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Datasheet for the decision of 2 March 2017

Case Number: T 2033/11 - 3.4.03

Application Number: 06726639.5

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Language of the proceedings: EN

Title of invention:
PATTERNING METAL LAYERS

Applicant:
Flexenable Limited

Headword:

Relevant legal provisions:
EPC 1973 Art. 54(2), 56
EPC Art. 52(1), 123(2)
EPC 1973 R. 71(2)
RPBA Art. 15

Keyword:
Inventive step - (no)

Decisions cited:
T 0482/92, T 0936/96

Catchword:

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Case Number: T 2033/11 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 2 March 2017

Appellant: (Applicant)	Flexenable Limited 34 Cambridge Science Park Milton Road Cambridge Cambridgeshire CB4 0FX (GB)
Representative:	Driver, Virginia Rozanne Page White & Farrer Bedford House John Street London WC1N 2BF (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 21 April 2011 refusing European patent application No. 06726639.5 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	G. Eliasson
Members:	S. Ward
	C. Schmidt

Summary of Facts and Submissions

I. The appeal is against the decision of the Examining Division refusing European patent application No. 06 726 639 on the ground that the claimed subject-matter of both the main request and the auxiliary request did not meet the requirements of Article 123(2) EPC and did not involve an inventive step within the meaning of Article 56 EPC.

II. With the notice of appeal, the appellant requested "cancellation of the decision in its entirety". In the statement of grounds of appeal the appellant stated the following:

> "We herewith submit a new set of claims to replace the set of claims according to the existing Main Request. As a new Main Request, we hereby request the grant of a patent on the basis of the attached new set of claims."

III. The Board issued a summons to oral proceedings and an accompanying communication under Article 15(1) RPBA, in which the Board expressed its provisional opinions.

In response, the appellant filed a further letter dated 14 February 2017 stating that "neither the applicant nor the applicant's representative will attend the Oral Proceedings scheduled for 2 March 2017". Subsequently, oral proceedings before the Board were held in the absence of the appellant.

IV. The following documents are referred to in this decision:

D1: EP 1 515 378 A2

D3: DE 199 51 721 A1
D4: US 2004/0266054 A1

V. Claim 1 of the main request reads as follows:

"A method of producing one or more semiconductor devices, including the steps of: (i) forming on a substrate an initial metal layer having a thickness of about 10nm or less; (ii) ablating selected portions of the metal layer using laser pulses each of an energy sufficient to ablate the entire thickness of the initial metal layer so as to pattern the initial metal layer; (iii) selectively depositing metal on the remaining portions of the patterned metal layer so as to form a patterned metal layer of increased thickness defining source and drain electrodes for each of the one or more semiconductor devices; and (iv) providing a semiconductor layer over the patterned metal layer of increased thickness to define a semiconductor channel between the source and drain electrodes, providing a gate dielectric layer over the semiconductor layer; and forming a gate over the gate dielectric layer and above the channel."

VI. The findings of the Examining Division, insofar as they are relevant to the present decision, may be summarised as follows:

The omission in claim 1 of the feature of a gate dielectric layer resulted in an intermediate generalization not foreseen in the application as filed contrary to Article 123(2) EPC.

Document D1 was the closest prior art, from which the subject-matter of claim 1 of the main request differed in that the formation of the electrodes comprised

electroplating of the electrodes and laser patterning of the seed layer followed by subsequent selective deposition of a second conductive layer.

The technical effect achieved was that an alternative for deposition and patterning of electrodes was provided. The objective problem to be solved was to find an alternative deposition and patterning method.

Document D3 disclosed an electroless metal plating process for depositing electrodes utilizing a laser patterning process for the electrodes in which the energy of the laser pulse was chosen such that one single laser pulse was sufficient to remove the whole metal layer. The advantage of this method was the formation of very sharp and clean edges. The skilled person departing from D1 and looking for a plating method would take the teaching of D3 and arrive at the solution of claim 1.

VII. The appellant's arguments, insofar as they are relevant to the present decision, may be summarised as follows:

Claim 1 of the new main request explicitly recited the feature that the Examining Division found should he recited in claim 1 in order for the claims to comply with the provisions of Article 123(2) EPC.

The present application provided the technical teaching that laser ablation can be used to pattern the source-drain electrodes of a top-gate TFT device. Performing the laser ablation on a sufficiently thin layer of metal could produce source-drain electrodes whilst suppressing vertical (topographical) issues (otherwise referred to as burring) to a level that did not result in leakage currents between the source-drain electrodes

and the gate electrode located very closely above the source-drain electrodes in the finished TFT device. The same technical teaching could not be found in any of the cited prior art documents, in particular, in document D3.

The patterning technique disclosed in D3 would not be an obvious candidate for the patterning of the source-drain electrodes of a top-gate TFT device without the benefit of the technical finding set out in the present application that burring could be suppressed to a level at which leakage currents between the source-drain electrodes and gate electrode could be avoided.

Document D3 was only concerned with achieving small lateral feature sizes, such as a small lateral width of an isolation trench between the conductive lines of a printed circuit board. The teaching of D3 about the achievement of edges that were sharp in the lateral dimension did not therefore make the technique of D3 an obvious candidate for the patterning of the source-drain electrodes of a top-gate TFT device.

Reasons for the Decision

1. The appeal is admissible.

As announced in advance, the duly summoned appellant did not attend the oral proceedings. According to Rule 71(2) EPC 1973, the proceedings nevertheless continued without the duly summoned party, that party then being treated as relying only on its written case. As the present case was ready for decision at the conclusion

of the oral proceedings (Article 15(5) and (6) RPBA), the voluntary absence of a party was not a reason for delaying the decision (Article 15(3) RPBA).

2. *Requests and issues to be decided*

2.1 In the communication under Article 15(1) RPBA, the Board stated the following:

> *"Although an auxiliary request formed part of the basis of the contested decision, no auxiliary request is mentioned in the statement of grounds of appeal, and it would appear that the sole request is now that a patent be granted based on the "new Main Request", filed with the statement (see third page, final paragraph)."*

The appellant has not contradicted this statement, and the Board therefore proceeds on the basis that there is just a single request (the "new Main Request").

2.2 The objection of the Examining Division that claim 1 of the main request then on file did not comply with the requirements of Article 123(2) EPC has been overcome by amendment, and the Board sees no reason to raise other objections in this respect.

2.3 Hence, the sole issue to be decided in the present appeal is whether the subject-matter of claim 1 involves an inventive step within the meaning of Articles 52(1) EPC and 56 EPC 1973.

3. *Closest prior art*

3.1 The Examining Division considered document D1 to be the closest prior art; the appellant did not comment explicitly on this matter.

3.2 According to the established case law of the Boards of Appeal, the closest prior art for assessing inventive step is normally a prior art document disclosing subject-matter conceived for the same purpose as the claimed invention and having the most relevant technical features in common (T 482/92, Reasons, point 4.1, third paragraph).

The method according to claim 1 is for producing a semiconductor device, which, given the further limitations now present (providing source, drain and gate electrodes, semiconductor layer, gate dielectric layer) is clearly a field effect transistor having a top gate architecture. Document D1 also discloses a method for forming such a device (see Figs. 4A-5). In this sense, the claimed invention and the method of document D1 can be said to have the same purpose.

However, the principal teaching of the invention clearly relates to the formation of the source and drain electrodes. In this regard, the claimed subject-matter differs from document D1 in every respect apart from the deposition of a metal layer on the substrate, a step which would be expected in essentially all such methods.

3.3 Claim 1 involves ablating selected portions of a metal layer using laser pulses, and the problems defined in the application (page 2, second paragraph) relate to avoiding the "unwanted topographical deformations" resulting from prior art laser ablation techniques.

This is considered a plausible account of the technical background motivating the claimed invention, and the Board does not see any reason to select a more remote prior art (which does not disclose laser ablation), and to reformulate the problem to the very general: "to find an alternative deposition and patterning method". In the opinion of the Board, this approach fails to recognize the specific technical teaching of the invention.

3.4 Hence, the Board does not consider document D1 to be a suitable choice as the closest prior art, at least for the reason that the prior art method described in the application itself must be considered closer to the present invention.

According to the prior art described in the present application, source and drain electrodes separated by a channel are defined, and a semiconducting active layer, a gate dielectric layer and a gate electrode are deposited (see page 1, second paragraph), the source and drain electrodes being formed by deposition of a metal layer to the required electrode thickness and subsequent patterning by laser ablation to form the electrodes (page 1, last two paragraphs; page 2, first two paragraphs).

No document reflecting this approach was cited in the application, and to avoid any doubt that this method forms part of the state of the art according to Article 54(2) EPC 1973, the Board in its communication under Article 15(1) RPBA cited document D4, which describes the formation of source and drain electrodes in a field effect transistor having a top gate architecture according to a method which is essentially the same as

that of the prior art described in the present application.

3.5 Thus, in the view of the Board, the prior art described in the application (or equivalently, document D4), represents the closest prior art.

4. *Difference and problem solved*

4.1 The claimed method differs from the closest prior art in the following:

(a) the initial metal layer has a thickness of about 10nm or less;
(b) the ablating laser pulses are each of an energy sufficient to ablate the entire thickness of the initial metal layer;
(c) a metal is selectively deposited on the remaining portions of the patterned metal layer so as to form a patterned metal layer of increased thickness.

4.2 The technical effect of these features is variously described as follows:

- "a method of patterning with high resolution a metallic layer" (page 1, first paragraph);
- avoiding "unwanted topographical deformations [which] are formed at the edge of the laser ablated pattern" (page 2, second paragraph);
- "to give a good resolution and no burring ... to provide the best possible resolution and edge quality" (page 3, fourth paragraph);
- providing a process "with high resolution and with good edge definition" (page 5, second paragraph; page 6, second paragraph);
- providing "the highest resolution" and "less burring" (page 7, first paragraph).

4.3 Two separate problems are therefore considered to be solved by features (a)-(c) as defined above (although both may be considered to come under the general heading of avoiding "unwanted topographical deformations").

The first problem is to provide high resolution and good edge definition. This is clearly a plausible - indeed, well-known - problem within the field of patterning of metal layers.

A second problem is to avoid "burring", which the Board understands to refer to vertical protrusions at the edges of the electrodes, formed as a result of the ablation process (the plane of the substrate being taken as horizontal).

Whilst it is possible that such burrs may result from laser ablation, the Board has some difficulty with the manner in which this is explained. In the final paragraph on page 10, it is stated that with gold source-drain electrodes patterned by laser ablation "significant burring occurs with gold around or above 50 nm in thickness, and this often causes a vertical short between the source / drain and the gate that is situated a micron above the channel."

Thus, for an electrode "around" 50 nm in thickness, it is alleged that burrs may be produced which extend to the gate which is a micron (1000 nm) above the channel; these burrs therefore have a vertical dimension twenty times the thickness of the electrode. In the communication under Article 15(1) RPBA, the Board expressed a doubt whether this was credible, and indicated that the appellant might be asked to explain

this. No further substantive submissions having been received from the appellant, these doubts remain.

In any event, even if this explanation is, *arguendo*, accepted, since two distinct problems (at least) are set out in the application as being solved by the distinguishing features, the analysis of inventive step amounts to asking whether, on the basis of the prior art, the skilled person would find it obvious to incorporate the distinguishing features into the closest prior art in order to solve *either* the first problem (resolution and edge definition) or the second problem (burring).

5. *Document D3*

5.1 Obtaining patterned metal structures having high resolution and good edge definition is a problem which is clearly not restricted to the formation of source and drain electrodes for FETs, and the skilled person would not confine the search for a solution to FET, or even to semiconductor, technology.

Document D3 describes a method of making patterned metal structures (very fine circuits) on substrates. The patterns thus created are high resolution structures having very sharp and clean edges (see e.g. column 2, lines 2-17). Thus document D3 proposes a solution to the first of the problems mentioned above.

5.2 According to document D3, a metal base is deposited which may have a thickness of 5 to 500 nm, more preferably 10 to 100 nm (column 2, lines 7-10; Fig. 1). Thus, both 5nm and 10nm (corresponding to distinguishing feature (a), above) are explicitly disclosed.

5.3 A pulsed laser is then used to ablate the unwanted parts of the metal layer (Fig. 2). According to document D3 (column 3, lines 47-50):

> *"Wie sich gezeigt hat, ist aufgrund des geringen Energieeinsatzes in der Regel je Flächeneinheit lediglich ein einziger Laserimpuls erforderlich, um die Strukturen zu erzeugen."*

[Translation of the Board: As has been shown, because of the small energy input as a rule only a single laser pulse per unit area is necessary to produce the structures].

It is therefore considered that the distinguishing feature (b) is disclosed in document D3.

5.4 Following this patterning, a metal is selectively deposited on the patterned metal layer so as to form a patterned metal layer of increased thickness (by electroless plating - see e.g. claim 1; Fig. 3). Distinguishing feature (c) is therefore disclosed in document D3.

5.5 Starting from the prior art described in the application (or equivalently, document D4), and wishing to provide source and drain electrodes with high resolution and good edge definition, a skilled person would find in document D3 a method in which the posed problem is solved by the distinguishing features (a)-(c) of claim 1. In this way, the skilled person would be led in an obvious manner to the claimed subject-matter, which consequently does not involve an inventive step within the meaning of Articles 52(1) EPC and 56 EPC 1973.

5.6 It is not necessary for the Board to decide whether the problem of burring, in the manner in which it has been explained in the application, is credible, or if so, whether the skilled person would be led to the claimed subject-matter on the basis of this problem. Subject-matter which has been shown to be obvious on the basis of a realistic technical problem cannot be rendered non-obvious merely because it solves a further technical problem (see e.g. T 936/96, Reasons, point 2.6).

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated