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**D E C I S I O N**  
**of 29 January 2004**

**Case Number:** T 1034/01 - 3.4.3

**Application Number:** 93119391.6

**Publication Number:** 0601468

**IPC:** H01J 37/32

**Language of the proceedings:** EN

**Title of invention:**

Process and electromagnetically coupled planar plasma  
apparatus for etching oxides

**Patentee:**

APPLIED MATERIALS, INC.

**Opponent:**

Institute of Technological Information, Inc.

**Headword:**

-

**Relevant legal provisions:**

EPC Art. 54, 56, 87, 114

**Keyword:**

"Abuse of procedure (no)"

"Lack of inventive step of one alternative of an independent  
claim renders the whole claim not allowable (cf. "Reasons for  
the Decision", item 6.6)"

"Inventive step (denied)"

**Decisions cited:**

T 0951/91, T 1019/92, T 0113/96, G 0002/98, T 0465/92,  
T 0511/92

**Catchword:**

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Case Number: T 1034/01 - 3.4.3

**D E C I S I O N**  
**of the Technical Board of Appeal 3.4.3**  
**of 29 January 2004**

**Appellant:** Institute of Technological Information, Inc.  
(Opponent) 2-2, Kitahara 2-chome  
Asaka-shi Saitama-ken 351 (JP)

**Representative:** Marsh, Roy David  
Hoffman Eitle,  
Patent- und Rechtsanwälte  
Arabellastrasse 4  
D-81925 München (DE)

**Respondent:** APPLIED MATERIALS, INC.  
(Proprietor of the patent) 3050 Bowers Avenue  
M/S 2061  
Santa Clara  
California 95054-3299 (US)

**Representative:** Zimmermann, Gerd Heinrich  
Zimmermann & Partner  
P.O. Box 33 09 20  
D-80069 München (DE)

**Decision under appeal:** Interlocutory decision of the Opposition  
Division of the European Patent Office posted  
17 July 2001 concerning maintenance of European  
patent No. 0601468 in amended form.

**Composition of the Board:**

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

## Summary of Facts and Submissions

- I. The present appeal is against the decision of the Opposition Division to maintain the European patent No. 0 601 468 in amended form according to Article 102(3) EPC.

The wording of the independent apparatus claim 1 as amended and considered by the Opposition Division to comply with the requirements of the EPC is as follows:

"1. An apparatus producing in operation a fluorine-containing plasma for selectively etching oxides on a substrate, comprising:

a chamber (12), having

a dielectric window (18),

a port (17) for plasma precursor gases to be fed to said chamber (12),

a substrate support (13) within said chamber (12),

an electrically conductive planar coil (20),

means (36) for coupling a radio frequency source (30) to said coil (20),

characterized by:

a fluorine scavenger (26) in or near the plasma;

wherein said fluorine scavenger is an article of silicon, a silicon-containing gas, an article of graphite, or a carbon-rich gas."

The patent as amended comprised further an independent method claim.

- II. The opposition was directed against the patent as a whole and was based on the grounds that the subject-matter of the patent did not involve an inventive step

(Articles 100(a), 52(1) and 56 EPC), that the patent did not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art (Article 100(b) EPC), and that the subject-matter of the patent extended beyond the content of the application as filed (Article 100(c) EPC).

III. The following prior art documents were *inter alia* cited in the opposition proceedings:

E1: US-A-4 948 458

E3: JP-A-64 15930, with its full translation

E7: EP-A-0 552 491

Document E7, however, was not admitted in the proceedings by the Opposition Division under Article 114(2) EPC, since, in their view, it was not *prima facie* relevant and was filed one week before the oral proceedings before the Opposition Division, ie outside the nine month time limit specified in Article 99(1) EPC and after expiry of the time limit of Rule 71a EPC. The Opposition Division considered that, as the priority for the patent was validly claimed, document E7 belonged to the state of the art under Article 54(3) EPC, and was therefore relevant only for novelty. The apparatus according to claim 1 required a planar electrically conductive coil, whereas document E7 did not unequivocally disclose that the one turn coil mentioned on page 7, line 10, is planar.

According to the decision it was not in dispute that document E1 represented the closest state of the art and disclosed an apparatus comprising all the features according to the preamble of claim 1. The objective technical problem addressed by the patent having regard to document E1 was, therefore, to improve the selectivity of etching between Si and SiO<sub>2</sub>. This was achieved by providing a fluorine scavenger according to any of the four options specified in the characterizing part of claim 1. Document E3, however, describes only the use of a SiC heating plate as fluorine scavenger. For these reasons, the scavenger materials according to claim 1 of the patent were not suggested by the state of the art.

Moreover, the Opposition Division considered that the specification in claim 1 that the scavenger should be positioned "in or near" the plasma, when read in the light of the description, enabled the skilled person to carry out the invention, since the person skilled in the art understood from the description that a chemical reaction had to take place between fluorine and the scavenger and would choose the position of the scavenger accordingly (Article 100(b) EPC).

Finally, the amended patent fulfilled the requirements of Articles 123(2) and (3) EPC.

- IV. The opponent lodged an appeal on 17 September 2001 against the interlocutory decision of the Opposition Division, paying the appeal fee on the same day. The statement of the grounds of appeal received on 23 November 2001 referred to the following further document:

E8: JP-A-63 9120, with its full translation.

V. In response to a communication of the Board accompanying the summons to oral proceedings according to Rule 11(1) RPBA, the respondent (patent proprietor) submitted four sets of claims according to a main and first to third auxiliary requests.

VI. In the course of the oral proceedings held on 29 January 2003, the appellant opponent had raised objections under Article 123(2) EPC against the wording of the amended independent claims of the respondent's requests and had submitted that the priority date of 1 December 1992 from the US patent application 07/984 045 for the apparatus and method claims was not valid. With a view to overcome the objections, the respondent withdrew his previous requests, and requested that the patent be maintained in amended form on the basis of the main request filed during the oral proceedings.

The appellant requested that the decision under appeal be set aside and the patent be revoked.

VII. The wording of the independent apparatus claim according to the respondent's request reads as follows (the amendments with respect to the version of the claim on which the decision of the Opposition Division was based are highlighted by the Board):

"1. An apparatus producing in operation a fluorine-containing plasma for selectively etching oxides on a substrate, comprising:  
a chamber (12), having

**an access port (14) in a wall thereof,**  
a dielectric window (18) **sealed to said wall,**  
a port (17) for plasma precursor gases to be fed to  
said chamber (12),  
**a port for ingress and egress of said substrate,**  
a substrate support (13) **for holding said substrate**  
**generally parallel to said access port (14),**  
an electrically conductive planar coil (20) **located**  
**outside said chamber (12) and proximate to the**  
**dielectric window (18),**  
means (36) for coupling a radio frequency source (30)  
to said coil (20),  
characterized by:  
a fluorine scavenger (26) in or near the plasma;  
wherein said fluorine scavenger is an article of  
silicon **mounted between said dielectric window and said**  
**substrate support and generally parallel thereto,** a  
silicon-containing gas, an article of graphite, or a  
carbon-rich gas."

The respondent's request further comprised an independent method claim, which is, however, not relevant for the present decision.

VIII. The appellant argued essentially as follows:

- The opposed patent is not entitled to the date of priority, since the priority document discloses in independent claim 1 an apparatus having more features than the apparatus according to claim 1 of the patent. According to the opinion G 2/98 of the Enlarged Board of Appeal, however, the right of priority shall be acknowledged only if the skilled person can derive the subject-matter of

the claim directly and unambiguously, using common general knowledge, from the previous application as a whole. The opposed patent claims a much broader subject-matter than the priority document. However, it cannot be directly and unambiguously derived from the priority document that the invention can be broadened as in the claim.

- Document E7 discloses an apparatus for selectively etching oxides on a substrate comprising a fluorine scavenger of pure silicon, a silicon compound such as silicon carbide or graphite. RF energy is supplied by a source comprising an antenna of at least one turn or coil. A one turn antenna will be interpreted by the skilled person as being planar. The apparatus according to claim 1 is not new over the disclosure of document E7, since a difference in wording alone cannot establish novelty. This finding is valid regardless of whether the opposed patent is entitled to the priority date or not, since in the latter case document E7 constitutes prior art under Article 54(3) EPC.
- Document E7 should, moreover, be admitted into the proceedings due to its high relevance for assessing the novelty and presence of inventive step in the subject-matter of the claims.
- Document E1 represents the closest state of the art. The apparatus according to claim 1 does not involve an inventive step having regard to the combination of this document with documents E3 or



E8, which disclose different materials as scavengers for fluorine.

IX. The respondent argued essentially as follows:

- The filing of document E7 just one week before the date of oral proceedings before the Opposition Division amounted to an abuse of procedure, since this document was already cited in the European Search Report of the contested patent and there were no reasons which could have hindered the appellant to file his objection in due time. Document E7 should, therefore, be disregarded.
- The view of the Opposition Division that document E7 is not *prima facie* relevant is fully justified, since the one-turn coil disclosed in this document is not necessarily planar. A conclusion of lack of novelty, however, may be reached only if the prior art document contains a clear and unmistakable disclosure of the subject-matter of the claims.
- The respondent requested furthermore that the case be remitted to the department of first instance, in the event that the Board admits document E7 into the procedure, since this would amount to a factual framework different from the one which has been considered by the first instance for reaching its decision.
- The priority right of the patent in suit is valid, since the invention, established by taking into account the content of the priority document as a whole and the common general knowledge of the

skilled person, is the same as that claimed in the patent in suit.

- Moreover, it is uncertain if document E7, an European patent application, is entitled to the priority dates claimed. This document claims the priority dates of two US patent applications, Serial No. 07/941507 of 8 September 1992 (=US1) and Serial No. 07/824856 of 24 January 1992 (=US2). Both US patent applications are, however, continuations-in-part of US Serial No. 07/722 340 of 27 June 1991 (=US3). Article 87(1) EPC specifies that the right to priority can be exercised in respect to the same invention for a period of twelve months from the date of filing the first application. However, the filing date of US Serial No. 07/722 340 is more than twelve months before the filing date of document E7 (ie the 23 December 1992). The disclosures of document E7 and US Serial No. 07/722 340 have, therefore, to be compared to determine if they relate to the same invention or not.
  
- Document E1 is mentioned in the description of the contested patent and forms the preamble of claim 1. Document E3, on the other hand, merely discloses the use of a heating plate made of SiC as a scavenger for fluorine. Consequently, a combination of these documents does not render obvious the use of a scavenger according to any of the four options specified in claim 1.

- The same conclusion is reached when considering the combination of documents E1 and E8, since document E8 merely discloses a mounting base made of single crystal silicon as scavenger for fluorine. However, it is not suggested in document E8 to locate the scavenger between the dielectric window and the substrate to be etched. This is advantageous for achieving maximum effectiveness and good uniformity of the etching process. The other materials disclosed in document E8 as scavengers are related to the use of chlorine-containing etching gas. It is, however, not obvious for a skilled person to use scavengers for chlorine as scavengers for fluorine.

### **Reasons for the Decision**

1. The appeal is admissible.
2. *Late filed documents and abuse of procedure*
  - 2.1 Document E7 was filed by the appellant one week before the oral proceedings before the Opposition Division. The respondent objected to the introduction of document E7 into the proceedings at such a late stage, since this document was already mentioned in the European Search Report and there were no apparent reasons which could have hindered the appellant to file the document in time. Such a behaviour amounts to an abuse of the procedure.

2.2 In this connection, although the Board concurs with the respondent that the parties should submit all the facts, evidence and arguments relevant to their case as early and completely as possible (cf. T 951/91, OJ 1995, 202), particularly when such an evidence was already known to the party concerned, in the present case it can hardly be assumed that the introduction of document E7 took the respondent by surprise, since he had been made aware of the existence of this state of the art document by the European Search Report. Moreover, there is no evidence that the late filing of document E7 was deliberately done for tactical reasons amounting to an abuse of procedure (cf. T 1019/92).

2.3 The circumstances in the present appeal proceedings are quite different from the proceedings before the Opposition Division where little time was left to consider document E7 in detail. Nevertheless, the Opposition Division discussed the validity of the priority date of the patent, found it to be valid and concluded therefrom that document E7, being part of the state of the art under Article 54(3) EPC, was not relevant for assessing the novelty of the subject-matter claimed in the contested patent, since it did not unequivocally disclose a planar coil.

The filing of document E7 was done on 6 March 2001, ie nearly three years before the oral proceedings before the Board. The parties and the Board had, therefore, sufficient time to assess its relevance.

2.4 Document E8 was submitted with the statement of grounds of appeal. Its disclosure merely reinforces the line of attack to the patent made before the Opposition

Division, namely that the use of silicon as a scavenger for fluorine was known in the state of the art. Its filing, therefore, has to be considered as the normal behaviour of a losing party and cannot be regarded as an abuse of procedure (cf. T 113/96).

2.5 The Board considers, moreover that the disclosures of documents E7 and E8 are *prima facie* highly relevant for assessing the novelty and inventive step of the subject-matter of the claims.

2.6 For the above mentioned reasons, the Board allows the introduction of documents E7 and E8 into the proceedings.

### 3. *Remittal to the department of first instance*

3.1 The respondent requested that the case be remitted to the department of first instance in the event that document E7 is allowed, since this would define a factual framework different from the one which has been considered by the first instance for reaching its decision.

3.2 As already mentioned, the Opposition Division considered the disclosure of document E7 and found it to be of no relevance for the subject-matter according to the claims of the contested patent. It also decided that the priority right of the patent in suit was valid and that document E7 belonged to the state of the art under Article 54(3) EPC. There is thus no justification for remittal for reconsideration of the same issue, ie. the relevance of document E7. Moreover, contrary to the respondent's argument the factual framework of the case

remains unchanged, since the Opposition Division correctly assessed first the disclosure of document E7 before deciding not to allow it under Article 114(2) EPC

3.3 For these reasons, the Board decides not to remit the case to the department of first instance.

4. *Priority*

Claim 1 as amended during the oral proceedings before the Board comprises all the features of claim 1 of the priority document (US Serial No. 07/984 045) and, therefore, overcomes all the objections raised by the appellant in respect of the claimed priority.

For this reason, the priority date of 1 December 1992 can be allowed for the contested patent.

5. *Relevance of Document E7*

5.1 As correctly pointed out by the respondent, document E7 claims two priority dates of US patent applications US1 and US2 which are both continuations-in-part of previous US patent application US3. The filing date of application US3 is, however, more than twelve months before the filing date of the European patent application E7. The respondent submitted, therefore, that document E7 was not entitled to the claimed priority dates, since documents US1 and US2 were not the 'first application' for the same invention as required by Article 87(1) EPC.

5.2 The question whether document E7 has a priority date earlier than the priority date of the contested patent and, consequently, whether the document belongs to the state of the art according to Article 54(3) EPC, does not need to be considered here, as the Board comes to the same conclusion as the Opposition Division that document E7 does not disclose unambiguously an apparatus for etching oxides comprising an electrically conductive **planar** coil, as will be shown below.

Document E7 discloses in the embodiments illustrated in Figures 1 and 2 an apparatus for etching oxides comprising a RF antenna 30 in the form of a multiple turn, cylindrical coil. Preferably, the coil surrounds a dome of the chamber for inductively coupling the high frequency electromagnetic energy into the chamber to form the plasma (cf. page 5, lines 33 and 43 to 44). It is further stated that the antenna may be formed by at least one turn or coil (cf. page 8, line 10). The appellant relied on this statement to establish that document E7 discloses a planar coil as specified in claim 1 of the patent in suit.

The Board, however, cannot follow the appellant's argument, since it is the established case law of the Boards of Appeal that for an invention to lack novelty its subject-matter has to be clearly and directly derivable from the prior art (cf. T 465/92, OJ 1996, 32; T 511/92).

Although document E7 discloses that a one turn coil can be used as antenna, it is not directly derivable that this coil necessarily lies in a plane. On the contrary, in the present case, it would be reasonable to form the

one turn coil in the shape of a one turn helix, since, as pointed out by the respondent, with this shape the coupling of RF energy into a large volume can be accomplished. It is the consistent teaching of document E7 that the plasma is formed in the source region 16A, ie a volume overlying the processing region 16B in which the substrate to be treated is located (cf. Figures 1 and 2; page 8, lines 38 to 44; page 16, lines 31 to 32; page 23, lines 27 to 30). Creation of a plasma in a volume is, however, difficult if a one turn planar coil is used as antenna.

5.3 For the above mentioned reasons, the Board concludes that document E7 does not disclose an apparatus according to claim 1 of the patent in suit. It is, therefore, not necessary to determine the validity of the claimed priority date of document E7.

6. *Inventive step*

6.1 It is common ground that document E1 represents the closest state of the art. This document discloses an apparatus for producing a magnetically-coupled planar plasma having all the features specified in the preamble of claim 1 of the contested patent (cf. column 3, lines 19 to 43; column 5, lines 33 to 53; column 6, lines 11 to 13; Figures 1 and 2).

6.2 The apparatus according to claim 1 differs, therefore, from the disclosure of document E1 in that a fluorine scavenger is provided in or near the plasma and that the scavenger is:



- (i) an article of silicon mounted between the dielectric window and the substrate support, generally parallel thereto,
- (ii) a silicon-containing gas,
- (iii) an article of graphite, or
- (iv) a carbon-rich gas.

6.3 According to the patent in suit, the provision of a fluorine scavenger improves the selectivity of etching oxide films or layers and gives improved anisotropy and etch rate (cf. page 2, lines 47 to 48 and lines 52 to 54).

When the fluorohydrocarbon gas present within the apparatus chamber is exposed to the plasma, various fragments are generated, including e.g. F, CF and CF<sub>2</sub> radicals. The free fluorine etches oxides, but other species form C-F polymers that can deposit onto the sidewalls of the etched via and also act to protect underlying and overlying layers from being etched. However, this polymer is attacked by oxygen and also by free fluorine radicals, reducing thus the etch selectivity between the oxide and the other layers. The provision of a fluorine scavenger, however, reduces the amount of free fluorine radicals, thus reducing the attack of the substrate by free fluorine (cf. page 3, lines 46 to 54 of the contested patent).

The objective problem addressed by the invention having regard to document E1 corresponds, therefore, to the one originally stated in the contested patent.

- 6.4 Document E8 discloses, however, a plasma-etch apparatus wherein the mounting base (17) for a substrate is a piece of single crystal silicon. The base consumes the free fluorine radicals present in the plasma which come close to the periphery of the mounting base by reaction with the silicon to form  $\text{SiF}_4$  (cf. page 4, 3rd paragraph). It is further disclosed in document E8 that other materials may be used instead of silicon as long as they consume the free radicals in the plasma. As examples of these materials SiC is *inter alia* mentioned (cf. page 7, end of the 3rd paragraph and claims 1 and 6).
- 6.5 Document E3, on the other hand, discloses the use in a plasma-etch apparatus of a heating plate 12 made of SiC which reacts with the free fluorine radicals of the reaction gas producing the stable gases  $\text{CF}_4$  and  $\text{SiF}_4$  which are discharged by the pumping system (cf. page 8, 2nd paragraph). The heating plate is placed above and facing the substrate support 6 (cf. Figure 1 and page 5, 3rd paragraph). The removal of the fluorine radicals from the reaction gas not only reduces the adhesion of the products of the plasma-etch process to the walls of the apparatus, but also greatly improves the etching selectivity between Si and  $\text{SiO}_2$  (cf. last three lines on page 3; page 4, 2nd paragraph; page 6, 2nd paragraph).
- 6.6 From the teachings of documents E3 and E8 the skilled person learns that a fluorine scavenger can be made of different materials as long as they consume the fluorine radicals. The possible materials comprise *inter alia* Si and SiC, although a source of carbon

would also react with the fluorine radicals producing  $CF_4$ . Moreover, the location of the scavenger can be below the substrate to be treated, as done in document E8, or above the substrate, as in document E3. It is, therefore, obvious for a skilled person to locate a fluorine scavenger made of silicon above the substrate to be treated, since by locating the scavenger above the substrate the scavenger's surface exposed to the plasma increases and the scavenging of free fluorine radicals is improved with respect to the apparatus disclosed in document E8 in which a portion of the scavenger is covered by the substrate and the scavenging action only takes place at the substrate's periphery.

Accordingly option (i) of claim 1, ie the use of an article of silicon as fluorine scavenger mounted between the window and the substrate, does not involve an inventive step having regard to the combined teaching of documents E1, E3 and E8. A finding of lack of inventive step with respect to one alternative of the invention as claimed, however, renders the whole claim including different alternatives not allowable. For this reason, it is not necessary to discuss the presence of an inventive step of the other options provided in claim 1.

The patent, moreover, does not disclose any technical effect that is achieved by locating the scavenger above the substrate when it is formed by an article of silicon that is not achieved by a scavenger formed by an article of graphite. Such a limitation in the claim renders the claimed subject-matter new with respect to

the state of the art, but is hardly suitable to render it inventive.

6.7 The Board, moreover, does not concur with the respondent's argument that the teachings of documents E1, E3 and E8 cannot be combined with one another, since they are directed to different kinds of plasma-etch apparatus. Although it is true that these apparatus differ e.g. in the gas distribution system and the pressure ranges used, the skilled person learns from documents E3 and E8 that the presence of free fluorine radicals is the main cause for a poor etch selectivity of the oxide layers and that the free fluorine radicals have to be removed from the reaction gas. For the skilled person it is, in consequence, obvious to apply these teachings also to the plasma-etch apparatus disclosed in document E1.

6.8 For these reasons, in the Board's judgement, the apparatus according to claim 1 does not involve an inventive step in the sense of Article 56 EPC.

**Order**

**For these reasons it is decided that:**

1. The decision under appeal is set aside.
2. The patent is revoked.

The Registrar:

The Chairman:

D. Meyfarth

R. K. Shukla