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Datasheet for the decision of 19 March 2020

Case Number: T 1721/16 - 3.4.03

Application Number: 06117783.8

Publication Number: 1748475

IPC: H01L21/3065, H01L21/00

Language of the proceedings: EN

Title of invention:
Etching method and etching apparatus

Applicant:
SPP Technologies Co., Ltd.

Headword:

Relevant legal provisions:
EPC 1973 Art. 54(1), 56, 84, 111(1)

Keyword:
Clarity - after amendment (yes)
Remittal to the department of first instance - (no)
Novelty and inventive step - (yes)

Decisions cited:

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It can be changed at any time and without notice.

Catchword:

This datasheet is not part of the Decision.
It can be changed at any time and without notice.

Beschwerdekammern

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Case Number: T 1721/16 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 19 March 2020

Appellant: (Applicant)	SPP Technologies Co., Ltd. Keidanren Kaikan 15F, 1-3-2, Otemachi, Chiyoda-ku, Tokyo 1000-0004 (JP)
Representative:	Isarpatent Patent- und Rechtsanwälte Behnisch Barth Charles Hassa Peckmann & Partner mbB Postfach 44 01 51 80750 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 5 February 2016 refusing European patent application No. 06117783.8 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	G. Eliasson
Members:	M. Papastefanou
	T. Bokor

Summary of Facts and Submissions

I. The appeal is against the decision of the examining division refusing the European patent application No. 06 117 783.8. The decision under appeal was a so called "decision on the state of the file" (see also *Guidelines for Examination in the EPO*, November 2019, C-V, 15) issued at the request of the applicant.

In this decision, the examining division made reference to its communications dated 20 January 2016, 17 August 2015 and 6 November 2007 in which it had raised objections under Articles 84 and 123(2) EPC. In particular, in its communication of 20 January 2016 the examining division had raised only objections for lack of clarity (Article 84 EPC) against the Main Request, which was filed on 18 December 2015 and underlies the impugned decision.

II. The appellant (applicant) requested that the decision under appeal be set aside that that a patent be granted on the basis of the claims of the Main Request or one of Auxiliary Requests 1 to 8, all filed with the statement of the grounds of appeal.

III. Reference is made to the following documents:

D1: WO 2004/112120 A
D2: JP 2003 092286 A
D3: WO 00/62328 A
D4: Shouliang Lai; Westerman R; Johnson D; Nolan J: "Advanced pressure control in time division multiplexed (TDM) plasma etch processes", Proceedings of the SPIE, vol. 5342, 2004, pages 94-102
D5: WO 2004/086478 A.

IV. The Main Request consists of the following application documents:

- Description: pages 1 to 23, filed with appellant's letter of 21 November 2019;
- Claims 1 to 3 of the Main Request, filed with the statement of the grounds of appeal;
- Drawings: Sheets 1/7 to 7/7 as originally filed.

V. Claim 1 of the Main Request is worded as follows:

A method of etching a silicon substrate (K) loaded onto a platform (12) within a processing chamber (11), the etching method comprising (a) an etching operation which is executed for a predetermined first processing time (E) and in which, in a state in which gas within the processing chamber (11) has been exhausted to pump down the chamber interior, etching gas is supplied into the processing chamber (11) for at least a predetermined first supply time and converted into plasma, and the silicon substrate (K) is etched by applying a bias potential (Wp) to the platform (12) for at least a predetermined application time, and (b) a protective-film deposition operation which is executed for a predetermined second processing time (D) and in which, in a state in which gas within the processing chamber (11) has been exhausted to pump down the chamber interior and no bias potential is applied to the platform (12), protective-film deposition gas is supplied into the processing chamber (11) for at least a predetermined second supply time and converted into plasma, and a protective film is formed on the silicon substrate (K); and said operations (a) and (b) being alternately repeated;
the etching method characterized in that :
the etching gas or the protective-film deposition gas is being supplied into the processing chamber (11) at

least when the corresponding operation is started; the supply of etching gas or of protective-film deposition gas is halted when a preestablished time (De, Ee) prior to the close of the processing time (D, E) of the corresponding operation is reached; and from the preestablished time (De, Ee) until the close of the processing time (D, E) of the corresponding operation, the exhaust flow rate (V_{HI}) at which gas is exhausted from inside the processing chamber (11) is made greater than the exhaust flow rate (V_{H2}) prior to when the preestablished time (De, Ee) is reached.

VI. The wording of the claims of the Auxiliary Requests is not relevant for this decision.

VII. The appellant argued essentially that, with the amendments carried out in the claims of the Main Request, the objections of the examining division regarding lack of clarity had been overcome.

Reasons for the Decision

1. The claimed invention

1.1 The invention relates to a method of etching a silicon substrate. The substrate is loaded onto a platform within a processing chamber and dry etching is carried out using a gas. In order to achieve etching in depth (e.g. grooves, holes) but limited etching in the side walls of the etched grooves/holes in the substrate, the etching is interrupted at regular intervals and a protective film is deposited on the substrate. After the deposition of the protecting film the etching operation continues. As ions of the etching gas hit the substrate, in the areas of the substrate which are more exposed and the ion bombardment is heavier (like the

top surface of the substrate and the bottom of the holes/grooves) the deposited protective film is removed and the substrate is etched further (deeper). In areas of the substrate which are less exposed and ion bombardment is lighter (like the side walls of the holes/grooves) the removal of the protective film is slower and there is no time for it to be completely removed and any etching of the substrate to take place before the etching phase ends and a new phase of protective film deposition starts.

1.2 The whole process is thus an alteration of etching phases ("operations" in the terminology of the application) and protecting film deposition phases (operations). A specific gas (etching gas, protective film deposition gas) is supplied into the chamber for each corresponding operation. A common problem in such processes is the transition from one operation to the other, which requires the exchange (replacement) of the corresponding gas in the chamber. Normally the gas cannot be exhausted from the chamber instantly and there is a period during the transition from one operation to the other in which both gases coexist inside the chamber. This delays the operation that is about to start (etching or protective film deposition) and affects the rate of alteration from one phase to the other and, consequently, increases the duration of the whole etching process (see paragraphs [0002] to [0012] of the published application).

1.3 The claimed invention addresses this problem by halting the supply of the gas before the corresponding operation ends and increasing the flow rate at which gas is exhausted from the chamber for a certain period before the end of each operation (see Figure 2). In this way, when the next operation (etching or

protective film deposition) starts, the gas of the previous operation has been (almost) completely exhausted from the chamber and the corresponding operation can start (almost) immediately at full rate (see paragraphs [0013] and [0014] of the application as published).

Main Request

2. Amendments (Article 123(2) EPC)

2.1 Claim 1 of the Main Request finds support in original claim 1 and Figures 2 and 6, as well as paragraph [0058] of the originally filed application. Dependent claims 2 and 3 are supported by original claims 2 and 3 respectively.

2.2 The description has been adapted to the claims of the Main Request and the prior art documents have been cited and commented in it without adding subject-matter.

2.3 The board is, hence, satisfied that the application according to the Main Request meets the requirements of Article 123(2) EPC.

3. Clarity (Article 84 EPC 1973)

3.1 The examining division was of the opinion that claims 1 and 4 of the Main Request before it were not clear. Claim 4 is not included in the current Main Request.

3.2 There were two objections for lack of clarity against claim 1 raised and maintained throughout the examination procedure (see for example the examining division’s communication of 20 January 2016, point

1.1.1):

(a) The etching and the protective film deposition operations were defined by supplying the corresponding gas (etching/protective film deposition gas) into the processing chamber and converting it into plasma. For the etching operation, a bias potential was applied at the same time to the platform to etch the silicon. The discontinuation of one of these simultaneously performed steps would end the etching/protective film deposition operation. It was not clear, therefore, how any of these simultaneously applied steps could be discontinued prior to the close [closing] of the etching/protective film deposition step (as defined in the claim), since it was the discontinuation of any of these steps that defined the end of the operation.

(b) According to the claim definition, the etching operation was performed during a predetermined processing time and stopping the application of the bias potential to the platform stopped the etching operation. According to the description (see paragraph [0065]), however, the application of the bias potential to the platform during the etching operation was stopped before the end of the etching operation. This inconsistency between the claims and the description created an ambiguity regarding the scope of protection sought, rendering the claims unclear.

3.3 The board is of the opinion that with the amendments carried out in claim 1 of the Main Request, these objections of the examining division have been

overcome.

3.3.1 Claim 1 defines now that the etching operation and the protective film depositing operation are executed for predetermined processing times (E and D respectively).

3.3.2 In the board's view, this definition means that in the predetermined time of each operation (E or D) several actions take place: supply of the gas corresponding to the specific operation (etching or protective film deposition), application of bias potential (for the etching only), conversion of the supplied gas into plasma, the specific operation itself (etching or protective film deposition) and the exhaust of the gas from the chamber. In other words, the claim now does not require that during the whole time of the etching operation (E) (or protective film deposition time (D)) the silicon substrate (K) is being actually etched (or protective film is being deposited), see also Figure 2 and paragraphs [0066] to [0073] of the application.

3.3.3 The board understands that when the supply of the etching gas into the chamber and the application of the bias potential will stop and the exhaust of the etching gas will start (when the time period Ee is reached - see Figures 2 and 3) the etching will still go on for some time until the chamber is completely empty from etching gas. Hence, the actual etching of the substrate will stop sometime after Ee and and ideally before E is reached. The board agrees with the examining division that it is not possible for the skilled person to know exactly when the etching of the substrate will stop.

However, this is irrelevant, since the period of the etching operation in the claim is defined with a predetermined processing time (E). The skilled person

does not need to know when the actual etching of the substrate stops, because etching operation is defined as a time period, which is given and is independent of the actual etching action. Similar considerations apply also to the period of the protective film deposition operation, which is defined with a predetermined time (D), as well.

3.3.4 Summarising, the board is of the opinion that, according to the proper interpretation of claim 1, the etching operation and the film deposition operation are predetermined time periods (E and D respectively), which do not depend on the execution of the actual actions of etching of the substrate or the deposition of the protective film, respectively.

The skilled person is, thus, in a position to understand these features and the claimed scope of protection as a whole in a clear and unambiguous manner.

4. Non-Remittal

4.1 The board notes that the Main Request on file overcomes the sole ground of refusal invoked by the examining division.

4.2 During the examination procedure before the examining division the compliance of the claimed subject-matter with the remaining requirements of the EPC, especially those of Article 52(1) EPC was not assessed.

4.3 The board notes, however, that in the Search Opinion it was indicated that the subject-matter of original claim 1 was new and involved an inventive step (see point

3.1).

4.4 Given the fact that the current version of claim 1 is a more limited version of original claim 1, and taking into account the length of the procedure before the examining division (filing date in 2006, decision issued in 2016) and the expected positive outcome for the appellant (see below), the board decides to exercise the power conferred by Article 111(1) EPC and proceeds to decide the case on its merits without remitting it to the examining division.

5. Novelty and inventive step (Articles 54(1) and 56 EPC 1973)

5.1 From the prior art documents cited in the procedure so far, D1 to D5 describe methods for etching a silicon substrate which comprise alternating phases (operations) of etching and protective film deposition.

5.2 D3 and D4 address the problem of transition from one phase/operation (e.g. etching) to the other (e.g. protective film deposition).

5.2.1 D3 addresses the problem by, among others, starting the supply of the gas for one operation (e.g. etching) before the previous operation (e.g. protective film deposition) ends. For a transitional period, both gases are present in the chamber and etching (or film deposition) can start at the beginning of the etching operation even if at a slower rate. Alternatively, both gases are supplied continuously, but during each operation the corresponding gas is supplied at a higher flow rate than the other gas. In such a case, the increase of the flow rate of the gas for one operation (e.g. protective film deposition) occurs before the end

of the previous operation (e.g. etching) (see page 5, line 15 to page 7, line 19).

There is no disclosure or suggestion in D3 of halting the supply of the gas before the end of the corresponding operation nor of increasing the exhaust rate of the gas for a period before the end of each operation.

5.2.2 In D4 the same problem is addressed by monitoring the pressure inside the chamber and adjusting the flow rate of the gases accordingly. There are three different solutions described: i) the pressure is monitored constantly and the flow rate is adjusted accordingly ("pressure control mode"), ii) upon transition from one operation to the other, the flow rate is adjusted at predetermined rates without monitoring the pressure inside the chamber ("position control mode"), and iii) a combination of the two, which is what D4 suggests (see points 1 to 2.1).

There is no disclosure or suggestion of halting the supply of the gas before the end of the corresponding operation nor increasing the exhaust rate of the gas for a period before the end of each operation in D4, either.

5.3 The board considers that either of D3 or D4 could be considered as closest prior art to the claimed invention, as they both describe methods which have the most technical features in common with the claimed method and address the same technical problem. Starting from either of these documents, the skilled person is thus faced with the technical problem of providing an alternative way of optimising the transition from an etching operation to a protecting film deposition

operation (and vice versa).

5.4 Neither in D3 nor in D4 nor in any other of the prior art documents would the skilled person find any suggestion of how to modify the method(s) of D3 and/or D4 and arrive at the claimed method in an obvious and straightforward manner.

5.5 The board concludes, therefore, that the subject-matter of claim 1 is both new (Article 54(1) EPC 1973) and involves an inventive step (Article 56 EPC 1973). Claims 2 and 3 depend on claim 1 and are, thus, both new and inventive.

6. The board is, thus, satisfied that the patent application according to the Main Request and the invention to which it relates meet the requirements of the EPC and EPC 1973 and, hence, a patent is to be granted according to Article 97(1) EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division with the order to grant a patent in the following version:

   - Description: pages 1 to 23, filed with appellant's letter of 21 November 2019
   - Claims 1 to 3 of the Main Request, filed with the statement of the grounds of appeal
   - Drawings: Sheets 1/7 to 7/7 as originally filed

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated