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Datasheet for the decision of 13 March 2014

Case Number: T 1324/10 - 3.4.03

Application Number: 98963988.5

Publication Number: 1040524

IPC: H01L29/772

Language of the proceedings: EN

Title of invention:
IMPROVED STATIC INDUCTION TRANSISTOR

Applicant:
Northrop Grumman Systems Corporation

Headword:

Relevant legal provisions:
EPC 1973 Art. 56

Keyword:
Inventive step (no)

Decisions cited:

Catchword:

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European Patent Office
D-80298 MUNICH
GERMANY
Tel. +49 (0) 89 2399-0
Fax +49 (0) 89 2399-4465

Case Number: T 1324/10 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 13 March 2014

Appellant: (Applicant)
Northrop Grumman Systems Corporation
1840 Century Park East
Los Angeles, CA 90067-2199 (US)

Representative:
Gray, Helen Mary
ZACCO GmbH
Bayerstrasse 83
80335 München (DE)

Decision under appeal:
Decision of the Examining Division of the European Patent Office posted on 4 January 2010 refusing European patent application No. 98963988.5 pursuant to Article 97(2) EPC.

Composition of the Board:

Chairman: G. Eliasson
Members: R. Bekkering
T. Bokor

Summary of Facts and Submissions

I. The appeal is against the refusal of application no. 98 963 988 for added subject-matter, Article 123(2) EPC (main and first auxiliary request) and for lack of an inventive step, Article 56 EPC (second auxiliary request).

II. With the statement setting out the grounds of appeal dated 12 May 2010, the appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the following:

Main request:

Claims 1 to 5 according to the Main Request filed with the statement setting out the grounds of appeal,

Auxiliary request:

Claims 1 to 5 according to the 1st Auxiliary Request filed with the statement setting out the grounds of appeal.

III. Reference is made to the following documents:

D2: DE 29 10 566 A

D5: US 5 612 547 A

IV. A summons to oral proceedings was issued by the board, provided with an annex in which a provisional opinion of the board on the matter was given.

In particular, the appellant was informed that claim 1

of the main request lacked an inventive step in the sense of Article 56 EPC 1973 over documents D5 and D2.

Claim 1 of the auxiliary request also lacked an inventive step in the sense of Article 56 EPC 1973 over documents D5 and D2.

Thereupon, the appellant withdrew its request for oral proceedings and requested a decision based on the status of the file.

No arguments were provided by the appellant in response to the board's observations.

On that, the oral proceedings were cancelled by the board.

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

"*A static induction transistor structure, comprising:*
(A) a silicon carbide semiconductor body (12; 80; 110) of a selected conductivity type having at least one source (16; 90; 112) for supplying majority carriers and at least one drain (14; 82; 118) for collecting said carriers;
(B) said source and drain being vertically spaced on opposite sides of said semiconductor body;
(C) at least two gates (22; 92; 120) positioned laterally in said semiconductor body on either side of said drain or source for controlling flow of said carriers from said source;
(D) said semiconductor body having a first channel region (36; 88; 130) contiguous to said source and gates and located between said gates and extending from said source to the bottom of said gates or below said gates in which said gates control flow of said carriers

from said source to said drain, and a second drift region (38; 86; 132) extending from said first region to said drain;
said structure being characterised in that
(E) said first and second regions (22, 36; 92, 88; 120, 130) have predetermined impurity atoms of a dopant added thereto, the doping concentration of said first region being $1x10^{16}$ cm^{-3} to $2x10^{16}$ cm^{-3} and the doping concentration of said second region being $1x10^{15}$ cm^{-3} to $5x10^{15}$ cm^{-3}."

VI. Claim 1 of the auxiliary request corresponds to claim 1 of the main request with feature (D) reading as follows (amendments marked by the board):

"*(D) said semiconductor body having a first channel region (36; 88; 130) contiguous to said source and gates and located between said gates and extending from said source to ~~the bottom of said gates or~~ below said gates in which said gates control flow of said carriers from said source to said drain, and a second drift region (38; 86; 132) extending from said first region to said drain;* ***said gates being separated from said drain by said first and second regions;***"

VII. The appellant's arguments submitted with the statement setting out the grounds of appeal, as far as relevant to the present decision, may be summarised as follows:

None of the cited prior art disclosed or suggested the two-doping channel structure defined in features (D) and (E) of claim 1 according to the main request. In particular, document D2, figure 14, showed a three-doped channel region with a lightly doped region between the gate and source regions, specifically designed to reduce gate-source capacitance and gate-

drain capacitance. As such, this embodiment appeared rather to teach away from the claimed invention. Accordingly, the subject-matter of claim 1 of the main request involved an inventive step.

The additional features of claim 1 according to the first auxiliary request were also not disclosed in the prior art. Therefore, the subject-matter of claim 1 of this request involved an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. Main request

2.1 Novelty

Document D5 discloses a static induction transistor fabricated of silicon carbide.

In particular, document D5 discloses, using the terminology of claim 1, a static induction transistor structure, comprising:
(A) a silicon carbide semiconductor body of a selected conductivity type having at least one source (20; 120) for supplying majority carriers and at least one drain (12; 112) for collecting said carriers;
(B) said source and drain being vertically spaced on opposite sides of said semiconductor body;
(C) at least two gates (22; 122) positioned laterally in said semiconductor body on either side of said drain or source for controlling flow of said carriers from

said source;
(D) said semiconductor body having a first channel region contiguous to said source and gates and located between said gates and extending from said source to the bottom of said gates or below said gates in which said gates control flow of said carriers from said source to said drain, and a second drift region (14; 114) extending from said first region to said drain (cf column 3, line 17 to column 5, line 47 and figures 1A to 1K; column 6, line 31 to column 7, line 7 and figure 3).

Accordingly, document D5 discloses a structure according to the pre-characterising portion of claim 1.

Moreover, according to D5 the drift layer (14, 114) has a n^- doping and thus a doping concentration of about 10^{15} to 10^{16} dopants/cm^3, thereby anticipating the doping concentration of the second drift region as defined in claim 1 (cf D5, column 5, lines 33 to 35; column 3, lines 24 to 30; column 6, line 52 to 54; figures 1A to 1K, 3).

However, in D5 the channel region also lies in this layer (14, 114), having an n^- doping and thus a doping concentration of about 10^{15} to 10^{16} dopants/cm^3 (cf column 3, lines 24 to 30).

The subject-matter of claim 1, thus, differs from D5 in that the first channel region has a higher doping concentration of $1x10^{16}$ to $2x10^{16}$ cm^{-3}.

Accordingly, the subject-matter of claim 1 of the main request is new over document D5, Article 54(1) EPC 1973.

The subject-matter of claim 1 of the main request is also new over the remaining available, more remote prior art.

2.2 *Inventive step*

In view of the above distinguishing feature with respect to document D5, the objective problem to be solved is to optimise the characteristics of the static induction transistor.

Document D2 is concerned with optimising the characteristics of a static induction transistor. In order to improve the integration density and the efficiency, document D2 provides a n^- doped channel region (33), having a higher doping concentration than the n^{--} doped drift region (31) (page 40, third paragraph to page 41, first paragraph; figure 14). This higher doped channel region extends below the gates.

It is noted that according to D2 a further region (32), which is n^{--} doped, is provided between the gate and the source in order to reduce the gate-source capacitance (page 40, third paragraph to page 41, first paragraph; figure 14). However, where a higher gate-source capacitance is not a concern, it would be obvious for a person skilled in the art to omit this further region (32), saving the additional complexity. In this case, the n^- doped channel region (33) would extend from the source to below the gates.

The selection of an appropriate doping concentration for the drift region, and an appropriate higher doping concentration for the channel region, falls within the routine tasks of the skilled person. Accordingly, the skilled person would arrive at the claimed dopant

concentrations for the channel region of $1x10^{16}$ cm^{-3} to $2x10^{16}$ cm^{-3} and for the drift region of $1x10^{15}$ cm^{-3} to $5x10^{15}$ cm^{-3}, without the exercise of any inventive skills.

The appellant argued that document D2 appeared rather to teach away from the claimed invention, as figure 14 of D2 showed a three-doped channel region including a lightly doped region 32 between the gate and source regions, specifically designed to reduce gate-source capacitance and gate-drain capacitance.

As noted above, however, as the lightly doped region 32 in D2 specifically serves to reduce the gate-source capacitance, the skilled person would consider its omission if deemed unnecessary.

No further arguments were submitted by the appellant in response to the board's observations provided in the annex to the summons to oral proceedings, which essentially correspond to the above.

Accordingly, the subject-matter of claim 1 of the main request is obvious to a person skilled in the art and thus lacks an inventive step in the sense of Article 56 EPC 1973.

The appellant's main request is, therefore, not allowable.

3. *Auxiliary request*

Claim 1 of the auxiliary request further specifies that:

- the first channel region extends from the source to

below the gates, and that

- the gates are separated from the drain by the first and second regions.

However, as noted above, having regard to the solution proposed in document D2, it would be obvious for a person skilled in the art to omit further region (32), in which case the n- doped channel region (33) extends from the source to below the gates.

Moreover, as can be seen from figure 14, in document D2 the gates (14) are separated from the drain (11) by the first channel region (33) and the second drift region (31). Accordingly, these features do not add anything inventive.

The subject-matter of claim 1 of the auxiliary request is, thus, also obvious to a person skilled in the art and, therefore, lacks an inventive step in the sense of Article 56 EPC 1973.

Accordingly, the appellant's auxiliary request is not allowable either.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated