BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

Internal distribution code:

(A) [ ] Publication in OJ
(B) [ ] To Chairmen and Members
(C) [ ] To Chairmen
(D) [X] No distribution

Datasheet for the decision of 21 November 2008

Case Number: T 0950/06 - 3.4.03

Application Number: 03090204.3

Publication Number: 1381089

IPC: H01L 29/786

Language of the proceedings: EN

Title of invention:
Polycrystalline silicon thin film used in a thin film transistor and a device using the same

Applicant:
Samsung SDI Co., Ltd.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 123(2)

Relevant legal provisions (EPC 1973):
EPC Art. 56, 84

Keyword:
"Inventive step (yes)"
"Clarity - after amendment (yes)"

Decisions cited:
-

Catchword:
-

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0950/06 **-** 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 21 November 2008

Appellant: Samsung SDI Co., Ltd.
575, Shin-dong
Paldal-Gu
Suwon-city
Gyeonggi-do (KR)

Representative: Hengelhaupt, Jürgen
Gulde Hengelhaupt Ziebig & Schneider
Patentanwälte - Rechtsanwälte
Wallstrasse 58/59
D-10179 Berlin (DE)

Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 31 January 2006 refusing European application No. 03090204.3 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: R. G. O'Connell
Members: G. Eliasson
U. Tronser

Summary of Facts and Submissions

I. This is an appeal against the refusal of patent application 03 090 204 for added subject matter and lack of clarity.

II. The following prior art document, among others, was cited in the examination procedure:
D1: US 5 821 562 A.

III. In response to a communication accompanying summons to oral proceedings, the appellant applicant sent amended claims with a letter of 21 October 2008.

IV. At oral proceedings before the board, the appellant applicant requested that the decision under appeal be set aside and a patent granted with the following documents:

Claims 1 and 2 sent with the letter dated 21 October 2008;

Description pages 1 to 15 sent with the letter dated 21 October 2008;

Drawings Sheets 1 to 12 as originally filed.

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

"1. A polycrystalline silicon thin film comprising a plurality of first transistors (TR1) and a plurality of second transistors (TR2), the plurality of first transistors (TR1) being perpendicular to the plurality of second

transistors (TR2), the first transistors (TR1) having active channels, the active channels having a first length (L1) and first width (W1), the second transistors (TR2) having active channels, the active channels having a second length (L2) and second width (W2), and the polycrystalline silicon thin film comprising rectangular crystal grains defined by primary crystal grain boundaries to be arranged at an angle of inclination θ between — 45° <= θ <= 45° in respect to a direction perpendicular to the active channel direction of the first and second transistors (TR1, TR2) and having a first grain size (Gs1) being measured along an axis which is perpendicular to the axis of the primary crystal grain boundaries which are arranged at an angle of inclination θ between — 45° <= θ <= 45° in respect to a direction perpendicular to the active channel direction of the first transistors (TRI) and a second grain size (Gs2) being measured along an axis which is perpendicular to the axis of the primary crystal grain boundaries which are arranged at an angle of inclination θ between —45° <= θ <= 45° in respect to a direction perpendicular to the active channel direction of the second transistors (TR2),
characterised in that

the first and second grain size (Gs1, Gs2) of the crystal grains is such that

[(L1*Cos(θ)+W1*Sin(θ)-(Nmax1-1)*Gs1)/Gs1 < 0.25 or (L1*Cos(θ)+W1*Sin(θ)-(Nmax1-1)*Gs1)/Gs1 > 0.75]

and

[(L2*Cos(θ)+W2*Sin(θ)-(Nmax2-1)*Gs2)/Gs2 <0.25 or (L2*Cos(θ)+W2*Sin(θ)-(Nmax2-1)*Gs2)/Gs2 > 0.75],

where Nmax1 is the minimum integer number which is bigger or equal to (L1*Cos(θ)+W1*Sin(θ))/Gs1 and Nmax2 is the minimum integer number which is bigger or equal to (L2*Cos(θ)+W2*Sin(θ))/Gs2."

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments and Clarity*

Claim 1 is based on claims 1, 3, 4, 13 and 15 as originally filed (see also paragraphs 0047, 0051 and 0053 of application as published). Claim 2 corresponds to special cases disclosed at paragraphs 0056, 0057, 0064 and 0065. The board is therefore satisfied that the claims comply with Article 123(2) EPC.

The claims have been amended to define terms such as "primary grain boundaries" objected to in the decision under appeal for being unclear. The board judges that the claims as amended now meet the requirements of Article 84 EPC 1973.

3. *Inventive step*

3.1 Document D1 discloses formation of crystalline silicon regions by Sequential Lateral Solidification (SLS)

crystallisation of amorphous Silicon. A catalyst (Ni) is introduced into the regions of the amorphous silicon layer to be crystallised. It is observed that the crystalline growth is essentially one-dimensional (column 14, lines 42 to 60). Thin Film Transistors (TFTs) are arranged on the crystallised regions such that the channel region is oriented in the crystal growth direction in order to avoid grain boundaries across the current direction of the channel, resulting in a TFT with high mobility (column 10, lines 4 to 11). If the channel region is oriented perpendicularly to the crystal growth direction, ie a channel region having several grain boundaries across it, a TFT with low mobility is obtained. Such a TFT has however a high on/off ratio, as no grain boundaries are formed in the edge portion of the drain region (column 29, line 48 to column 30, line 2).

3.2 Document D1 does not disclose any relationship between the channel length and the grain size. Hence the features of the characterising part of claim 1 are not known from document D1.

3.3 The application addresses the problem of improving uniformity among a plurality of TFTs where one group of the TFTs have their channel regions aligned perpendicularly to those of a second group of TFTs. It is well-known that "primary" grain boundaries in the channel region, here defined to be crystal grains whose boundaries are arranged at an angle of inclination θ between $-45° <= \theta <= 45°$ in respect to a direction perpendicular to the active channel, have profound effects on the properties of the TFT: A higher number of primary grain boundaries in the channel will

significantly lower the mobility and thereby the switching speed of the transistor. When the claimed conditions are fulfilled by adjusting the channel length, the grain size and the angle between the primary crystal grain boundaries and the channel region, the fluctuations in the number of primary crystal grains within the channel region is minimized. The result is a reduced fluctuation in device properties among the plurality of TFTs.

3.4 As none of the available prior art documents addresses the problem of keeping the fluctuations in the number of crystal grain boundaries in the channel as small as possible, the claimed subject matter is not derivable therefrom. Neither, in the board's judgement, is it otherwise obvious for the person skilled in the art to arrive thereat.

3.5 Hence the subject matter of claim 1 is to be considered as involving an inventive step within the meaning of Article 56 EPC 1973.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division with the order to grant a patent in the following version

Description pages 1 to 15,
Claims 1 and 2 sent with letter dated 21 October 2008;

Drawings Sheets 1 to 12 as originally filed.

Registrar Chair

S. Sánchez Chiquero R. G. O'Connell