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File Number: T 656/90 - 3.4.1

Application No.: 86 200 752. 3

Publication No.: 0 201 963

Title of invention: Charge-coupled device and method of manufacturing the same

Classification: H01L 21/28

D E C I S I O N
of 13 November 1991

Applicant: N.V. Philips' Gloeilampenfabrieken

Headword:

EPC Article 56

Keyword: "Inventive Step (no)"

Headnote



Case Number : T 656/90 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 13 November 1991

Appellant :

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Decision under appeal :

Decision of Examining Division 048 of the
European Patent Office dated 4 April 1990
refusing European patent application
No. 86 200 752.3 pursuant to Article 97(1) EPC.

Composition of the Board :

Chairman : G.D. Paterson
Members : H.J. Reich
R.K. Shukla

Summary of Facts and Submissions

- I. European patent application No. 86 200 752.3 (publication No. 0 201 963) was refused by decision of the Examining Division.

- II. The decision was based on Claim 1 filed with letter dated 30 January 1990. Claim 1 reads as follows:

"1. A method of manufacturing a charge-coupled semiconductor device in which a first silicon layer, an oxidation-preventing layer and a second silicon layer are successively provided on an electrically insulating layer, after which the second silicon layer is etched according to a pattern comprising a number of parallel silicon strips and the second silicon layer is then partly oxidized for forming an oxidized edge portion thereof, whereupon the uncovered parts of the said oxidation-preventing layer and then the exposed silicon oxide are etched away, a thermal oxidation is subsequently carried out, the uncovered parts of the oxidation-preventing layer are etched away selectively and grooves are etched through the parts of the first silicon layer thus exposed in order to form a number of electrodes serving for charge transport, characterized in that between at least two electrodes the groove wall is then only superficially oxidized, after which an electrically conducting layer is provided over the electrodes, which layer fills the groove and is then etched throughout its surface until only the part thereof present within the groove remains, this part forming a transfer electrode."

Claims 2 to 4 are dependent on Claim 1.

III. The Examining Division took the view that the subject-matter of Claim 1 did not satisfy the requirements of Articles 52 and 56 EPC having regard to documents:

D1: DE-A-2 703 013, and

D2: GB-A-2 111 304

for the following reasons: the features of the first part of Claim 1 are known from document D2 whereas all the features of the characterising portion of Claim 1 are contained in the teaching of the prior art document D1. Since document D2 ends with the formation of grooves, further teaching would be required in order to be able to complete the device. Since document D1 gives only examples related to the formation of CCDs, combining this teaching with that of document D2 was an obvious selection of one of several possibilities in accordance with circumstances.

IV. The Appellant filed an appeal against this decision, mainly arguing, that the grooves in the final product of the method according to document D2 need not - as document D1 teaches - be filled with a further "electrically conducting layer for forming electrodes", because in the final product of the method according to document D2 all the electrodes for the functioning of this one-layer CCD are already present.

V. In its communication accompanying the summons to oral proceedings, the Board drew the Appellant's attention to the following:

(a) In view of the object of the invention which is to provide a CCD with transfer electrodes which require little space, document D1, and not document D2, has to be seen as the nearest prior art.

- (b) Starting from document D1, the objective problem underlying the invention reduces to an amelioration of the integration density of the device.
- (c) Its solution by replacing the groove manufacturing steps in Figures 2a to 2e of document D1 by the groove manufacturing steps in Figures 46 to 51 of document D2 may be regarded as obvious in view of the smaller groove width indicated in document D2. Due to the fact that document D2 is explicitly directed to a "method of providing a groove" and in view of the great variety of examples given in this document it appeared rather unlikely that a skilled person would restrict the teaching of document D2 to the separation of neighbouring electrodes in a one-layer CCD.

VI. Oral proceedings were held on 13 November 1991, at the end of which the Appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of Claims 1 to 4 filed with letter dated 30 January 1990 and annexed to the decision under appeal.

VII. In support of his request the Appellant argued essentially as follows:

- (a) A skilled person would not regard document D1 as the closest prior art but document D2, because the method according to the latter has the advantage that no second electrode layer is needed, whereas in document D1 such second electrode layer is necessary due to the large distance between neighbouring first layer electrodes which distance does not allow to transfer charges between the first layer electrodes.

- (b) The present invention starts from document D2 and provides additional electrodes within 1 μm wide grooves in the first electrode layer. In this manner use is made of the space between adjacent electrodes which otherwise would have been lost.

- (c) The provision of additional electrodes according to the invention would not be obvious because at 1 μm distance between neighbouring electrodes no further transfer gates are needed. Though document D2 teaches the method steps in the first part of Claim 1, a skilled person also learns from document D2 that one electrode layer is sufficient. Hence, the skilled person -without hindsight - would see no technical reason to make the manufacturing process more complex and to apply the teaching of document D1 in the method according to document D2.

- (d) Furthermore, a skilled person would not regard a groove with 1 μm width to offer enough space for the provision of an additional electrode.

VIII. At the conclusion of the oral proceedings, the decision was announced that the appeal was dismissed.

Reasons for the Decision

1. Inventive step

- 1.1 In the present case, a main point which arises in connection with the determination of the question of inventive step is the identification of the closest prior art document, and in particular the choice of document D1 or D2 as the closest prior art; such identification of the closest prior art being the first stage of the problem-

and-solution approach to the assessment of inventive step.

As is generally recognized in the jurisprudence of the Boards of Appeal, in cases where a claimed invention is attacked on the basis of more than one prior document each belonging to the same technical field as the claimed invention, the closest prior art is the prior document, starting from which the claimed invention could most easily have been made by a skilled person at the filing date. As stated in decision T 254/86, OJ EPO 1989, 115, in paragraph 15, "the objectively closest state of the art is the most promising springboard towards the invention which was available to the skilled person." In each case, the objective choice of the closest prior art document depends upon the nature of the claimed invention and of the disclosures in the relevant prior documents.

- 1.2 In the present case, the claimed invention is a method of manufacturing a charge-coupled semiconductor device (CCD), which has a particular defined construction including two conductive layers at the completion of such method. Although both documents D1 and D2 describe methods of manufacture of such devices, only the method described in document D1 describes the formation of an electrode structure including two conducting layers, as in the invention claimed. This fact in itself indicates prima facie that document D1 represents the closest prior art, rather than D2. Furthermore, both D1 and the claimed invention are concerned with the same technical objective, namely improving the integration density of a two-layer CCD; in document D1 this is achieved by shortening the width of transfer gates 52, whereas in the claimed invention this is achieved by the use of the defined self-aligned etching technique. Thus the method described in

document D1 has more relevant features in common with the claimed invention than the method described in document D2 and is concerned with the same technical problem, and primarily for these reasons, in the Board's view, document D1 should be regarded as the closest prior art.

1.3 This view is confirmed by the consideration that in practice, a skilled person can be expected normally to be more interested in improving the way of manufacturing a known product with known advantageous characteristics, rather than changing the structure of a known and operable product. Moreover, etching is one of the main tools used in the manufacture of semi-conductor devices, and thus variations in etching techniques are constantly under study, in order to find out whether they lead to a better result.

1.4 From the closest prior art according to document D1 there is known (in the wording of Claim 1):

"A method of manufacturing a charge-coupled semiconductor device in which a first silicon layer (36 in Figure 4a) and an oxidation-preventing layer (38) are successively provided on an electrically insulating layer (34 in Figure 4b) and grooves (48 in Figure 4a) are etched through the parts of the first silicon layer exposed in order to form a number of electrodes serving for charge transport (see Figures 2d + 2e in combination with page 11, lines 18 to 22) which is characterised in that at least between two electrodes the groove wall is then only superficially oxidised (50 in Figure 4b, and page 11, lines 26 to 28), after which an electrically conducting layer (52 in Figure 4c) is provided over the electrodes, which layer fills the groove and is then etched throughout its surface until only the part thereof present within the

groove remains (52 in Figure 4d), this part forming a transfer electrode (page 5, lines 2 and 3 and page 12, lines 13 and 14)."

- 1.5 Starting from document D1, the objective problem underlying Claim 1 is - in line with the description of the present application, page 2, lines 13 to 18 - an amelioration of the integration density. It is generally known that this problem belongs to the routine duties of a skilled person in the semiconductor field. Therefore, in the Board's view, no contribution to inventive step is to be found in the definition of the above problem.

The aim of a substantially equal thickness of the insulating layer under a transfer and a storage electrode - see EP-A1-0 201 963, page 2, lines 19 to 21 - cannot be included into the objective problem, because the distinguishing features over document D1 no longer include the oxidation step of the grooves and Claim 1, as a whole, contains no means which allow to achieve this aim.

- 1.6 The above objective problem is solved by the remaining subject-matter of Claim 1, i.e. by the measures in the pre-characterising part of Claim 1 directed to manufacturing steps of the grooves, which steps are all known from document D2 as follows:

"a first silicon layer (1 in Figure 46 of D2), an oxidation-preventing layer (2 in Figure 46) and a second silicon layer (3) are successively provided on an electrically insulating layer (61), after which the second silicon layer is etched according to a pattern comprising a number of parallel silicon strips (Figure 47) and the second silicon layer is then partly oxidised for forming an oxidised edge portion (5 in Figure 48) thereof, whereupon the uncovered parts of the said oxidation-

preventing layer and then the exposed silicon oxide are etched away (Figures 49 and 50), a thermal oxidation is subsequently carried out (6, 7 in Figure 50), the uncovered parts of the oxidation-preventing layer are etched away selectively and grooves (8 in Figure 51) are etched through the parts of the first silicon layer thus exposed in order to form a number of electrodes (1A, 1B etc. in Figure 51) serving for charge transport."

- 1.7 Hence, in deciding on the existence of an inventive step, the crucial question is not whether a skilled person would provide further electrodes inbetween electrodes 1A and 1B of document D1 (see paragraph VII(b) and (c)), but whether a skilled person would replace the groove manufacturing steps in Figures 2a to 2e of document D1 leading to the structure of Figure 4a of D1 by the groove manufacturing steps known from Figures 46 to 51 of document D2.
- 1.8 In the Board's view, such a replacement was obvious to a skilled person for the following reasons: the skilled person derives explicitly from the text of the corresponding documents that the groove width can be made smaller when determined by the extension of oxidised edge portions 5 in Figure 48 of D2 (smaller than 1μ ; see D2, page 7, lines 23 to 28) than via the length of the lateral etching (46 in Figure 2d of D1) of oxidation-preventing layer 38 in Figure 2d of document D1 (2μ ; see D1, page 12, line 13). Document D2 is explicitly directed to a "method of providing a groove in a substrate region (see D2, page 1, in particular lines 3 and 4), and its Figure 51 is only one of many examples wherein this method is applied. Therefore, in the Board's view, a skilled person will not restrict his opinion on the usability of the method of D2 to separating neighbouring electrodes in a one-layer CCD from each other. Moreover, a skilled person is regarded to be aware of the fact that the

results of the above-mentioned groove manufacturing process are technically independent from the subsequent use of the produced layer structure.

- 1.9 The Appellant has not shown that his argument according to paragraph VII(d) represents a generally accepted technical prejudice in the art. Furthermore, Claim 1 does not specify the width of the grooves to be produced. Thus, the Board regards the skilled person to be able to make for his particular purposes the optimum choice of the size of the oxidised edge portions 5 in Figure 48 of document D2 and thus of the width of groove 8 in Figure 51 of document D2 in order to overcome eventual difficulties.
- 1.10 The Appellant has limited his arguments for the existence of an inventive step in paragraph VII above exclusively to the disclosure in document D2 as the technical starting point for his invention. However, a method which lacks inventive step over certain disclosures in the state of the art cannot be rendered patentable in view of non-obviousness over other disclosures; see Decision T 164/83, OJ EPO 1987, 149, paragraph 7. As shown in detail in points 1.4 to 1.9 above, a skilled person would have arrived at the subject-matter of Claim 1 without an inventive step by using the groove-manufacturing technique known from document D2 in the closely analogous situation of the two-layer CCD of document D1.
2. Therefore, in the Board's judgement, Claim 1 does not involve an inventive step and is not allowable pursuant to Articles 52(1) and 56 EPC. Claims 2 to 4 fall because of their dependence on Claim 1.

Order

For these reasons, it is decided that:

The appeal is dismissed.

The Registrar:



M. Beer

The Chairman:



G.D. Paterson

