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D E C I S I O N
of 6 December 2004

Case Number: T 0761/03 - 3.4.3

Application Number: 98931533.8

Publication Number: 1016134

IPC: H01L 21/3213

Language of the proceedings: EN

Title of invention:

Plasma reactor for passivating a substrate

Patentee:

LAM RESEARCH CORPORATION

Opponent:

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Headword:

-

Relevant legal provisions:

EPC Art. 54, 56

Keyword:

"Novelty: yes (after amendments)"

"Inventive step: yes"

Decisions cited:

-

Catchword:

-



Case Number: T 0761/03 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 6 December 2004

Appellant:

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Representative:

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Decision under appeal:

Decision of the Examining Division of the
European Patent Office posted 1 April 2003
refusing European application No. 98931533.8
pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: R. K. Shukla
Members: V. L. P. Frank
P. Mühlens

Summary of Facts and Submissions

I. The appeal lies from the decision of the Examining Division dated 1 April 2003 refusing the European patent application No. 98 931 533.8. The grounds for the refusal were lack of clarity (Article 84 EPC) and lack of inventive step (Article 52(1) and 56 EPC).

The following prior art documents were cited in the decision under appeal:

D1: US-A-5 545 289

D2: Patent Abstracts of Japan, vol. 096, No. 006,
28 June 1996 & JP 08 031803 A

II. The appellant (applicant) lodged an appeal against the above decision on 25 April 2003, paying the appeal fee the same day. The statement setting out the grounds of appeal was filed on 9 June 2003 together with an amended set of claims.

III. In a communication under Article 11(1) RPBA annexed to the summons to oral proceedings, the Board raised several clarity objections and expressed its doubts on the novelty of the claimed subject-matter having regard to document D1.

IV. During the oral proceedings before the Board which took place on 6 December 2004, the appellant replaced his previous request by a new one, requesting the grant of a patent with the following patent application documents:

Claims: 1 to 7, filed during the oral proceedings

Description: pages 1 to 3, 3a, 4 to 9, 9a and 10 to 15, filed during the oral proceedings

Drawings: Figures 1 to 6, as originally filed.

The wording of the only independent claim is as follows:

"1. Use of a single plate baffle (420) in a plasma processing chamber for processing a substrate with a H₂O plasma, said substrate including a layer of photoresist disposed thereon, said baffle plate being disposed between a plasma generating region of said plasma processing chamber and said substrate, the baffle plate comprising:
a circular solid central blocked portion (432) disposed in a center region of said baffle plate, said blocked portion blocking the flow of plasma to the surface of said substrate; and
an annular portion (434) of the baffle plate surrounding said central blocked portion, said annular portion including a plurality of through holes permitting a H₂O plasma comprising reactive neutral species to pass through said holes to reach a surface of said substrate;
wherein said blocked portion is sized to block substantially all ultraviolet rays originated from said plasma generating region and said H₂O plasma from directly impinging on said surface of said substrate during said processing."

Dependent claim 2 was submitted for the first time during the oral proceedings before the Board. Its wording is as follows:

"2. Use of a baffle plate as claimed in claim 1, wherein the holes have a constant diameter through the baffle plate so that any UV light that enters the holes will strike inner walls of the holes without directly impinging on the substrate surface."

V. The argumentation of the Examining Division which is relevant to the present decision can be summarized as follows:

Document D1, which is the closest state of the art, discloses a baffle plate having an annular portion with through holes for permitting a water plasma to pass through it and reach the surface of a substrate. The baffle plate according to the application in suit differs from the baffle disclosed in this document in that it has a central blocked portion surrounded by the annular portion. It is however disclosed in document D2 that UV radiation generated in the plasma forming region should not impinge on the substrate as it may damage it. Document D2 suggests therefore using a UV shielding baffle plate which nevertheless allows active species to pass through it. The skilled person would thus have modified the baffle known from document D1 by adding a UV shielding baffle plate at its center to prevent undesired radiation from reaching the substrate. As there is no requirement in claim 1 that a single plate baffle should be used, but only the requirement that the central area is blocked, the

provision of a second baffle plate is also covered by the wording of the claim.

Dependent claim 5 specifies that no further deflection plate is required, such that only a single baffle plate is used. However, the skilled person would recognize that the screening solution suggested by the combination of documents D1 and D2 is quite cumbersome and would try to simplify it. To block the central area above the substrate in a single baffle plate, rather than adding a second baffle plate, would however be an obvious design possibility for the skilled person, while the additional advantages obtained by using a single baffle plate disclosed in the application in suit are bonus effects when employing the non-inventive baffle plate.

VI. The appellant argued essentially as follows:

Documents D1 and D2 disclose baffle plate arrangements in which direct passage of ultraviolet (UV) radiation is blocked, but the flow of plasma is possible. The permeability of the baffles to the plasma is the same across the width of the plates. There is no central region at which flow is prevented. Any perceived need to improve the UV shielding might lead to formation of a more effective labyrinthine baffle, but there would be no motivation to introduce a central region having different properties to the outer regions.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

Claim 1 is based on claims 1, 3 and 4 as filed originally and has been clarified having regard to the embodiment depicted in Figures 4 and 5 of the application in suit. The expression a "circular solid central blocked portion" is disclosed on page 10, line 15.

Claim 2, which depends on claim 1, was submitted for the first time during the oral proceedings before the Board. It is based on the paragraph bridging pages 10 and 11 of the application in suit and defines the shape and UV radiation blocking function of the through holes.

Claims 3 to 7 correspond respectively to claims 6 to 10 as filed originally.

The Board is therefore satisfied that the requirements of Articles 84 and 123(2) EPC are fulfilled.

Furthermore, the description has been amended to concord with the amended claims.

3. *Novelty*

3.1 Document D1 discloses a showerhead type diffuser 62 which is used for homogeneously distributing a water plasma in the passivation process of a semiconductor

substrate. The diffuser 62 is located between the plasma generating region 54 and the substrate 20. It is formed by an upper and a lower plate joined together by a peripheral U-shaped connecting portion and is, in other words, a **hollow** baffle plate. The upper and the lower plate have holes in alternating positions allowing the water plasma to traverse it (cf. Figure 2; column 3, lines 39 to 42 and 54 to 56; column 5, lines 52 to 55).

Although the function of the through holes is not disclosed in this document, it is evident to the skilled person that the diffuser 62 blocks any ultraviolet light from the plasma generating region from reaching the substrate 20 and also prevents a direct flow of water plasma onto the substrate.

3.2 In document D2, on the other hand, the baffles shown in the embodiments depicted in the drawings of the Japanese patent application are formed by two superposed planes. In the first embodiment, each one of the two baffle planes is formed by a multitude of parallel, inclined lamellas so that the two planes together define a V shaped passage for the plasma (cf. Figures 1 and 2). In the second embodiment, two plates are superposed on each other having holes in alternating positions (cf. Figures 3 and 4). In this manner the water plasma can traverse the baffle, but any UV radiation generated by the plasma is effectively blocked from impinging on the substrate (cf. the English abstract).

3.3 The baffle plate according to claim 1 of the application in suit differs from the baffle plates

disclosed in documents D1 and D2 by being formed by a single plate and by having a solid central blocking portion.

3.4 For this reason, the Board considers the use of a baffle plate according to claim 1 as new (Article 54 EPC).

4. *Inventive step*

The only remaining issue in this appeal is that of inventive step.

4.1 According to the application in suit, the water plasma generated in the reactor consists of charged species, neutral species and electrons. The neutral species, which include O, OH and H, seem to be the most active elements in the passivation process. However, the reactive neutral species density is reduced by recombination upon contact with an interior surface of the plasma processing chamber, increasing thus the required passivation time (cf. page 4, lines 3 to 12 and page 8, line 27 to page 9, line 13).

4.2 As mentioned above, the baffle plate specified in claim 1 differs from the one disclosed in document D1, which is the closest available state of the art, in that it is formed by a single plate and has a solid central blocking portion.

The objective problem addressed by the application in suit having regard to these differences corresponds therefore to the problem originally specified in the

application, namely the reduction of the recombination surface within the processing chamber.

4.3 In the baffle plate according to the invention the internal recombination surface is reduced with respect to the processing chambers disclosed in documents D1 and D2 by using a single plate baffle having a solid central blocking portion. The baffle plate according to document D1 has a larger recombination surface due to the hollow space inside the baffle plate. Also the baffle plates according to the two embodiments disclosed in document D2 have a larger recombination surface, as the total exposed surface area of a multitude of lamellas as shown in Figures 1 and 2 or of two superposed plates 5 with openings 4 as shown in Figures 3 and 4 is considerably greater than that of a single plate.

4.4 The Examining Division argued under point 4.7 of the contested decision that the use of a single plate was obvious for the skilled person, since he would consider that the UV screening solution suggested by the combination of documents D1 and D2 is cumbersome and would try to simplify it. He would therefore keep a central portion covering the substrate and add an annular portion with through holes to distribute the water plasma over the substrate's surface.

The Board, however, cannot follow this line of argumentation and concurs with the appellant, since documents D1 and D2 both disclose a baffle plate, which is not divided into two different portions, one portion for blocking the UV rays and for directing flow of water plasma, and another portion for distributing the

plasma over the substrate. In the baffles of the state of the art both functions, i.e. blocking the UV rays and distributing the plasma, are done by the baffle as a whole.

Moreover, the experimental results shown in Figure 6 of the application in suit indicate that a more uniform stripping rate is achieved when using the baffle according to the invention compared to a conventional baffle having a uniform distribution of holes across its entire surface (cf. the example starting at page 13 and Figure 6). This effect is surprising, since it could be expected that the plasma is more uniformly distributed over the substrate when using a baffle without any blocked portion, and cannot be regarded as merely a bonus effect as done by the Examining Division.

5. It is therefore the Board's judgement that the application in suit fulfils the requirements of the 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 in the following version:

Claims: 1 to 7

Description: pages 1 to 3, 3a, 4 to 9, 9a and 10 to 15, both filed in the oral proceedings

Drawings: figures 1 to 6, as originally filed.

The Registrar:

The Chairman:

P. Cremona

R. K. Shukla