the art is confronted with the problem of providing a more efficient sensor for the detection of biological molecules, and in particular of nucleic acids.

2.5 The person skilled in the art would look for modifications of the sensor of document D1 that would solve the problem formulated above and might consider document D4 which discloses a sensor of the FET type with a glucose oxidation enzyme for the detection of glucose. From this document the person skilled in the art would learn that such an enzyme is useful as a receptor when it is attached to the gate electrode of a field effect transistor. When transferring this teaching to the sensor of document D1 the person skilled in the art would then have to find a way to apply the receptor enzyme on the sensor transistor. This can be done as in document D4, i.e. by binding the enzyme on the gate of a FET formed by a conventional semiconductor technique, or - at least in principle - as taught in document D1, i.e. by attaching the enzyme to self-assembling organic molecules as a sensing end group thereof. However, document D1 only discloses exemplary self-assembling organic molecules constituted by conjugated segments

that are said to be "very rigid" or "useful for sensing small molecules" (paragraph [0039]) and having attached thereto sensing end groups of a relatively low molecular weight ("halides, nitrites, ketones, amines, amides and the like", paragraph [0038]). Therefore, assuming that the skilled person would have considered the teaching of document D1 as being applicable to sensing end groups having a relatively high molecular weight such as an enzyme, he would then have been confronted with the subsequent problem of finding appropriate self-assembling organic segments to which the enzyme can be attached without impairing the self-assembling characteristics of the resulting molecules. There is, however, no disclosure in document D1 that would have taught the skilled person how to proceed with sensing end groups constituted by an enzyme, let alone that would have prompted the skilled person, without hindsight knowledge of the claimed invention, to arrive at an arrangement of enzyme molecules coupled to the surface of a semiconductive film formed by organic molecules having a hydroaffinity opposed to that of the enzyme molecules - i.e. hydrophobic organic molecules - and thus having its interior substantially free of enzyme molecules as required by the claimed subject-matter.

The remaining documents on file are less relevant than documents D1 and D4.

2.6 Therefore, the subject-matter of claim 1 involves an inventive step with regard to the prior art on file (Article 56 EPC 1973).

2.7 Method claim 10 defines a method of fabricating the corresponding organic field effect transistor and

therefore also meets the requirements of Article 56 EPC 1973.

2.8 Claims 2 to 9 and 11 to 13 are dependent on claims 1 and 10 respectively and therefore also involve an inventive step.

3. To meet the requirements of Rule 42(1) EPC the description has been adapted.

4. As the main request is allowed, there was no need to appoint oral proceedings that were requested as a precaution only.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent in the following version:

Description:
Pages 6-15, 17, 18, 20 as originally filed.
Pages 16, 19 as filed with the letter of 15 May 2007.
Pages 1-5 as filed with the letter of 2 February 2015.

Claims:
No. 1-13 of the main request as filed with the letter of 2 February 2015.

Drawings:
Sheets 1/6 - 6/6 as originally filed.

The Registrar: The Chairman:

M. Kiehl B. Müller

Decision electronically authenticated