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D E C I S I O N
of 14 February 2000

Case Number: T 0668/95 - 3.4.3

Application Number: 88113783.0

Publication Number: 0307671

IPC: H01L 21/90

Language of the proceedings: EN

Title of invention:
Method of making an electrically programmable integrated circuit with meltable contact bridges

Applicant:
TEXAS INSTRUMENTS DEUTSCHLAND GMBH

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0668/95 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 14 February 2000

Appellant: TEXAS INSTRUMENTS DEUTSCHLAND GMBH
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 15 March 1995 refusing European patent application No. 88 113 783.0 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: R. K. Shukla
Members: M. Chomentowski
M. J. Vogel

Summary of Facts and Submissions

I. European patent application No. 88 113 783.0 (Publication No. 0 307 671) was filed on 24 August 1988 and claims the priority of 19 September 1987. This application was refused by a decision of the examining division dated 15 March 1995 on the ground that the subject-matter of claim 1 lacked an inventive step having regard to documents **D1**: EP-A-0 146 688 and **D2**: EP-A-0 162 145. A further document **D3**: "Microchip Fabrication, a practical guide to semiconductor processing", by P. **van Zant**, McGraw Hill Publishing Co. USA, 1990, pages 227 to 236, in particular page 232, "Resist-etch barriers and dry etching", was cited in the decision under appeal for information.

The only independent claim of the set of 6 claims forming the basis of said decision reads as follows:

"1. A method of making an electrically programmable integrated circuit comprising:

providing a substrate (10) of a semiconductor material;

forming a protective layer (14, 16) resistant to plasma etching on said semiconductor substrate (10) and covering the top surface thereof;

depositing conductive material on said protective layer (14, 16) to provide a conductive layer (20) on said protective layer;

forming an etching-protective mask (24) on said

conductive layer (20) covering only the portions of said conductive layer (20) from which a contact bridge (22) is to be formed;

performing a plasma etching procedure to selectively remove portions of said conductive layer (20), thereby defining a patterned conductive layer forming a contact bridge (22) on said protective layer (14, 16); and

depositing metallic material (26, 28) onto said protective layer to form electrical contact members in electrical engagement with said contact bridge (22);

characterized in that said substrate (10) of semiconductor material is provided so as to have at least one circuit-function defining zone (12) provided with electrical conductivity and opening onto the top surface thereof;

selectively patterning said protective layer (14, 16) resistant to plasma etching to form an aperture (18) extending therethrough to at least a portion of said at least one zone (12) exposing a contact area of said at least one zone (12) of said semiconductor substrate (10);

depositing the conductive material on said protective layer (14, 16) and the exposed contact area of said at least one zone (12) to provide a conductive layer (20) on said protective layer (14, 16) and said contact area of said at least one zone (12) in overlying relation thereto;

forming the etching-protective mask on said conductive

layer (20) covering only the portions of said conductive layer (20) from which a contact bridge (22) and an associated connecting end are to be formed and the portion of said conductive layer (20) overlying said contact area of said at least one zone (12);

performing the plasma etching procedure to selectively remove the exposed portions of said conductive layer (20), thereby defining a patterned conductive layer (20) having a contact bridge (22) and an associated connecting end formed thereon and including a portion overlying said contact area of said at least one zone (12);

forming a second etching-protective mask (24) on the patterned conductive layer (20) covering only the region of said patterned conductive layer (20) forming the contact bridge (22);

depositing the metallic material on the structure including the second etching-protective mask (24) and the exposed portions of the patterned conductive layer (20) to provide at least one metallic layer (26, 28) thereover; and

performing a second plasma etching procedure to selectively remove portions of said metallic layer (26, 28) on said patterned conductive layer (20) while retaining portions of said metallic layer (26, 28) overlying said contact area of said at least one zone (12) and the portion of said patterned conductive layer (20) defining the connecting end associated with the contact bridge (22) to provide a patterned metallic layer forming the electrical contact members;

the second etching-protective mask (24) shielding the region of said patterned conductive layer forming the contact bridge (22) from etching during the second plasma etching procedure."

II. In said decision, the examining division took the following view:

The method of claim 1 is distinguished from the method known from document **D1** by the following features:

(i) the sequence of the process steps has been changed, i.e. the second protective mask (24) is formed in claim 1 prior to the formation of the metallic layer (26, 28) to pattern the contact members of the meltable contact bridge (22), whereas in document **D1** the protective layer (7) is deposited after the forming of the corresponding contact members (5, 6) of the fuse link (3);

(ii) the patterning of said contact members (26, 28) is carried out in claim 1 by a second plasma etching, and not by wet etching, as in document **D1**.

Moreover, although document **D1** does not explicitly mention the formation of an opening in a protective layer to expose a contact area of a circuit zone, it is considered that, in general, a fusible link structure comprises a conductive member which electrically interconnects a pair of circuit elements and, when desired, this interconnection can be broken by melting the conductive member; thus, this feature is **implicit** in document **D1** and cannot be part of the problem to be solved.

Concerning the same feature, it is considered that a fuse should be interconnected between two circuit elements through an insulating layer formed on the circuit elements; in claim 1, the conductive layer (20) is patterned in such a way that it remains within the opening (18) between the zone (12) and the corresponding contact member. Indeed, in the method of document **D1**, the interconnection of the fuse with the corresponding circuit elements is performed by the contact members, which are patterned so that each contact member overlies the corresponding fuse end, as well as the corresponding contact area of the circuit element. This **slight modification** with respect to the method of document **D1** is considered as being **a design possibility** which cannot form part of the objective problem, and no hint can be found in the whole application that this manner of interconnecting the fuse structure to circuit elements might represent an advantage over the prior art.

Hence, starting from the nearest prior art represented by document **D1**, the objective problem underlying the claimed method reduces to the technical aim of avoiding the use of wet etching to pattern contact members on a fuse structure, **and simultaneously** protecting said fuse structure during the patterning process of said contact members.

The first distinguishing feature (i) is known for the same purpose from document **D2** whereby, **evidently**, the layer (13) deposited on the fuse layer (32) prior to the formation of the contact members serves as a protective layer exactly as in claim 1.

On the other hand, it is a matter of **common sense** that better protection of the fuse structure during the patterning of the contact members will be achieved by the process step sequence defined in document **D2**, i.e. by covering the fuse structure with a protective layer, namely, the layer (13) depicted in Figure 2B of document **D2**, prior to the formation of the contact members on both fuse ends.

The second distinguishing feature (ii), i.e. a second plasma etching step, is evident because it is a well known substitute to wet etching and because, although not explicitly disclosed in document **D2** in relation with patterning the contact members, it would be evident since it is considered that the selection of the etching process falls within the competence of the average practitioner. In this respect, the applicant's argument stressing that the particular process of document **D2**, i.e. the photoengraving process (PEP), uses a photoresist mask and that plasma etching is normally not employed with a photoresist mask, was not convincing because it was known in the art that in both wet and dry etching processes a patterned photoresist layer was the preferred etch barrier mask; the document "**van Zant**" (see page 232, "Resist etch barriers in dry etching") was cited and annexed to the decision for information to illustrate this finding.

As a consequence, an average practitioner would readily take advantage of the teaching of document **D2** when manufacturing a fuse structure according to document **D1**; the selection of the etching process among well-known processes, e.g. wet or plasma etching, to pattern

the contact member, was not considered as involving an inventive step.

III. The applicant lodged an appeal against this decision on 12 May 1995 paying the appeal fee the same day. The statement of the grounds of appeal was filed on 22 July 1995.

IV. In response to communications from the Board, the appellant filed with its letters dated 19 October 1999 and 23 December 1999 a new set of claims and amended pages of the description. Claim 1 of the new set has been amended in relation to claim 1 forming the basis of the decision, so that it is drafted in the one-part form, without the expression "characterized in that", and contains the terms "continuous" and "meltable" with respect to the conductive layer (20) and the contact bridge (22), respectively.

Claim 1 is the only independent claim and reads as follows:

"1. A method of making an electrically programmable integrated circuit comprising:

providing a substrate (10) of a semiconductor material, said substrate (10) having at least one circuit-function defining zone (12) provided with electrical conductivity and opening onto the top surface thereof;

forming a protective layer (14, 16) resistant to plasma etching on said semiconductor substrate (10) and covering the top surface thereof;

selectively patterning said protective layer (14, 16) resistant to plasma etching to form an aperture (18) extending therethrough to at least a portion of said at least one zone (12) exposing a contact area of said at least one zone (12) of said semiconductor substrate (10);

depositing conductive material on said protective layer (14, 16) to provide a **continuous** conductive layer (20) on said protective layer and said contact area of said at least one zone (12) in overlying relation thereto;

forming an etch-protective mask on said conductive layer (20) covering only the portions of said conductive layer (20) from which a **meltable** contact bridge (22) and an associated connecting end (21) are to be formed and the portion of said conductive layer (20) overlying said contact area of said at least one zone (12);

performing a plasma etching procedure to selectively remove portions of said conductive layer (20), thereby defining a patterned conductive layer forming the meltable contact bridge (22) and the associated connecting end (21) on said protective layer (14, 16) and including the portion overlying said contact area of said at least one zone (12);

forming a second etching-protective mask (24) on the patterned conductive layer (20) covering only the region of the patterned conductive layer (20) forming the meltable contact bridge (22);

depositing metallic material (26, 28) on the structure

including the second etching-protective mask (24) and the exposed portions of the patterned conductive layer (20) to provide at least one metallic layer (26, 28) thereover to form electrical contact members in electrical engagement with said meltable contact bridge (22);

performing a second plasma etching procedure to selectively remove portions of said metallic layer (26, 28) on said patterned conductive layer (20) while retaining portions of said metallic layer (26, 28) overlying said contact area of said at least one zone (12) and the portion of said patterned conductive layer (20) defining the connecting end (21) associated with the meltable contact bridge (22) to provide a patterned metallic layer forming the electrical contact members (28);

the second etching-protective mask (24) shielding the region of said patterned conductive layer forming the meltable contact bridge (22) from etching during the second plasma etching procedure."

V. The appellant requests that the decision under appeal be set aside and that a patent be granted on the basis of the following patent application documents:

Claims: Nos. 1 to 6 as filed with appellant' letter dated 19 October 1999;

Description: Pages 1, 1a and 2 as filed by the appellant with letter dated 23 December 1999;
Pages 3 to 6 as filed;

Drawings: Sheet 1/1 as filed.

VI. The appellant has argued in substance as follows in support of his request:

The first plasma etching procedure of claim 1 is for defining a patterned conductive layer having a contact bridge (22) and an associated connecting end formed thereon and including a portion overlying a contact area of at least one circuit-function defining zone (12) of the semiconductor substrate provided with electrical conductivity and opening onto the top surface thereof. In document **D1,** the circuit-function zone (12) of the substrate is not present. The method step of claim 1 of selectively patterning the protective layer (14, 16) resistant to plasma etching for forming an aperture (18) therethrough to expose a contact area of the zone (12) is not disclosed in document **D1** either.

Moreover, the oxide layer (7) of document **D1** is an oxide layer formed after the wet etching of the titanium-tungsten layer (5) and the aluminium or aluminium alloy layer (6) for the electrical contact members and does not correspond to a protective mask of claim 1 for assisting the patterning of the metallic layer in forming electrical contact members by shielding the relevant region during the second plasma etching step.

Therefore, document **D1** also does not disclose the process step of depositing a conductive material on the protective layer (14, 16) and the exposed contact area of the zone (12), as claimed in claim 1 of the

application in suit.

Further, in document **D1,** whatever masking may be provided with respect to the platinum-silicon layer (3), neither the mask nor the platinum-silicon layer for the meltable contact bridge to be patterned overlie the contact area of the zone (12).

Moreover, the wet etching procedure of document **D1** is in clear contrast to the second plasma etching procedure specified in claim 1.

The advantage over the prior art resides in the use of first and second plasma etching procedures within the context of making an electrically programmable integrated circuit having one or more contact bridges forming fuses for interconnecting electrical-function performing components, where the sequence of first and second plasma etching procedures, as contrasted to the use of a wet etching procedure in conjunction with a plasma etching procedure of the type as disclosed in document **D1**, enables structures of reduced geometrical dimensions to be made which would not be possible when employing wet etching methods.

From document **D2**, only a photoengraving process (PEP) for a fusible link structure is derivable. There is no indication therein about a plasma etching procedure for patterning the connecting ends of the meltable fusible link. Document **D3** (see in particular page 232), cited for information in the decision under appeal, supports the appellant's submission that a photoresist mask is generally not used for patterning with a dry etching procedure. In any case, this document of 1990 is

published after the claimed priority date of the application in suit.

Consequently, the method step sequence recited in claim 1 is in no way taught or suggested by document **D1** and/or **D2** and, therefore, the subject-matter of present claim 1 involves an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

As mentioned here above (cf. item IV), claim 1 has been amended to overcome the objections raised by the Board. Thus, it is now specified that zone (12) is formed prior to the formation of the protective layer (14, 16), that the conductive layer (20) deposited on the protective layer (14, 16) is **continuous** and that the contact bridge (22) formed from said conductive layer (20) is **meltable**. These features are derivable from the whole content of application as filed (see in particular page 2, lines 11 to 27).

Claims 2 to 6 are dependent claims which concern particular embodiments of the present invention. Claims 2 to 4 relate to the forming of the electrical contact members (26, 28) with two metallic layers (26) and (28), claims 5 and 6 concern the composition of the continuous conductive material (20) and the provision of an insulation layer (14) between the top surface of

the semiconductor substrate and the protection layer (16), respectively, all these features being disclosed in Figures 1 to 4 together with the corresponding text of the original application.

Therefore, the Board is satisfied that the application meets the requirements of Article 123(2) EPC that a European patent application may not be amended in such a way that its subject-matter extends beyond the content of the application as filed, and Article 84 EPC.

3. *Inventive step*

3.1 A method of making an electrically programmable integrated circuit is known from document **D1** comprising:

providing a substrate (10) of a semiconductor material;

forming a protective layer (2a, 2b) resistant to plasma etching on said semiconductor substrate (10) and covering the top surface thereof;

depositing conductive material on said protective layer (2a, 2b) to provide a conductive layer (3) on said protective layer;

forming an etching-protective mask on said conductive layer (3) covering only the portions of said conductive layer (3) from which a contact bridge (3) is to be formed;

performing a plasma etching procedure to selectively

remove portions of said conductive layer (3), thereby defining a patterned conductive layer forming a fuse link (3), i.e. a contact bridge (3) on said protective layer (2a, 2b); and

depositing metallic material (5, 6) onto said protective layer (2a, 2b) to form electrical contact members (5, 6) in electrical engagement with said contact bridge (3) (cf. page 7, line 3 to page 8, line 36).

Moreover, as stated in the decision under appeal, it is disclosed in document **D1** (see in particular page 8, lines 35 to 36) that vias are necessary to connect the fuses (3) located on the layer (2; 2a, 2b) of insulating materials covering the semiconductor substrate (10) to the underlying active circuit elements formed in said substrate.

Nevertheless, as correctly pointed out by the appellant in the statement of the grounds of appeal, there is no disclosure in document **D1** regarding the formation of a plasma etching-protective mask covering only the portions of conductive layer from which both the meltable contact bridge and the portion containing the active zone of the underlying active circuit element are formed. Consequently, the subsequent plasma-etching steps for patterning the conductive layer using the etching-protective mask is also not present in the method according to document **D1**.

Thus, the method according to claim 1 is distinguished from document **D1** in that

(i) an etching-protective mask (i.e. hereinafter "a first etching-protective mask") is formed which covers only the portions of the conductive layer (20) from which the meltable contact bridge (22), an associated connecting end (21) and also the portion of the conductive layer overlying the contact area of the zone (12) are formed;

(ii) a plasma etching process is carried out using the first etching-protective mask to pattern the conductive layer;

(iii) a second etching-protective mask (24) is provided to cover the meltable contact bridge;

(iv) subsequently, at least one metallic layer (26, 28) is deposited on the second etching-protective mask and the exposed portions of the patterned conductive layer including the portion overlying the contact area of the active zone, and

(v) the metallic layer(s) (26, 28) is selectively etched by a plasma etching process whereby electrical contact members are formed on the conductive layer portion overlying the contact area of the zone (12) and on the associated connecting end (21), the second protective mask shielding the meltable contact bridge from etching during the plasma-etching process.

In document **D2** there is described a method of forming a fuse element in a semiconductor device (see page 3, line 34 to page 4, line 20), wherein after the

formation of the fuse element (12) on a field oxide film (11) , an insulating film (13) (corresponding to the second etching-protective mask of claim 1) is provided on the fuse element which acts as an etching-protective mask during a photoengraving process for forming electrical contact members (15A, 15B).

In the decision under appeal, it was argued by the examining division that the above disclosure in document **D2** rendered obvious the use of the second etching-protective mask as set out in the features (iii) to (v) above, since the photoengraving process mentioned in document **D2** employing a photoresist as a mask can also be used in conjunction with a plasma-etching process as shown in the disclosure in document **D3**.

Leaving aside the question whether it was obvious to use a plasma-etching process in the photoengraving process mentioned in document **D2**, in the Board's view the photoengraving process of the document using the insulating film (11) as a mask does not produce an electrical contact member on a portion of the conductive layer overlying the contact area of the zone (12), so that a straight-forward incorporation of the teaching of document **D2** in the method of document **D1** does not lead to the second etching process as set out in the features (iii) to (v) above.

Moreover, the Board also considers, in agreement with the submissions by the appellant, that the method involving the use of the first and second etching-protective masks has to be seen in its totality. The use of first and second etching-protective masks in the

claimed method provides a fuse element having the meltable contact bridge and the conductive portion overlying the contact area of the zone (12), both being formed from the same conductive layer and in the same plasma-etching procedure, and an electrical contact member in contact with the zone (12) via the conductive layer overlying the contact area of the zone. There is no disclosure in either of the documents **D1** and **D2** regarding the use of the first or second etching-protective mask with a view to producing such a fuse element.

In this connection, the Board does not agree with the assertion in the decision under appeal that the formation of the meltable contact bridge and the conductive portion overlying the contact area of the zone in the same plasma etching process using the first etching-protective mask was a mere design possibility without any advantage over the prior art. In the Board's view, on the contrary, this departure from the prior art method of document **D1** considerably simplifies the process of forming a connection between the fuse element and the active zone and, in absence of any hint in this direction in the prior art, it cannot be regarded as obvious within the meaning of Article 56 EPC.

3.2 For the foregoing reasons, in the Board's judgement, the subject-matter of claim 1 is not rendered obvious by the cited prior art, and the claim involves an inventive step in the sense of Article 56 EPC.

3.3 The claims 2 to 6 are dependent claims and concern particular embodiments of the method of claim 1, so

that their subject-matters also involve an inventive step for the same reasons.

4. Therefore, the present claims are patentable in the sense of Article 52(1) EPC and a patent can be granted on this basis (Article 97(2) EPC).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent on the basis of the following patent application documents:

   Claims: Nos. 1 to 6 as filed with appellant' letter dated 19 October 1999;

   Description: Pages 1, 1a and 2 as filed by the appellant with letter dated 23 December 1999;
   Pages 3 to 6 as filed;

   Drawings: Sheet 1/1 as filed.

The Registrar: The Chairman:

D. Spigarelli R. Shukla