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D E C I S I O N
of 2 August 1996

Case Number: T 1080/93 - 3.4.1

Application Number: 89400470.4

Publication Number: 0331555

IPC: H01L 21/306

Language of the proceedings: EN

Title of invention:
Gettering treatment process

Applicant:
FUJITSU LIMITED

Opponent:
-

Headword:
Gettering treatment/FUJITSU LIMITED

Relevant legal provisions:
EPC Art. 52(1), 56

Keyword:
"Inventive step - yes"

Decisions cited:
-

Catchword:
-



Case Number: T 1080/93 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 2 August 1996

Appellant: FUJITSU LIMITED
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Decision under appeal: Decision of the Examining Division of the European
Patent Office dated 5 August 1993 refusing
European patent application No. 89 400 470.4
pursuant to Article 97(1) EPC.

Composition of the Board:

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

Summary of Facts and Submissions

I. The appeal lies from a decision of the Examining Division refusing European patent application No. 89 400 470.4 relating to a gettering treatment process for an insulating layer. The application was refused on the ground that the subject-matter of claim 1 under consideration did not involve an inventive step having regard to the following prior art documents:

D1: Solid State Technology, vol. 25, no. 7, July 1982, pages 83 to 86 and

D2: EP-A-0 246 802.

II. Claim 1 filed on 3 May 1993 and forming the basis of the above decision has the following wording :

"A gettering treatment process comprising the step of irradiating an ultraviolet light (16) onto an insulating layer (3) in a chlorine-containing gas atmosphere, whereby chlorine radicals are generated and uniformly penetrate said insulating layer(3) to trap metal impurities within said insulating layer (3)."

III. The reasons for the finding of lack of inventive step, given in the above decision, can be summarised as follows:

The gettering treatment process according to claim 1 under consideration differs from that known from document D1 in that in the claimed process ultraviolet light is irradiated onto the insulating layer, thereby generating chlorine radicals, whereas in the process of document D1 the chlorine radicals are generated, apparently by heating the insulating layer and the

chlorine containing gas. Since the gettering process of document D1 involves the same reaction of chlorine radicals with metal impurities as in the claimed gettering process, it follows that in the prior art process of document D1 chlorine radicals penetrate the insulating layer.

Document D2 discloses the use of UV radiation to decompose a chlorine-containing gas and thereby generate chlorine radicals which form chemical bonds with metal impurities in a semiconductor substrate. Document D2 is thus concerned with the same technical field as the invention, so that a skilled person concerned with providing an alternative method of forming chlorine radicals in the gettering process of document D1 would use the teaching of document D2 to form chlorine radicals without the exercise of inventive skill.

IV. In the Statement of the grounds of appeal dated 8 December 1993, the Appellant contests the finding of lack of inventive step and requests that the decision refusing the application be set aside. The Applicant thus implicitly requests the grant of a patent on the basis of the following application documents:

Claims: 1 to 12 filed with the letter dated 3 May 1993;

Description: page 1 as filed;
pages 2, 2a and 7 as filed with the letter dated 3 May 1993;
pages 3 to 6 as filed with the letter dated 22 March 1990, and

Drawings: Sheets 1/4 to 4/4 as filed.

- V. The Appellant's submissions in support of its request can be summarised as follows:

The heading of the final section of document D1, i.e. "Combination of Chlorine Oxidation / Annealing and other Gettering Techniques" makes it clear that the gettering effect due to chlorine is rooted in the combined measure of chlorine oxidation and annealing. Also, the final section discusses an amalgamation of two separate techniques: the chlorine oxidation with annealing and back-side or internal gettering, so that there is no disclosure as to which of these techniques produces the observed gettering characteristics.

Moreover, there is no information in document D1 that the step of heating produces chlorine radicals and that the chlorine radicals penetrate into the oxide layer to trap heavy ions.

Document D2 is in fact concerned with a process for cleaning the surface of a semiconductor substrate through an etching step conducted by exposing the substrate to a halogen atmosphere irradiated with UV light. The etching involved in document D2 is distinct from the gettering treatment according to the invention, so that a combination of documents D1 and D2 would be disregarded a priori by the skilled person, given that D1 fails to provide any clear teaching on an effective form of gettering using chlorine radicals.

Reasons for the Decision

1. *Inventive step*

In the present appeal the only issue is that of inventive step in the subject-matter of claim 1.

1.1 The application relates to a gettering treatment process of an insulating layer (in particular, silicon oxide, see claim 3) and involves irradiation of the insulating layer by ultraviolet light in a chlorine-containing gas atmosphere. According to the gettering process of claim 1 under consideration, chlorine radicals generated by the UV radiation **penetrate the insulating layer uniformly** to trap metal impurities within the insulating layer (emphasis added). This uniform penetration of chlorine radicals into the insulating layer is disclosed in column 5, lines 4 to 8 and can also be seen in Figure 7 of the application as published. Thereby, the diffused chlorine radicals are able to trap heavy metal ions which are not very mobile in the insulating layer, and consequently, are distributed somewhat randomly in the insulating layer (see column 1, lines 50 to 62 of the application).

1.2 Document D1 reviews silicon oxidation in the presence of chlorine-containing species, e.g. HCl, Trichloroethylene, C₂HCl₃, etc. (see "chlorine oxidation", page 83, right-hand column to page 84), and also describes an annealing treatment of an oxide layer (formed by chlorine oxidation) at a relatively high temperature in a mixture of N₂, and small amounts of O₂ and HCl in order to improve electrical properties of thin gate oxides in the MOS LSI fabrication process (see "Post-Oxidation Chlorine Annealing", page 85, left-hand column). It is reported that an oxide layer formed in

this way, i.e. by chlorine oxidation at low temperatures followed by post-oxidation chlorine annealing at high temperatures, has a reduced defect density and is electrically stabilised.

In document D1, there is no specific disclosure that during the post-oxidation annealing, HCl gas dissociates. In the Board's view, however, an expert in the field of gaseous chemical reactions at a surface is aware of the fact that such chemical reactions at high temperatures necessarily proceed by dissociation of the gases. In the context of the disclosure in document D1, wherein chlorine component alone, and not a chlorine containing compound such as HCl, trichloroethylene or C_2HCl_3 , is disclosed to be the species responsible for gettering impurities during chlorine oxidation, to the expert in the field it was implicit that in the post oxidation chlorine annealing, HCl dissociates at the high temperatures employed. It might well be, as has been submitted by the Applicant in paragraph 3.8 of the Statement of the grounds of appeal, that HCl does not dissociate easily, so that gettering by post-oxidation chlorine annealing requires a high temperature, a high chlorine concentration, and/ or a long oxidation time, as disclosed in document D1 (see " Post-Oxidation Chlorine Annealing", last paragraph, on page 85).

Nevertheless, in document D1 the gettering mechanism involved in post-oxidation chlorine annealing is not explained, so that the Board agrees with the Applicant's submissions in paragraph 3.6 of the Statement of the grounds of appeal that document D1 makes no suggestion that chlorine **radicals** have to be created for an effective gettering, and that chlorine **radicals** are able to penetrate the insulating layer. The use of chlorine radicals as a gettering means for trapping heavy metal ions distributed throughout the insulating layer is thus

not suggested in document D1 (see also paragraph 1.1 above). The Board would like to note that chlorine radicals, unlike chlorine ions, are neutral in charge and are in an excited energy state (see for example document D2, page 3, lines 10 to 11). Moreover, in document D1 the only gettering effect which is explicitly associated with the post-oxidation annealing treatment is the elimination of stacking faults in the oxide (see " Post-Oxidation Chlorine Annealing ", last paragraph, page 85), so that, in the Board's view, there is no suggestion in this document that this gettering treatment on its own is effective in trapping metal impurities.

1.3 As stated in paragraph 1.1 above, in the gettering treatment process according to the present invention, chlorine radicals generated by the UV radiation are able **to penetrate the insulating layer uniformly** whereby metal impurities, especially heavy metal ions, within the entire insulating layer can be trapped. The objective problem addressed by the present invention can therefore be seen as providing a gettering treatment process for an insulating layer which is effective in trapping metal impurities, particularly heavy metal ions, in the entire insulating layer.

1.4 Document D2 is concerned with a process for cleaning the surface of a semiconductor substrate and describes a process in which the surface of a silicon substrate heated to a temperature of about 100 °C is etched in a chamber containing high purity Cl₂ gas, the substrate being irradiated with UV radiation. Cl radicals in the excited state are generated by the UV radiation and etch the surface of the silicon substrate to a depth of 10 to 100nm (see page 3, lines 10 and 11). At the same time the chlorine radicals are stated to form chemical bonds with **surface contaminants**, such as alkali or other

metals, which are then removed as reaction products when the substrate is subsequently cleaned in an aqueous solution (emphasis added by the Board; see page 2, lines 38 to 47 and page 3, lines 5 to 11).

It is thus evident that document D2 is concerned primarily with cleaning the surface of a semiconductor substrate, and teaches that the reactant chlorine radicals which can be created by UV irradiation of chlorine gas are capable of etching silicon and forming chemical bonds with surface contaminants such as alkali or other metals. In the Board's view, chemical behaviour of chlorine radicals in relation to an oxide layer cannot be predicted from the above teaching of document D2. In particular, it cannot be derived that chlorine radicals are capable of penetrating an insulating layer uniformly, this being a prerequisite for trapping metal impurities within the insulating layer. The Board also agrees with the Applicant's submission (see paragraph 4 of the statement of the grounds of appeal) that as document D1 fails to give any clear teaching on an effective gettering treatment for metal impurities within an insulating layer after its formation using chlorine radicals, there was no incentive for the skilled person to incorporate the teaching of document D2, i.e. to produce chlorine radicals using UV radiation, in the post-oxidation chlorine annealing gettering treatment of document D1.

- 1.5 For the foregoing reasons, in the Board's judgment, claim 1 meets the requirement of inventive step within the meaning of Article 56 EPC.

Order

For these reasons it is decided that:

1. The decision of the first instance is set aside.
2. The case is remitted to the first instance with the order to grant a European patent with text and drawings as specified in paragraph IV. above.

The Registrar:

The Chairman:

M. Beer

G. D. Paterson