BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

A		B		C	X

File No.: T 0964/90 - 3.4.1

Application No.: 86 905 535.0

Publication No.: 0 235 256

Classification: HO1L 21/306

Title of invention: Gaseous process and apparatus for removing films from substrates

DECISION
of 20 October 1993

Applicant: FSI Corporation, et al

Headword:

EPC: Art. 56

Keyword: "Inventive step (yes , after amendments)"

Headnote
Catchwords

Europäisches Patentamt
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Boards of Appeal

Office européen des brevets
Chambres de recours

Case Number: T 0964/90 - 3.4.1

DECISION
of the Technical Board of Appeal 3.4.1
of 20 October 1993

Appellant:
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Decision under appeal:
Decision of the Examining Division 048 of the European Patent Office dated 24 August 1990 refusing European patent application No. 86 905 535.0 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: G.D. Paterson
Members: R.K. Shukla
U.G.O.M. Himmler

Summary of Facts and Submissions

I. European patent application No. 86 905 535.0 (WO 87/01508) was refused in a decision of the Examining Division on the ground of lack of inventive step on the basis of the prior art documents

D1 - DE-A-1 041 164

D2 - US-A-3 773 578

D3 - IBM Technical Disclosure Bulletin, vol.19, no.7, December 1976, page 2513 and

D4 - Patent Abstracts of Japan, vol.5, no.159 (E-77)[831], October 14, 1981.

II. Independent Claims 1 and 20 as filed on 27 November 1989 and forming the basis of the decision read as follows:

Claim 1

> "A gaseous process of removing at least a portion of a silicon oxide film from a substrate, comprising exposing the substrate to a hydrogen halide gas and to moisture, and using an inert gas at least as sweep, characterized in that moisture and flowing anhydrous hydrogen halide gas are supplied from separate controlled sources and react with each other in removing a portion of the film, and that said inert gas is dry and flowed over the substrate and film as sweep before and after exposing the substrate to the flowing anhydrous hydrogen halide gas, and may be flowed continuously

as diluent during the exposing to said hydrogen halide gas."

Claim 20

"Apparatus for carrying out the process according to anyone of Claims 1-19, comprising a process chamber (10) to confine the substrate (W) and having a vent (13) open to atmosphere, characterised in that a gas mixing means (36) is connected in fluid communicating relation to the process chamber for supplying mixed gases into said process chamber, a first source (17) of anhydrous hydrogen fluoride gas having connection to said gas mixing means, through a flow control (41), a second source (16) of dry inert gas, a third source (19) of water vapor associated with a metering pump (22), means (32, 33, 29) connecting the second and third sources to the gas mixing means for mixing inert gas and water vapor with anhydrous hydrogen fluoride gas and to be delivered therewith into the processing chamber to produce reaction with the film on the substrate."

III. According to the above decision, a gaseous process for removing a silicon oxide film from a substrate is known from D3. In this process, the substrate was exposed to a mixture of hydrogen halide and moisture. From D2 it was known to use an inert gas both as a diluent gas and as a sweep gas. Further, in semiconductor technology, it was customary to employ dry nitrogen gas so that this feature of the claimed process fell within the routine competence of a skilled person. Finally, it was obvious from the process described in D2 that controllability and repeatability of the etching process would be increased if the reactants were supplied separately. The process as defined in Claim 1, therefore, did not involve an inventive step.

As to Claim 20 relating to an apparatus, according to the above decision, the only feature of the claim that was not disclosed in D2 was the use of a metering pump for the source of water vapour. This feature was, however, a mere design possibility which would be selected by the skilled person in accordance with the circumstances without requiring inventive skill.

IV. The Applicant lodged an appeal against the decision and submitted essentially the following arguments in the statement of the grounds of appeal.

Although D3 refers to removal of SiO_2 in presence of a gaseous HF/H_2O mixture, it does not describe a process,is silent as to terminating the etching, flow of any gases, environmental conditions such as temperature and pressure, and sources of material. In D1 it is not stated that an inert gas is used as a diluent or as a sweep gas. D2 refers to an inert carrier gas as an element that is provided in a closed chamber, so that there is no flow of the gas. Moreover, there is no suggestion in either D1 or D2 that the inert gas is dry. Also the cited prior art does not disclose the use of anhydrous HF gas, moisture from a separate source and an inert gas which is dry and flows over the substrate before and after exposing the substrate to the anhydrous HF gas.

Regarding Claim 20, D2 describes a process chamber which is closed, so that there is no flow of gases and the used etchants are not replaced. D2 also does not suggest any mixing means as set forth in Claim 20 .

V. In communications pursuant to Article 110(2) EPC, the Board expressed its provisional view that the subject-matter of Claims 1 and 20 relating respectively to a process and an apparatus for carrying out the process apparently lacked an inventive step having regard to documents D3, D2 and the following document A1 introduced into the proceedings by the Board pursuant to Article 114(1) EPC :

A1 - Solid State Technology, vol.20, no.4, April 1977, pages 78 to 80; " The DryOx Process for Etching Silicon Dioxide" by R.L.Bersin et al.

The Board however considered that the application contained patentable subject-matter and that appropriate amendments to Claims 1 and 20 could meet the objection of lack of inventive step. These and other amendments to the description were suggested in the above communications and in consultations by telephone.

VI. In response to the above, the Appellant filed the following application documents and requested the grant of a patent on the basis of these documents:

Description : pages 1 to 34 filed on 6 July 1993;

Claims: 1 to 18 filed on 6 July 1993, and 19 and 20 filed on 13 September 1993.

VII. New Claim 1 differs from Claim 1 as set out in paragraph II above in

(i) the addition of a phrase that the exposing of the substrate and the inert gas are at near room temperature and at near normal atmospheric pressure,

(ii) a modification in the wording that the etchant gas is hydrogen fluoride and

(iii) deletion of the word "anhydrous" from the expression "after exposing the substrate to the flowing anhydrous halide gas".

Independent Claim 20 forming the basis of the decision under dispute is renumbered as Claim 19 and concerns an apparatus **when used**. It is additionally amended to specify that the substrate is maintained at substantially room temperature at near normal atmospheric pressure.

The remaining claims and the description have been amended mainly for consistency with the new Claims 1 and 19 and to comply with the requirements of Rule 35(12)EPC.

Reasons for the Decision

1. *Allowability of the Amendments*

There are no formal objections to the above amendments under Article 123(2) EPC, since the amendment (i) and the amendments in Claim 19 are disclosed in the original description as filed, for example, on page 3, lines 11 to 17; page 3, line 30 to page 4, line 1; page 5, lines 3 to 12 and page 6, lines 25 to 28, whereas amendment (ii) above is disclosed, e.g. in Claim 2 as originally filed. Deletion of "anhydrous" as in (iii) renders the claim consistent with one embodiment of the invention disclosed in the paragraph bridging pages 15 and 16 as filed.

2. *Inventive step*

The only issue to be examined in the present appeal is, therefore, the question of inventive step.

2.1 In the Board's view, the prior art coming closest to the process as claimed in Claim 1 is described in document D3. This document discloses the basic idea underlying the claimed process, namely that silicon dioxide film covering a substrate (in the document, a silicon wafer) can be etched using a gaseous mixture of HF and H_20. In this known process, silicon wafers are placed above a bath containing HF solution, so that the reactants are not supplied from separate controlled sources and there is no controlled supply of anhydrous hydrogen fluoride gas. Moreover, there is no disclosure regarding the use of a dry inert gas as a sweep gas as set out in the claimed process.

The use of the dry inert gas as a diluent is optional according to the wording of Claim 1 so that this feature of the claimed process cannot be taken into consideration in the assessment of the inventive step.

2.2 The claimed process is thus distinguished over the prior art process in that

(a) moisture and anhydrous hydrogen halide gas are supplied from separate controlled sources;

(b) for removing silicon oxide film, hydrogen halide gas is flown over the substrate;

(c) the substrate is exposed to hydrogen fluoride gas and moisture at near room temperature and near normal atmospheric pressure;

(d) a dry inert gas is used to flush the system before and after the exposure of the substrate to the reactant gases and

(e) the inert gas is at near room temperature.

2.3 In view of the above distinguishing features taken together, the Board agrees with the Appellant that the objective problem in relation to the closest prior art can be seen as providing a gaseous process for etching silicon oxide film using a mixture of hydrogen fluoride and moisture, which process is capable of providing a controllable, repeatable and uniform etching.

2.4 In document A1, which is considered to be the most relevant among the subsidiary documents relied upon in the present appeal, two kinds of dry etching of silicon oxide using anhydrous hydrogen fluoride (HF) are described: direct etching and permeation etching (see page 78, right-hand column to page 80, left-hand column).

In direct etching, a part of the silicon oxide surface is covered by a mask of photo resist and only the exposed oxide surface is etched by HF. When etching a dry thermal silicon oxide, as against a CVD oxide which is relatively wet, the exposed oxide surface requires to be activated by vapour of an organic material.

In permeation etching, on the other hand, a part of the silicon oxide surface is covered with an appropriate negative photoresist, and anhydrous HF, at a temperature of between 150°C and 190°C, and HF pressures between 0.1 and 30 Torr, etches the covered part of the silicon oxide by permeation through the photoresist. Etching rates of up to 160 nm per minute can be obtained under the above etching conditions (see Figure 2).

In the Board's view, therefore, document A1 does not lead a person skilled in the art to employ the etching conditions as set out in (c) above. On the contrary, it recommends much higher temperatures and low pressures in comparison to the temperature and pressure employed in the invention as claimed. As is evident from the description on page 23 of the application in suit, a considerably high rate of etching (up to 1400 nm per minute) can be achieved under the conditions specified in (c).

2.5 Document D2 is concerned with the etching of silicon using vapour environment containing an inert carrier gas,water vapour, hydrogen fluoride, nitric oxide and oxygen. The etching conditions as set out in feature (c) for the etching of silicon dioxide are thus not disclosed in this document.

2.6 Similarly, document D1, although concerned with the etching of a silicon oxide film using a gaseous mixture of hydrogen fluoride and an inert gas, does not disclose etching conditions as in (c).

2.7 Document D4 is concerned with the etching of a phosphorus silicic acid glass film provided on a silicon dioxide substrate using HF gas. The silicon dioxide substrate is not etched by the HF gas.

2.8 It is evident from the above analysis of the prior art documents relied upon in the present appeal that the skilled person does not get any incitement from these documents to employ the ambient etching conditions as set out in (c).

In the Board's view, therefore, the subject-matter of Claim 1 involves an inventive step.

3. Independent Claim 19 relates to an apparatus **when used** for carrying out the process according to Claim 1, and employs the etching conditions as specified in (c) above. The considerations involved in the assessment of inventive step in the subject-matter of Claim 1 are, therefore, applicable to Claim 19, which therefore involves an inventive step within the meaning of Article 56 EPC.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent on the basis of the application documents as specified under item VI above.

The Registrar:	The Chairman:
M. Beer	G.D. Paterson