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**Datasheet for the decision
of 22 February 2019**

Case Number: T 0564/15 - 3.4.03

Application Number: 06256351.5

Publication Number: 1798759

IPC: H01L21/20, H01L21/02

Language of the proceedings: EN

Title of invention:

Polycrystalline silicon layer, flat panel display using the same, and methods of fabricating the same

Applicant:

Samsung Display Co., Ltd.

Headword:

Relevant legal provisions:

EPC 1973 Art. 84
RPBA Art. 13

Keyword:

Claims - clarity - main and first auxiliary request (no)
Late-filed auxiliary requests - admitted (no)

Decisions cited:

Catchword:



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Case Number: T 0564/15 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 22 February 2019

Appellant: Samsung Display Co., Ltd.
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Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 19 December
2014 refusing European patent application No.
06256351.5 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman T. M. Häusser
Members: M. Papastefanou
G. Decker

Summary of Facts and Submissions

- I. The appeal is against the decision of the examining division refusing the European patent application No. 06 256 351.5 on the ground of lack of inventive step of both the Main and the Auxiliary requests on file at the time.
- II. The final requests of the appellant (applicant) were that the decision under appeal be set aside and that a patent be granted on the basis of the Main request. As an auxiliary measure, the appellant requested that a patent be granted on the basis of the (First) Auxiliary request or one of the Second, Third or Fourth Auxiliary requests.

The Main and the (First) Auxiliary requests were filed with the statement setting out the grounds of the appeal. The Second, Third and Fourth Auxiliary requests were filed with the appellant's letter dated 22 January 2019.

- III. The following documents, cited in the decision under appeal, are being referred to:

D1: US 6,162,667 A;
D4: US 6,744,069 B1;
D5: US 2003/0010980 A1.

- IV. Independent claim 1 of the **Main request** has the following wording:

*A polycrystalline silicon layer on a substrate (100),
the polycrystalline layer comprising:*

a first pattern layer (130) arranged on an amorphous silicon layer (120) to expose a predetermined region of the amorphous silicon layer (120);

a second pattern layer (140) arranged on the first pattern layer (130) and contacting the predetermined region of the amorphous silicon layer (120),

a metal catalyst layer (150) arranged on the second pattern layer (140);

a seed region (170; 310), wherein the substrate (100) with the first pattern layer (130), the second pattern layer (140) and the metal catalyst (150) is adapted to be heat-treated in such a manner that the exposed predetermined region of the amorphous silicon layer (120) is crystallized to form the seed region (170); and

a crystallization region (190) grown from the seed region (170; 310), the crystallization region (190) and the seed region (170; 310) being located on the substrate (100);

wherein the seed region (170; 310) comprises a seed comprising a metal catalyst;

CHARACTERISED BY:

the second pattern layer (140) comprising a silicon nitride layer having a thickness in a range of from 50 to 5,000 Å (5 to 500 nm); and

in that the seed region (170; 310) is at least 400 μm^2 in size;

wherein the metal catalyst has a concentration of 1×10^{13} atoms/cm² or less.

V. Independent claim 1 of the **(First) Auxiliary Request** is worded as follows:

A polycrystalline silicon layer on a substrate (100),
the polycrystalline layer comprising:
a first pattern layer (130) arranged on an
amorphous silicon layer (120) to expose a
predetermined region of the amorphous silicon layer
(120);
a metal catalyst layer (150);
a seed region (170; 310); and
a crystallization region (190) grown from the seed
region (170; 310), the crystallization region (190)
and the seed region (170; 310) being located on the
substrate (100);
wherein the seed region (170; 310) comprises a seed
comprising a metal catalyst;
CHARACTERISED BY:
a second pattern layer (140) arranged on the first
pattern layer (130) and contacting the
predetermined region of the amorphous silicon layer
(120), the second pattern layer (140) comprising a
silicon nitride layer having a thickness in a range
of from 50 to 5,000 Å (5 to 500 nm);
in that the metal catalyst layer (150) is arranged
on the second pattern layer (140);
wherein the substrate (100) with the first pattern
layer (130), the second pattern layer (140) and the
metal catalyst (150) is adapted to be heat-treated
in such a manner that the exposed predetermined
region of the amorphous silicon layer (120) is
crystallized to form the seed region (170); and
in that the seed region (170; 310) is at
least 400 μm^2 in size;
wherein the metal catalyst has a
concentration of 1×10^{13} atoms/cm² or less.

VI. Compared to the Main request, in claim 1 of the **Second Auxiliary request** the expression "polycrystalline

silicon layer on a substrate (100), the polycrystalline layer" has been replaced by the expression "plurality of layers on a substrate (100), the plurality of layers", "polycrystalline" has been inserted before the first occurrence of "crystallization region", and it has been specified that the concentration of metal catalyst (see last feature of claim 1 of the Main request) is "in the seed region".

Moreover, the following features have been added at the end of the claim:

"...wherein directions of grain boundaries in the seed region (170; 310) are random and grain boundaries of the crystallization region (190) are formed radially centered on the seed region (170;310)."

VII. The **Third Auxiliary request** comprises only the method claims of the Second Auxiliary request. Independent claim 1 of the Third Auxiliary request has the following wording:

*A method of fabricating a polycrystalline silicon layer, the method comprising:
providing a substrate (100);
forming an amorphous silicon layer (120) on the substrate (100);
forming a first pattern layer (130) exposing a predetermined region of the amorphous silicon layer (120);
forming a second pattern layer (140) contacting the amorphous silicon layer (120) exposed by the first pattern layer (130);
forming a metal catalyst layer (150) on the second pattern layer (140); and
heat-treating the substrate (100) to form the seed in*

the exposed amorphous silicon layer (120), to crystallize the exposed amorphous silicon layer (120) to form a seed region (170) from the seed, and to cause the crystallinity of the seed region (170) to spread to regions other than the exposed amorphous silicon layer (120) to crystallize these regions into a crystallization region, wherein the crystallization region (190) and the seed region (170) are located on the substrate (100);

CHARACTERISED IN THAT:

the second pattern layer (140) comprises a silicon nitride layer having a thickness in a range of from 50 to 5,000 Å (5 to 500 nm);

the predetermined region is at least 400 μm² in size, forming a seed region (170) that is at least 400 μm² in size;

wherein the metal catalyst in the seed region has a concentration of 1x10¹³ atoms/cm² or less; and wherein directions of grain boundaries in the seed region (170; 310) are random and grain boundaries of the crystallization region (190) are formed radially centered on the seed region (170; 310).

VIII. Independent claim 1 of the **Fourth Auxiliary request** has the following wording:

A plurality of layers on a substrate (100), the plurality of layers comprising:

two pattern layers (130, 140) arranged on an amorphous silicon layer;

a metal catalyst layer (150) arranged on the two pattern layers (130, 140);

wherein either:

the two pattern layers comprise a first pattern layer (130) arranged on the amorphous silicon layer (120) to expose a

predetermined region of the amorphous silicon layer (120) and a second pattern layer arranged on the first pattern layer (130) and contacting the predetermined region of the amorphous silicon layer (120);

or

the two pattern layers comprise a second pattern layer (130) arranged on the amorphous silicon layer and a first pattern layer arranged on the second pattern layer (130) and exposing a predetermined region of the second pattern [sic] layer (140);

the plurality of layers further comprising:

a seed region (170; 310), wherein the substrate (100) with the first pattern layer (130), the second pattern layer (140) and the metal catalyst (150) is adapted to be heat-treated in such a manner that the exposed predetermined region of the amorphous silicon layer (120) is crystallized to form the seed region (170); and

a polycrystalline crystallization region (190) grown from the seed region (170; 310), the crystallization region (190) and the seed region (170; 310) being located on the substrate (100); wherein the seed region (170; 310) comprises a seed comprising a metal catalyst;

the second pattern layer (140) comprising a silicon nitride layer having a thickness in a range of from 50 to 5,000 Å (5 to 500 nm);

in that the seed region (170; 310) is at least 400 μm² in size;

wherein the metal catalyst has a concentration in the seed region of 1x10¹³ atoms/cm² or less; and wherein directions of grain boundaries in the seed region (170; 310) are random and grain boundaries

of the crystallization region (190) are formed radially centered on the seed region (170; 310).

- IX. In the decision under appeal, the examining division came to the conclusion that the subject-matter of claim 1 of the Main and the Auxiliary request before it did not involve an inventive step within the meaning of Article 56 EPC 1973. Starting from D1 as closest prior art, the skilled person would combine the teaching of D1 with the teaching of either one of D4 or D5 in an obvious way and arrive at the claimed subject-matter (section II of the decision).
- X. In a part of the decision titled "ADDITIONAL COMMENTS", the examining division presented further objections. In particular, it stated that the same objections as the ones against claim 1 of the Main request applied also for independent claim 9 (Point A.II. 1.) and to independent claims 16 and 17 (Point A.II. 2.). It further provided a list of passages in D1 where the features of dependent claims 2-8, 10 and 11 were disclosed (Point A.II. 3.). Finally, it considered that the subject matter of claims 12-15 lacked also an inventive step with respect to the disclosure of D1 and the skilled person's common general knowledge.
- XI. The appellant's arguments can be summarised as follows.

Clarity of the Main and (First) Auxiliary request

According to the appellant, the skilled person reading the definition of the polycrystalline layer in claim 1 would readily understand what the claimed invention was about. The claim was, therefore, clear. Moreover, the examining division had not raised any (lack of) clarity objection against this claim, which was another

indication that it was clear.

Admissibility of the Second, Third and Fourth Auxiliary requests

The appellant argued that they were addressing the lack of clarity objections raised by the board in its preliminary opinion. In addition, the Fourth Auxiliary request comprised only one independent claim per category and was thus addressing the board's preliminary objection under Rule 29(2) EPC 1973. Regarding inventive step, the appellant made reference to the corresponding arguments in the statement of the grounds of appeal stating that they were valid for these Auxiliary requests, as well.

Reasons for the Decision

1. The appeal is admissible.
2. Main Request - Clarity (Article 84 EPC 1973)
 - 2.1 Claim 1 of the Main request defines a polycrystalline silicon layer on a substrate. The board understands that this polycrystalline silicon layer is the layer obtained after the crystallization of the amorphous silicon layer (120) (see for example paragraph [0001] of the published application).
 - 2.2 Looking at the definition of this polycrystalline silicon layer in the claim, the board notes that, with the exception of the crystallization region (190), none of the other features, which are defined in the claim, is an attribute of the claimed polycrystalline silicon layer itself, since they all relate to different layers or to the amorphous silicon layer before it is

crystallized.

2.3 Claim 1, hence, attempts to define a product (polycrystalline silicon layer) by features of other products/entities, which are external to this product or relate to a base material of the product. This raises doubts as to the clarity of the claim.

2.4 The appellant argued that the skilled person would understand what is meant by the definition of claim 1 and pointed out that the examining division had not raised such an objection, which indicated that it considered the claim to be clear.

2.5 According to Article 84 EPC 1973, the claims shall define the matter for which protection is sought and shall be, among others, clear.

The requirement of clarity of the claims as defined in Article 84 EPC 1973 goes beyond the mere understanding of a possible meaning of the claims by a skilled person. The claims must define clearly the matter (or scope) for which protection is sought. The board understands that this means that the claims must set clear limits with respect to what is encompassed in the protected scope and what is not.

2.6 In the present case, claim 1 defines a product (a polycrystalline silicon layer) with features belonging to other products or entities. To the skilled reader it is not clear whether these entities, which are external to the claimed product, are part of the matter for which protection is sought or not. Neither is it clear which features of the claimed polycrystalline layer are supposed to be defined by/through the features of these external entities. In other words, the matter for which

protection is sought is not clearly defined.

- 2.7 An additional clarity objection concerns the last feature of claim 1, according to which "the metal catalyst has a concentration of 1×10^{13} atoms/cm² or less".

From the claim itself it is not clear whether this concentration of the metal catalyst refers to the concentration of the metal catalyst in the metal catalyst layer (150) or in the seed region (170; 310). From the description both possibilities are possible, since in paragraph [0031] this specific concentration of the metal catalyst is given in relation to the seed region and in paragraphs [0027] and [0049] a range of concentration values for the metal catalyst layer is given (1×10^{11} to 1×10^{15} atoms/cm²) which encompasses the value of the claim. The skilled person, therefore, cannot see from the claim which of the two concentrations is defined in the last feature, which is thus found to be unclear.

- 2.8 Regarding the appellant's argument that the fact that the examining division had not raised any objection under Article 84 EPC 1973 against this request meant that the requirements of this article were fulfilled, the board notes at first that the examining division rejected this request and refused the application on the ground of lack of inventive step.

According to Article 97(2) EPC, if the examining division is of the opinion that the European patent application or the invention to which it relates does not meet the requirements of the Convention, it shall refuse the application. Hence, it suffices that the application does not meet one of the requirements of

the EPC for it to be refused.

In the present case, the examining division based its decision on the ground that the application did not fulfill the requirement of inventive step (Article 52(1) EPC and Article 56 EPC 1973). In the absence of any relevant indication, the board cannot interpret this reasoning of the examining division's decision as an implicit acknowledgement that all other requirements of the EPC, including clarity of the claims, were met by the application and cannot, therefore, follow this argument of the appellant. In any case, the board is free to raise this objection even if it had not been raised during the first instance proceedings.

2.9 The board comes, hence, to the conclusion that claim 1 of the Main request does not fulfill the requirement of clarity according to Article 84 EPC 1973.

3. First Auxiliary request

This request was filed with the statement of grounds of appeal. It is titled "Auxiliary request", since it was the only auxiliary request at the time. After the filing of the further auxiliary requests (Second, Third and Fourth Auxiliary requests) it was agreed with the appellant to refer to this request as "First Auxiliary request".

3.1 In essence, the First Auxiliary request differs from the Main request only in that the claims relating to a flat panel display (claims 12-15 of the Main request) have been deleted. Otherwise, despite some re-ordering of the features in the independent claims, the claimed subject-matter is the same as the Main request.

3.2 The objections concerning claim 1 of the Main request (see points 2.1 - 2.8 above) apply, therefore, to claim 1 of the First Auxiliary request, as well, which is thus found to be lacking clarity according to Article 84 EPC 1973.

4. Second Auxiliary request - Admissibility

4.1 The Second Auxiliary request was filed with the appellant's letter dated 22 January 2019, i.e. after oral proceedings were scheduled and the board's preliminary opinion was issued. This request represents thus an amendment to the Appellant's case.

4.2 According to Article 13(1) RPBA, amendments to a party's case can be admitted in the proceedings only at the board's discretion. The board will exercise its discretion in view of inter alia the complexity of the new subject matter submitted, the current state of the proceedings and the need for procedural economy.

According to established case law of the Boards of Appeal, one of the criteria to take into account by the Board in exercising discretion is whether the amended request addresses the outstanding issues without introducing new ones (see *Case Law of the Boards of Appeal of the European Patent Office*, 8th Edition, 2016, IV.E.4.4.1-4.4.2).

4.3 Compared to the Main request, in claim 1 of the Second Auxiliary request the term "A polycrystalline silicon layer" has been replaced by the term "A plurality of layers". It has also been specified that the concentration of the metal catalyst refers to the concentration in the seed region. The features of dependent claims 5 and 6 have also been added into

claim 1 (see also point VI above).

- 4.4 The appellant's comments regarding the Second Auxiliary request as presented in the accompanying letter dated 22 February 2019 are repeated here:

"We herewith file a second auxiliary request in which the features of previous claims 5 and 6 have been incorporated in each of the independent claims. The claims have moreover been amended to set out the layer structure of in a different manner.

Although we do not agree with the objection raised in section 3.1.1 of the preliminary opinion is submitted that the claims submitted as part of this auxiliary request are also in conformity with Art. 84 EPC With regard to inventive step, D1 discloses that the crystal growth rapidly in the manner shown in figure 13. However, the shape of the crystal grain boundaries are not disclosed by D1."

- 4.5 During the oral proceedings, the appellant explained that the amendments addressed the objections regarding lack of clarity raised by the board against the Main request in its preliminary opinion (see points 2.1 to 2.10 above).

Regarding inventive step, the appellant made reference to the statement of grounds of appeal stating that the arguments presented therein were still applicable.

- 4.6 Despite the fact - as pointed out by the board during the oral proceedings - that the board's reasoning regarding inventive step in the preliminary opinion was different from the reasoning in the decision under appeal, the appellant stated that the situation was still the same and that the arguments in the statement

of grounds of appeal still applied.

To the remark of the board that the features of claims 5 and 6, which were added in the independent claims of the Second Auxiliary request, were considered disclosed in D1 in the decision under appeal, the appellant replied that this was not important since these features were not necessary for arguing the presence of inventive step in the claimed subject-matter.

- 4.7 Although it can be acknowledged that the amendments carried out address the board's objections regarding lack of clarity, the board finds that the Second Auxiliary request does not prima facie overcome the objection for lack of inventive step as raised against the Main request.
- 4.8 The appellant has not provided any arguments against the Board's preliminary opinion. Contrary to the Appellant's assertions, the board's objection is not the same as the one by the examining division.
- 4.8.1 In the decision under appeal, the examining division considered D1 to represent the closest prior art. The features distinguishing claim 1 of the former Main request from D1 were that the seed region was at least $400 \mu\text{m}^2$ in size and that the second pattern layer comprised a silicon nitride layer having a thickness in a range from 50 to 5000 Å (decision under appeal, page 5, second paragraph).

As technical effect of this difference, the examining division identified the increase in crystallization length (page 5, third paragraph).

Regarding the size of the seed region, the skilled

person would look in the teaching of either D4 or D5 and arrive at the claimed size for the seed region without inventive skills (page 5, fourth paragraph).

Regarding the thickness of the second pattern layer, the skilled person would, starting from the teaching of D1 and using only common general knowledge, arrive at the claimed range without employing inventive skills (page 5, fifth paragraph).

- 4.8.2 In its preliminary opinion as issued in the communication under Article 15(1) RPBA, the board starting from the same document as closest prior art (D1) and the same distinguishing features (point 3.2.2 of the communication), formulated two different, less ambitious partial technical problems (how to implement the seed region and the second pattern layer - see point 3.2.5) and concluded that the skilled person would solve these problems in an obvious manner based only on the teaching of D1 and common general knowledge (point 3.2.6).
- 4.8.3 In the statement setting out the grounds of appeal, the appellant contested neither the selection of D1 as closest prior art nor the analysis of its disclosure and the identification of the two features distinguishing claim 1 of the Main request from D1, as presented in the decision under appeal (and adhered to by the board).

The appellant's arguments were directed mainly to why the skilled person would not combine the teaching of D1 with the teaching of either D4 or D5 in an obvious way (see page 1, line 23 to page 3, line 12 of the statement of grounds of appeal). In addition, the appellant contested the examining division's reasoning

and conclusion regarding the obviousness of the feature regarding the thickness of the second pattern layer, in view of the technical problem to be solved, based on the disclosure of D1 and the common general knowledge of the skilled person (page 3, line 15 to page 4, line 12 of the grounds of appeal).

- 4.9 The board is, thus, of the opinion that the appellant's assertion that "the situation is still the same" is not correct because the reasoning regarding inventive step in the board's preliminary opinion is not the same with the reasoning in the decision under appeal. The board finds, thus, that the appellant's arguments in the statement of grounds of appeal are not relevant for the issues at hand at this stage of the proceedings. The appellant has neither in its letter dated 22 January 2019 nor during the oral proceedings addressed the objections with respect to (lack of) inventive step in the board's preliminary opinion.
- 4.10 The amendments carried out in the claims do not *prima facie* address this issue, either.
- 4.10.1 In claim 1 (and the other independent claims) of the Second Auxiliary request the features of claims 5 and 6 of the Main request have been added.

The board notes that these claims correspond to claims 5 and 6 of the Main request underlying the decision under appeal. In the decision (Additional Comments, point A.II.3), the examining division pointed out that the features of these claims were disclosed in D1 (column 11, lines 1 to 8 for claim 5; column 10, lines 57 to 62 for claim 6), see also point X above.

4.10.2 The appellant has not addressed this point at all, despite the board pointing it out during the oral proceedings (see also point 4.6 above). It neither contested the conclusion that the features were disclosed in D1 nor provided any arguments as to how they would combine with the remaining features of claim 1 in order to arrive at non-obvious subject-matter.

4.11 Summarising with regard to inventive step, the Second Auxiliary request was submitted as a reaction to the Board's preliminary opinion. Compared to the Main request, in claim 1 of the Second Auxiliary request two features, which were seen as disclosed in the prior art in the decision under appeal, were added. Moreover, the appellant did not provide any arguments that would put the board's preliminary opinion regarding lack of inventive step into question.

4.12 The board concludes, thus, that the Second Auxiliary request does not *prima facie* overcome the objection for lack of inventive step as raised against the Main request. Exercising its discretion under Article 13(1) RPBA the board, hence, decided not to admit this request into the proceedings.

5. Third and Fourth Auxiliary requests

5.1 These requests were filed with the appellant's letter dated 22 January 2019, as well.

5.2 As the appellant explained during the oral proceedings, these requests did not differ in substance from the Second Auxiliary request. They were filed mainly to address the board's preliminary objections under Article 84 EPC 1973 (Third Auxiliary request) and

Rule 29(2) EPC 1973 (Fourth Auxiliary request).

5.3 As neither of these requests *prima facie* addresses the objection for lack of inventive step, the board, exercising its discretion under Article 13(1) RPBA, decided not to admit them into the proceedings for the same reasons as the Second Auxiliary request.

6. Summarising, the board concludes that the Main and First Auxiliary requests lack clarity within the meaning of Article 84 EPC 1973. The Second, Third and Fourth Auxiliary requests are not admitted into the proceedings under Article 13(1) RPBA.

Since none of the appellant's admitted requests is allowable, the appeal must fail.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



S. Sánchez Chiquero

T. Häusser

Decision electronically authenticated