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**Datasheet for the decision
of 19 December 2017**

Case Number: T 0569/13 - 3.4.03

Application Number: 10176985.9

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H01L29/417, H01L29/739,
H01L29/78

Language of the proceedings: EN

Title of invention:
Power semiconductor device

Applicant:
Mitsubishi Electric Corporation

Headword:

Relevant legal provisions:
EPC Art. 52(1), 54, 76(1), 84, 123(2)
RPBA Art. 15(1)

Keyword:
Novelty - main request (no)
Amendments - added subject-matter (yes)

Decisions cited:

Catchword:



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Case Number: T 0569/13 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 19 December 2017

Appellant: Mitsubishi Electric Corporation
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Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 29 August 2012
refusing European patent application No.
10176985.9 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman G. Eliasson
Members: S. Ward
W. Van der Eijk

Summary of Facts and Submissions

- I. The appeal is against the decision of the Examining Division refusing European patent application No. 10 176 985 on the ground that the subject-matter of claim 1 of the main request then on file did not involve an inventive step within the meaning of Article 56 EPC. The claims according to the auxiliary request were not admitted into the procedure pursuant to Rule 137(3), Rule 116(1) and Rule 116(2) EPC.
- II. At the oral proceedings held before the Board 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 auxiliary request 1, both filed with letter of 18 October 2017.
- III. The following document is referred to:
- D1: US 2004/0232484 A1
- IV. Claim 1 of the main request reads as follows:
- "A power semiconductor device comprising:
a semiconductor substrate (1) having a main surface;
and a cell region and a guard ring region,
wherein in said cell region a plurality of unit cells
of a vertical power device arranged in rows and columns
are formed at a main surface of said semiconductor
substrate,
wherein said cell region has a central portion (CR) and
an outer peripheral portion (PR) surrounding said
central portion (CR) wherein said guard ring region
surrounds the outer periphery of the cell region and in
the guard ring region a plurality of guard rings (18)*

surrounding the outer periphery of the cell region are formed at the main surface of said semiconductor substrate and wherein a cell structure included in said plurality of unit cells located in said central portion (CR) of said main surface has a lower current carrying ability than a cell structure included in said plurality of unit cells located in said outer peripheral portion (PR) of said main surface."

Claim 1 of auxiliary request 1 differs from claim 1 of the main request in the addition of the following feature:

"and wherein said guard ring region is adjacent the outer peripheral portion (PR)",

and in that the final clause begins:

"wherein each cell structure".

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

Document D1 (paragraphs [0026] to [0049] and Fig. 1) disclosed the subject-matter of claim 1 except the feature that the power device was a vertical power device. Claim 1 was therefore novel. This difference did not, however, involve an inventive step.

- VI. In a communication under Article 15(1) RPBA the Board expressed the view it was rather difficult to imagine that the cells in D1 were anything other than vertical, and so it was arguable that this feature was implicitly disclosed and that the claimed subject-matter was not

novel. Furthermore there were doubts whether the requirements of Articles 123(2), 76(1) and 84 EPC were met.

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

In relation to novelty, it was not necessary to decide whether vertical power devices were disclosed in D1 or not, since, according to claim 1, the guard ring region surrounded the outer periphery of the cell region, which was not the case in D1. In D1 the guard ring region 604 (Fig. 6A and 6B) surrounded the B and C cells (which were not active device cells) and therefore did not surround the outer periphery of the cell region (i.e. the region of the active A cells).

The B cells and C cells in D1 were termination structures which resulted in the active area of the device becoming smaller. The features of claim 1 solved the objective technical problem of providing power devices with a larger active area.

Claim 1 of the first auxiliary request explicitly specified that the guard ring region is adjacent the outer peripheral portion PR. The basis was page 13, lines 17 to 18, and Figs. 3, 5 and 7. The word "adjacent" clarified that there was nothing between the guard ring region and the outer peripheral portion PR of the cell region. Additionally claim 1 specified that "each" cell structure located in the central portion had a lower current carrying ability than a cell structure located in the outer peripheral portion PR.

Reasons for the Decision

1. The appeal is admissible.
2. *Main request: Articles 123(2), 76(1) and 84 EPC*
 - 2.1 The Chairman indicated in oral proceedings that the Board considered it expedient to start with the issue of novelty (and possibly inventive step). If it became necessary the Board would subsequently consider whether the present main request satisfactorily overcame the objections raised under Articles 123(2), 76(1) and 84 EPC in the communication under Article 15(1) RPBA.
 - 2.2 In view of the conclusions reached in the following section, it is not necessary for the Board to decide whether claim 1 of the main request meets the requirements of Articles 123(2), 76(1) and 84 EPC.
3. *Main Request: Novelty*
 - 3.1 The appellant argued that claim 1 of the main request differed from the disclosure of D1 in the feature:

"wherein said guard ring region surrounds the outer periphery of the cell region".

It was not argued that any of the remaining features further distinguished the claimed subject-matter from the disclosure of D1. In particular, the view of the Board expressed in the communication under Article 15(1) RPBA that it was implicit that the cells in D1 were vertical was not challenged by the appellant, and

is maintained. The question of novelty therefore hinges entirely on the feature cited above.

- 3.2 In D1 the guard ring region 604 extends around the edges of the device (see Figs. 6A, 6B), and in the interior of the device are located active A cells and peripheral B and C cells, which are not active cells.

The argument that in D1 the guard ring region does not surround the cell region is based firstly on the appellant's identification of the claimed "cell region" with the region of the A cells in Figs. 6A and 6B, and secondly on the meaning which the appellant ascribes to the word "surrounds".

Undoubtedly "surrounds" conveys at least the meaning of "encircles", "encloses" or "encompasses". In addition, however, the appellant argues that "surrounds" implies that nothing intervenes between the thing which surrounds and the thing which is surrounded. Thus, the guard ring region may be said to surround the region of the B and C cells, but it does not surround the outer periphery of the A cell region (identified as the claimed "cell region"), since the B and C cells intervene.

- 3.3 The Board accepts that the definition of "to surround" *includes* arrangements in which the surrounding object both encircles and directly adjoins the object surrounded, for example in the case of a frame or border. The Board does not accept, however, that the proper definition is *restricted* to such arrangements, or that an intervening element between the two objects would categorically exclude the arrangement being described in terms of one object surrounding the other.

Thus, even if, *arguendo*, it were accepted that the claimed "cell region" corresponded only to the region of the A cells in Figs. 6A and 6B, the Board does not believe that the presence of the B or C cells would preclude the guard ring region being properly described as surrounding the A cell region.

- 3.4 The Board therefore judges that the single feature identified by the appellant as distinguishing the claimed subject-matter from D1 is in fact disclosed in that document, and that the subject-matter of claim 1 of the main request is therefore not new within the meaning of Articles 52(1) and 54 EPC.

4. *First Auxiliary Request: Article 123(2) EPC*

- 4.1 According to claim 1 of the first auxiliary request, the guard ring region is "adjacent" the outer peripheral portion (PR) of the cell region. In the letter filed with this request the appellant gave as basis page 13, lines 17-18 and Fig. 7; in oral proceedings Figs. 3 and 5 were also cited.

The appellant's stated understanding of the term "adjacent" is that it excludes the possibility of any elements being located between the guard ring region and the outer peripheral portion of the cell region.

- 4.2 Whether the adjective "adjacent" applies only to objects which are immediately adjoining each other with nothing between them, as asserted by the appellant, is perhaps debatable. Nevertheless the Board is prepared to accept, *arguendo*, this understanding of the term.

There is no literal basis in the application as filed for introducing the word "adjacent"; the cited passage

(page 13, lines 17-18) merely states that the guard ring region "is present near outer peripheral portion PR". The terms "near" and "adjacent" do not have an identical meaning, at least according to the appellant's stated understanding of "adjacent".

- 4.3 Thus, the only possible basis is in the figures. However, whether the figures disclose the guard ring region to be adjacent to the cell region (in the sense understood by the appellant) is dependent on how these terms are defined.

As shown in Figs. 3 and 7, the device 20 comprises *inter alia* (from the periphery inwards): guard rings, the external part of a gate conductive layer 16 (the structure of which is best shown in Fig. 5) and a group of cells (visible via their emitter pads 11). If one were to adopt the perfectly plausible definition that the guard ring region is a region containing only the guard rings, and the equally plausible definition that the cell region is a region containing only the cells, then the guard ring region would not be disclosed as being adjacent the cell region (in the sense understood by the appellant), since part of gate conductive layer 16 would lie between them.

On the other hand, if the cell region were regarded as comprising the cells and the entire gate conductive layer, then Fig. 7 could be seen as disclosing that the cell region is adjacent to the guard ring region. Such a definition of the cell region appears to be implied by the (somewhat schematic) figure, as the caption "Cell Region" in Fig. 7 seems to refer to a region bounded by a dotted line lying just outside the outer part of gate conductive layer 16.

4.4 Thus, Fig. 7 discloses - at most - that the cell region is adjacent to the guard ring region according to a particular definition of what constitutes the cell region. Claim 1 of the first auxiliary request specifies that the guard ring region is adjacent to the outer peripheral portion of the cell region, without any corresponding definition that the cell region comprises the gate conductive layer (indeed, claim 1 fails to make any mention of the gate conductive layer at all, despite this feature being clearly disclosed in all of the figures cited by the appellant as a basis).

4.5 The Board therefore concludes that there is no textual support for the above-mentioned amendment to the claim, and that this amendment also goes beyond the specific arrangements disclosed in the cited figures. Claim 1 of the first auxiliary request does not, therefore, meet the requirements of Article 123(2) EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



S. Sánchez Chiquero

G. Eliasson

Decision electronically authenticated