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**Datasheet for the decision
of 29 January 2015**

Case Number: T 2001/12 - 3.4.03
Application Number: 08764638.6
Publication Number: 2166571
IPC: H01L29/06, H01L29/788,
H01L29/792, H01L21/28,
H01L21/336, H01L29/423
Language of the proceedings: EN

Title of invention:
MEMORY DEVICE AND ITS READING METHOD

Applicant:
National Institute of Advanced Industrial Science
and Technology

Headword:

Relevant legal provisions:
EPC 1973 Art. 54, 56, 83, 84, 111(1)
EPC Art. 123(2)

Keyword:
Sufficiency of disclosure - (yes)
Claims - essential features - relationship between Article 83
and Article 84 - clarity - main request (yes)

Decisions cited:
G 0001/03, T 0032/82, T 0133/85, T 0939/92, T 0260/98,
T 0400/98, T 0813/03, T 1079/08

Catchword:

An objection of insufficient disclosure under Article 83 EPC 1973 cannot legitimately be based on an argument that the application would not enable a skilled person to achieve a non-claimed technical effect (point 3.4).

A doubt that the invention as claimed is capable of solving the problem defined in the application may have the following consequences:

a) If the question arises because the claim fails to specify those features which are disclosed in the application as providing the solution to the problem, then the description and claims are inconsistent in relation to the definition of the invention, and an objection under Article 84 EPC 1973 may properly arise that the claims do not contain all the essential features necessary to specify the invention.

b) If this is not the case, but, having regard to the prior art, and irrespective of what may be asserted in the description, it does not appear credible that the invention as claimed would actually be capable of solving the problem, then an objection under Article 56 EPC 1973 may be raised (point 4.4).



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Case Number: T 2001/12 - 3.4.03

**D E C I S I O N
of Technical Board of Appeal 3.4.03
of 29 January 2015**

Appellant: National Institute of Advanced Industrial
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted on 27 April 2012
refusing European patent application No.
08764638.6 pursuant to Article 97(2) EPC.

Composition of the Board:

Chairman G. Eliasson
Members: S. Ward
T. Bokor

Summary of Facts and Submissions

I. The appeal is against the decision of the Examining Division refusing European patent application No. 08 764 638 "because the main request does not meet the requirements of Article 83 EPC, Article 84 EPC, and Article 54 EPC, and because the auxiliary request does not meet the requirements of Article 83 EPC and Article 84 EPC."

II. The following documents, cited by the Examining Division (under points 8, 14 and 21 of the contested decision), are referred to:

D2: JP 2000 156423 A
D2a: US 6 472 705 B1
D5: JP 2004 172616 A
D5a: EP 1 420 414 A1
D8: US 2003/0042534 A1.

III. In the letter stating the grounds of appeal the appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the main request or one of auxiliary requests I-VI, all filed with the said letter.

IV. Claim 1 according to the main request reads as follow:

"A memory device (1), comprising at least:

a first semiconductor region (100) having a length (Lg), a first surface (100A), and a cross-section surrounded by the first surface (100A);

a memory means (300) provided on the first surface (100A), wherein the memory means (300) is a multilayered insulation film; and

a gate (400) provided on the memory means (300);

wherein an equivalent sectional radius (r) of the cross-section of the first semiconductor region (100) is defined as a radius of curvature of a circle having the same cross-sectional area as the cross-section; and

an equivalent silicon oxide film thickness (tm) of the memory means (300) is defined as a sum of values of thickness of each layer of the multilayered insulation film, wherein each value of thickness is the film thickness of said layer multiplied by dielectric constant of silicon oxide and divided by dielectric constant of said layer;

and wherein the equivalent sectional radius (r) of the cross-section of the first semiconductor region (100) is equal to or smaller than the equivalent silicon oxide film thickness (tm) of the memory means (300);

characterized in that

the equivalent silicon oxide film thickness (tm) of the memory means (300) is 20 nm-to 6nm."

V. The Examining Division argued essentially as follows:

Claim 1 of the main request and claim 1 of the auxiliary request defined memory devices that were supposed to have a programming voltage that was "approximately 70% or less of the program voltage of a conventional planar type device", as was stated in

paragraph [0011] of the description, and the applicant had also argued that the inventive merit of the claimed devices should be seen in view of this possibility.

However, upon comparison it was clear that the device of Example 1 of the application did not have a programming voltage less than 70% of the ones of the conventional devices of both D2 and D8. Moreover, the device of Example 2 of the application did not achieve this programming-voltage effect when compared to the device of D8.

Claim 1 of the main request and claim 1 of the auxiliary request thus did not make it clear which feature was necessary in order to achieve the stated effect. These claims thus did not recite all the features essential for the definition of the invention and therefore did not meet the requirements of Article 84 EPC. Moreover, the application as a whole also did not disclose which features would lead to the effect, and the application as a whole therefore did not meet the requirements of Article 83 EPC.

The applicant's argument that this feature was no longer recited in the claims currently on file was not convincing because paragraphs 11 and 25 made it explicitly clear that the technical effect that the invention was supposed to provide is the reduction of the programming voltage below 70% of the one of a conventional planar device.

In relation to the question of novelty, document D5 (cf. figure 1 and associated text passages) disclosed a memory device comprising the features of claim 1 of the main request. Although D5 did not explicitly discuss an equivalent sectional radius and an equivalent silicon

oxide film thickness, the first semiconductor region (10) of D5 is a carbon nanotube, and it was considered to be at least implicitly disclosed that the radius was approximately 0.6 nm, such a value being normally encountered in the case of nanotubes (cf. paragraph 101 of the application). Moreover, paragraph 22 of D5 disclosed that the memory means 19 had a total thickness of less than 200 nm wherein the charge storage nitride layer had a thickness of 100 nm or less. Given the fact that silicon dioxide had a dielectric constant of about 3.9 and silicon nitride had a dielectric constant of about 6-8, the equivalent silicon oxide film thickness could be calculated to be 148 nm, which was larger than the carbon nanotube radius of 0.6nm. Consequently claim 1 of the main request was not novel.

Objections under Article 123(2) EPC arose against claim 5 of the main request (claim 4 of the auxiliary request), claim 6 of the main request (claim 5 of the auxiliary request), claim 15 of the main request (claim 14 of the auxiliary request) and paragraphs 11 and 25 of the description.

Clarity objections (Article 84 EPC) also arose in relation several claims of the main request and of the auxiliary request. In particular, Claim 1 of the main request and claim 1 of the auxiliary request did not provide a clear definition of which "first surface" was taken in the case of a hollow semiconductor region such as a carbon nanotube.

VI. Under point 26 of the "Additional Comments", the Examining Division also stated the following:

- *"In view of the fact that no supplementary European search report has been established for the present application and no further search for relevant prior art has been conducted during the written procedure, the examining division is of the opinion that it would be appropriate to return the file to the division for a detailed search and examination to be conducted in case that a set of application documents were presented that meets the requirements of Article 83 EPC, Article 84 EPC, and Article 123(2) EPC and contains an independent claim that is new and inventive over D5 (and D5a)."*

VII. The appellant argued essentially as follows:

Claim 1 of the main request was almost identical to claim 1 of the auxiliary request filed during the oral proceedings before the Examining Division.

In relation to the objections raised under Article 83 and Article 84 EPC, claim 1 did not describe the feature that the memory device had a programming voltage that is "approximately 70 % or less of the program voltage of a conventional planar type device".

In relation to the objection that the claimed subject-matter did not provide a clear definition of a "first surface" in the case of a hollow semiconductor region such as a carbon nanotube, claim 1 described a first surface of the first semiconductor region, on which a memory means was provided as a multilayered insulation film, wherein the memory means was covered at least partially by a gate. Thus, a person skilled in the art would understand easily that the first surface is not an inside surface of "a hollow semiconductor region

such as a carbon nanotube", and would automatically interpret the first surface as the external surface of the carbon nanotube.

The Examining Division did not object to the novelty of a memory device according to former claim 1 of the auxiliary request and therefore it was assumed that no such objection arose in the case of claim 1 of the main request.

The memory device according to claim 1 of the main request also involved an inventive step.

Document D5 was considered to be the closest prior art. The Examining Division had calculated the equivalent silicon oxide film thickness of the memory means to be 148 nm. The claimed equivalent silicon oxide film thickness of the memory means of 20 nm or less provided high local electrical fields at the first surface even in case of a significant low programming voltages, thus, the equivalent silicon oxide film thickness of the memory means of 20 nm to 6 nm is important for reducing the programming voltage of the memory device. The memory device according to claim 1 of the main request therefore required a lower programming voltage than the memory device of document D5.

Moreover, it was hardly possible to form an oxide layer or a nitride layer with a lower layer thickness on the carbon nanotube oriented perpendicular to the upper side of the substrate. Thus, the person skilled in the art studying document D5 would get the impression that it was not even possible to form a memory means with an equivalent silicon oxide film thickness of 20 nm or

less. Document D5 therefore would even lead the person skilled in the art away from the claimed memory device.

Reasons for the Decision

1. The appeal is admissible.
2. *Main Request: Article 123(2) EPC*
 - 2.1 No objection under Article 123(2) EPC was raised in the contested decision against claim 1 of the main request or claim 1 of the auxiliary request, and the Board sees no reason to raise any such objection against claim 1 of the present main request, which appears to be satisfactorily based on claims 1, 6 and 7 as originally filed together with features which may be found in paragraphs [0010] and [0076] of the description as originally filed. (The terms "description as originally filed" and "claims as originally filed" refer to the English translation of the description and claims of PCT application PCT/JP2008/059592 filed on entry into the European phase.)
3. *Main Request: Article 83 EPC 1973*
 - 3.1 Paragraph [0011] of the description begins as follows:
 - *"According to to the above-mentioned configuration, the equivalent sectional radius r is set to be equal to or smaller than the equivalent oxide film thickness t_m of the memory means".*

This relationship between the equivalent sectional radius and the equivalent oxide film thickness is included in claim 1 of the main request.

Paragraph [0011] then continues:

- *"and therefore it becomes possible to realize a memory device which can reduce the voltage for writing and erasing to approximately 70% or less of the program voltage of a conventional planar type device."*

This feature, which is not comprised in claim 1 of the main request, is central to the objection under Article 83 EPC made in the contested decision.

In particular, by comparing Examples 1 and 2 of the present application with the disclosures of documents D2 and D8, the Examining Division came to the conclusion that it was not credible that the invention defined by claim 1 of the main request would achieve the technical effect of reducing the voltage for writing and erasing to approximately 70% or less of that of a conventional planar type device. For this reason the Examining Division judged that the requirements of Article 83 EPC were not met.

3.2 Hence, a first question which arises is whether the allegation that the claimed invention is incapable of achieving the above-mentioned effect would - even if true - justify refusing the application for failure to meet the requirements of Article 83 EPC.

3.3 In Decision G 1/03 (OJ, 2004, 413) the Enlarged Board of Appeal stated the following:

- *"a lack of reproducibility of the claimed invention ... may become relevant under the requirements of inventive step or sufficiency of disclosure. If an effect is expressed in a claim, there is lack of sufficient disclosure. Otherwise, ie if the effect is not expressed in a claim but is part of the problem to be solved, there is a problem of inventive step (T 939/92, OJ EPO 1996, 309)." (See Reasons, point 2.5.2.)*

This passage has since been cited in other decisions; for example in T 1079/08 the point is made as follows:

- *"In Decision G 1/03 (OJ, 2004, 413) the Enlarged Board of Appeal indicated that a lack of reproducibility of the claimed invention is relevant under the requirements of sufficiency of disclosure if the technical effect is a technical feature of the claim, since then it is a feature characterising the subject-matter claimed (see point 2.5 of the reasons)." (T 1079/08, Reasons, point 4).*

The same point had been made in earlier decisions, for example in T 939/92 (cited by the Enlarged Board in the above excerpt from G 1/03), and in T 260/98 (also citing T 939/92) in which the following conclusion was drawn:

- *"However, since the claims only specify a reduced abrasiveness and do not require any synergistic activity of the components, the question as to whether or not such a synergic effect is achieved by the claimed printing inks is not relevant to the issue of sufficiency, although it may properly arise under Article 56 EPC, if this technical*

result turns out to be the sole reason for the alleged inventiveness of the printing inks (T 939/92 of 12 September 1995, Headnote point 2 and Reasons Nos. 2.4 to 2.6, OJ EPO 1996, 309)."
(T 260/98, Reasons, point 3.6.6.)

- 3.4 It is therefore the consistent position of the boards that an objection of insufficient disclosure under Article 83 EPC 1973 cannot legitimately be based on an argument that the application would not enable a skilled person to achieve a non-claimed technical effect.

In the present case, the technical effect in question is the reduction of the writing and erasing voltage to approximately 70% or less of the program voltage of a conventional planar type device. Achieving this effect is not part of the invention defined by claim 1 of the main request, and hence the Examining Division's objection that the application as a whole does not disclose features which would enable this effect to be obtained does not constitute a valid objection under Article 83 EPC 1973.

- 3.5 The Board therefore judges that claim 1 of the main request complies with the requirements of Article 83 EPC 1973.

4. *Article 84 EPC 1973*

- 4.1 The Examining Division also found that since claim 1 of the main request did not define features which would enable the above-mentioned effect to be obtained, the requirements of Article 84 EPC 1973 were not met, since the claims did not recite all the features essential for the definition of the invention.

4.2 Article 84 EPC requires that the claims are clear, concise and supported by the description. According to established case law of the boards, Article 84 EPC is to be interpreted as requiring that the claims indicate all essential features of the invention (see Case Law of the Boards of Appeal, 7th edition 2013, II.A.3.2).

In the decision T 32/82, the matter was put as follows:

- *"Article 84 EPC requires amongst other things that the claims, which define the matter for which protection is sought (i.e. the object of the invention as implied by Article 52(1) EPC) be clear. The Board of Appeal considers that this has to be interpreted as meaning not only that a claim from a technical point of view must be comprehensible, but also that it must define clearly the object of the invention, that is to say indicate all the essential features thereof.*

- *"As essential features have to be regarded all features which are necessary to obtain the desired effect or, differently expressed which are necessary to solve the technical problem with which the application is concerned." (see T 32/82 OJ 1984, 354, Reasons, point 15.)*

In the decision T 133/85 the point was made as follows:

- *"A claim which does not include a feature which is described in the application (on the proper interpretation of the description) as an essential feature of the invention, and which is therefore inconsistent with the description, is not*

supported by the description for the purpose of Article 84 EPC." (T 133/85, headnote I).

This requirement to eliminate inconsistency between the claims and the description also implies that where an invention has been presented in the description in terms of a modification of prior art which is cited or otherwise acknowledged in the application, the modifying features must be seen as essential (see e.g. T 813/03, point 5.1).

Hence, if the claims do not comprise a feature which is described in the application as essential, or which is disclosed in the description as being indispensable for solving the problem defined in the application, then an objection under Article 84 EPC 1973 may properly arise.

Examination for compliance with this requirement does not entail, and is independent of, a comparison of the claimed invention with the prior art, other than to determine whether there is consistency between the claims and the description in relation to any prior art cited in the application with respect to which the invention has been disclosed.

4.3 By contrast, the determination of the *objective* contribution of the claimed invention, i.e. having regard to the totality of the prior art, and in particular the objectively identified closest prior art, forms part of the examination for inventive step.

If, as a result of the comparison with the prior art, objective doubts arise that the claimed invention would *actually* be capable of solving the problem defined in the application (whatever may be asserted in the description), then an objection under Article 56 EPC

1973 may be raised, possibly requiring a reformulation of the problem (see e.g. T 400/98, points 4.3 - 4.3.6, and Case Law, op. cit. I.D.4.3.2).

This is also consistent with the passage cited from G 1/03 under point 3.3, above, in which a lack of reproducibility the claimed invention (i.e. a failure of the claimed features to deliver the effect aimed for) is seen to represent, in the case of an effect which is not expressed in a claim but is part of the problem to be solved, "a problem of inventive step".

4.4 In summary, a doubt that the invention as claimed is capable of solving the problem defined in the application may have the following consequences:

- If the question arises because the claim fails to specify those features which are disclosed in the application as providing the solution to the problem, then the description and claims are inconsistent in relation to the definition of the invention, and an objection under Article 84 EPC 1973 may properly arise that the claims do not contain all the essential features necessary to specify the invention.
- If this is not the case, but, having regard to the prior art, and irrespective of what may be asserted in the description, it does not appear credible that the invention as claimed would actually be capable of solving the problem, then an objection under Article 56 EPC 1973 may be raised.

4.5 In the light of the above analysis, the Board is called upon to decide whether the Examining Division was

correct in concluding that the claim 1 of the auxiliary request (essentially corresponding to claim 1 of the present main request) failed to meet the requirements of Article 84 EPC in that it did "not recite all the features essential for the definition of the invention". The Board's answer to this question is no, for two reasons.

- 4.6 Firstly, in the section entitled "Problem to be Solved by the Invention" (paragraphs [0007]-[0009]), several problems are mentioned, including providing a "memory device which can reduce the voltage for writing and erasing".

However, although providing a writing/erasing voltage of approximately 70% or less of that of a conventional planar type device is mentioned in the description, achieving this effect is not stated to be the problem to be solved by the invention, either in paragraphs [0007]-[0009] or elsewhere. There is therefore no basis for arguing that features necessary to achieve this degree of reduction are essential to the definition of the invention.

- 4.7 Secondly, even if it were accepted that the technical problem underlying the invention is to provide a writing/erasing voltage of approximately 70% or less compared to a conventional planar type device, according to the application this degree of reduction is achieved by ensuring that "the equivalent sectional radius r is set to be equal to or smaller than the equivalent oxide film thickness t_m of the memory means" (see e.g. paragraph [0011]).

Since this feature is indisputably comprised in claim 1 of the main request, no legitimate objection could be

raised under Article 84 EPC 1973 that claim 1 lacks a feature presented in the description as essential to solving the problem.

- 4.8 The actual objection of the Examining Division was that, in the light of document D2 (cited in the International Search Report) and document D8 (cited by the Examining Division), and despite the assertions in the description of the present application, it was not considered technically credible that the devices of the present application did in fact reduce the writing/erasing voltage to 70% or less than that of a conventional planar type device.

In the light of the analysis presented above, the Board takes that view that while such an argument might conceivably be of relevance in an examination of inventive step under Article 56 EPC 1973, it is not relevant to the question of compliance with the requirements of Article 84 EPC 1973.

- 4.9 The remaining objection against claim 1 under Article 84 EPC 1973 (mentioned under point 24.1 of the section "Additional Comments") is that in the case of a hollow semiconductor region, claim 1 does not provide a clear definition of which "first surface" (internal or external) is meant.

In the opinion of the Board, however, it is clear that the external surface is intended. Claim 1 of the main request defines:

- *"a first semiconductor region (100) having a length (Lg), a first surface (100A), and a cross-section surrounded by the first surface (100A)".*

Hence the "cross-section surrounded by the first surface" is a cross-section of the first semiconductor region. Taking the first surface to mean the internal surface of a hollow semiconductor region would imply that the cross-section of the semiconductor region would enclose none of the actual semiconductor material, but only the hollow interior region. It would be clear to the skilled person from the wording of the claim that this is not what is intended.

4.10 Claim 1 of the main request is therefore judged to meet the requirements of Article 84 EPC 1973.

5. *Further Procedure*

5.1 No objection of lack of novelty was raised against the subject-matter of claim 1 of the first auxiliary request then on file, nor does the Board see any reason to raise such an objection against the (broadly similar) subject-matter of claim 1 of the present main request in the light of the prior art currently on file.

5.2 In view of the statement in the contested decision that "no supplementary European search report has been established for the present application and no further search for relevant prior art has been conducted during the written procedure", the Board considers that the Examining Division's proposal that "it would be appropriate to return the file to the division for a detailed search and examination to be conducted" is sensible. Hence it is appropriate for the Board to exercise its discretionary power under Article 111(1) EPC 1973 to remit the case to the department of first instance for further prosecution.

5.3 In the section headed "Additional Comments" (said not to form part of the reasons for which the application was refused) the Examining Division briefly indicated its view (under point 25.1) that the subject-matter of claim 1 of the first auxiliary request did not involve an inventive step with respect to document D5/D5a. The Board finds it appropriate to refrain from commenting on this matter for the following reasons.

If, following the search mentioned above, the document D5/D5a is confirmed as the closest prior art in the remitted procedure and the Examining Division maintains its view on inventive step, then the applicant would be entitled to a full explanation of this objection in terms of the problem-solution approach, and taking into account any counter-arguments of the applicant (for example, those presented in the notice of appeal). For the Board to decide this matter in the present decision would deprive the appellant of two instances on the issue. Moreover, the search may reveal new relevant prior art which may either become the starting point for examination, or have a bearing on the argument starting from D5/D5a.

5.4 Hence, for the avoidance of any doubt, the Board has decided only that claim 1 of the main request filed with the notice of appeal satisfies the requirements of Article 84 EPC 1973 and Article 123(2) EPC, and that in respect of the invention defined in claim 1 of the main request filed with the notice of appeal the application meets the requirements of Article 83 EPC 1973.

All other matters remain to be decided by the Examining Division in the remitted procedure.

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 for further prosecution.

The Registrar:

The Chairman:



S. Sánchez Chiquero

G. Eliasson

Decision electronically authenticated