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D E C I S I O N
of 11 February 2003

Case Number: T 0710/99 - 3.4.3

Application Number: 90109477.1

Publication Number: 0398365

IPC: H01L 21/00

Language of the proceedings: EN

Title of invention:

Multiple chamber staged-vacuum semiconductor wafer processing system

Patentee:

APPLIED MATERIALS

Opponent:

Institute of Technological Information, Inc.

Headword:

-

Relevant legal provisions:

EPC Art. 56

Keyword:

"New requests filed during the oral proceedings before the Board - admitted (see point 2.4 of the "Reasons for the Decision")"

Decisions cited:

T 0095/83, T 0231/95, T 0482/89, T 1148/97

Catchword:

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Boards of Appeal

Chambres de recours

Case Number: T 0710/99 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 11 February 2003

Appellant: Institute of Technological Information, Inc.
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Decision under appeal: Interlocutory decision of the Opposition Division
of the European Patent Office posted 4 May 1999
concerning maintenance of European patent
No. 0 398 365 in amended form.

Composition of the Board:

Chairman: R. K. Shukla
Members: V. L. P. Frank
J. H. Van Moer

Summary of Facts and Submissions

I. European patent No. 0 398 365, based on European patent application 90 109 477.1, was opposed on the grounds mentioned in Article 100(a) EPC. The patent was maintained in amended form by the Opposition Division's interlocutory decision of 4 May 1999.

The opponent filed a notice of appeal on 5 July 1999, paying the appeal fee the same day. The statement of grounds of appeal was filed on 30 August 1999.

On 14 July 1999, the patent proprietor filed a notice of appeal and paid the prescribed fee. The statement of grounds of appeal was filed on 6 September 1999 together with a main request and first and second auxiliary requests.

II. The following prior art documents were *inter alia* considered in the opposition proceedings:

E1: GB-A-2 193 482

E3: EP-A-0 272 141

E5: US-A-4 825 808

E6: US-A-4 592 306 (cited by the patent proprietor)

E7: JP-A-63 303 059

III. In response to the communication of the Board annexed to the summons to oral proceedings, the appellant patent proprietor filed an amended second auxiliary request and a third auxiliary request.

IV. In the course of the oral proceedings held on 11 February 2003, the appellant patent proprietor submitted a main and an auxiliary request replacing all the previous requests.

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

The appellant patent proprietor requested that the decision under appeal be set aside and that the patent be maintained on the basis of new claim 1 according to the main request as filed at the oral proceedings and claims 2 to 13 as granted or, alternatively on the basis of new claim 1 according to the auxiliary request filed at the oral proceedings and claims 2 to 13 as granted.

VI. The wording of independent claim 1 according to the main request reads as follows:

"1. A multiple chamber staged-vacuum semiconductor wafer processing system comprising:

a plurality of semiconductor wafer processing chambers (34)

at least one wafer loading/unloading station (21) for supplying and receiving wafers,

a chamber housing (22) including

first (24) and second (28) wafer transfer chambers communicating with one another along a first transfer path (30) from the first wafer transfer chamber to the second wafer transfer chamber via a first intermediate processing

chamber (26) and along a second transfer path (32) from the second wafer transfer chamber via a second intermediate processing chamber (27) to the first wafer transfer chamber,

the at least one loading/unloading station (21) being mounted to and communicating with the first wafer transfer chamber (24) and

the semiconductor wafer processing chambers (34) being mounted to and communicating with the second wafer transfer chamber (28),

valve means (38) situated along said transfer paths and interposed between adjacent chambers and intermediate processing chambers selectively sealing said adjacent chambers to selectively isolate said adjacent chambers and intermediate processing chambers one from the other, and

vacuum means (50) communicating with said chambers for establishing a vacuum gradient across the system, and

said first (24) and second (28) wafer transfer chambers being isolatable from each other through selective operation of the valve means (38) situated along said transfer paths

the first and second wafer transfer chambers (24, 28) each having a robot (40, 42) mounted therein for respectively

(a) reciprocally transfer wafers between the at least one loading/unloading station (21) and the intermediate processing chambers (26, 27) and

(b) for reciprocally transferring wafers between individual ones of the semiconductor wafer processing chambers (34) and the intermediate processing chambers (26, 27)."

Claim 1 according to the auxiliary request differs from claim 1 of the main request in that the following feature is added at the end of it:

"the semiconductor wafer processing chambers (34) including at least a physical vapor deposition chamber."

VII. The appellant opponent objected to the late filing and admissibility of the new main and auxiliary request in the proceedings, since the objection of lack of novelty with respect to document E7 was already raised before the Opposition Division and maintained through all the proceedings before the two instances. It was only after a three hour long discussion during the oral proceedings before the Board that the appellant patent proprietor had reacted and submitted new requests for overcoming this objection. There was no justification at all for admitting such late filed amendments into the proceedings (cf. T 231/95 and T 95/83, OJ 1985, 75). In particular, since the proposed amendments were not clearly allowable contrary to the criteria established in decisions T 482/89 (OJ 1992, 646) and T 1148/97.

VIII. The appellant patent proprietor alleged that the interpretation of document E7 given by the appellant opponent during the oral proceedings before the Board to support his objection of lack of novelty was different from the one presented previously. The appellant opponent had consistently interpreted the three chambers 18, 19 and 20 of document E7 as forming a single chamber. Only at the oral proceedings he

interpreted this document in the sense that any of these chambers could be considered as the second wafer transfer chamber of the claim. The amendments to the independent claim were, therefore, only made to overcome the objection of lack of novelty in light of the new interpretation of this document which presented the appellant patent proprietor with a completely new case (cf. T 231/95). For these reasons, the new main and auxiliary requests should be admitted in the proceedings, since they were a *bona fide* attempt to overcome this objection.

IX. On the issue of inventive step the appellant opponent argued essentially as follows:

- Document E7 discloses (cf. Figure 1) a vacuum treatment equipment in which the three areas 18, 19 and 20 form a single chamber, since these areas communicate with one another at their upper portions and share a common exhaust opening. The single chamber formed by these three areas corresponds, therefore, to the second wafer transfer chamber as specified in claim 1, since this chamber is isolated from and interconnected to the first wafer transfer chamber by the intermediate processing chambers 13 and 16. Alternatively, each of the chambers 18, 19 and 20 can be considered as the second wafer transfer chamber within the meaning of claim 1, since the only features of this chamber as specified in the claim are that (a) a plurality of semiconductor wafer chambers are mounted to and communicate with this chamber and (b) it communicates with the first transfer chamber via two transfer paths which are sealable by respective valves. Consequently, the vacuum system according to claim 1 of the main request differs from the equipment disclosed in document E7 only in that a

robot is mounted in each one of the wafer transfer chambers for transferring the wafers to be processed. However, the use of robotic wafer transfer systems is known from documents E3 and E6. A skilled person would, therefore, have replaced the three chambers 18, 19 and 20 disclosed in document E7 by a single chamber with a robot for improving the transfer of the wafers, since there is nothing in the disclosure of document E7 that prevented him from removing these walls.

- The only difference between the processing system according to claim 1 and the equipment disclosed in document E1 (Figure 1) is that the first and second wafer transfer chambers are not isolatable from each other, since according to this document these two chambers are connected by a flat finder. However, this document also teaches that the flat finder can be bypassed when orientation of the wafers is not required. Document E5, on the other hand, discloses that a partition wall can be provided within a chamber to separate it into a plurality of chambers for independent processing. For these reasons, the wafer processing system according to claim 1 does not involve an inventive step.

- Claim 1 according to the auxiliary request further comprises the feature that the semiconductor wafer processing chambers include at least a physical vapor deposition chamber. This is, however, a deposition method usually employed in the manufacturing of semiconductor device mentioned eg. in document E3. Its inclusion in a semiconductor wafer processing system does not, therefore, involve an inventive step.

X. The appellant patent proprietor argued on the issue of inventive step essentially as follows:

- Document E7 comprises a plurality of intermediate chambers interposed between the respective vacuum processing chambers to avoid that particles of one processing chamber contaminate the other processing chambers. The three intermediate chambers 18, 19 and 20 communicate with each other at their upper portions so that they can be exhausted simultaneously. This, however, does not mean that the presence of the separation walls can be ignored and their removal goes against the whole teaching of this document. The vacuum exhaust pipe is shown in the figure to communicate with these chambers only at their mutual corner and, therefore, does not communicate these chambers. There is no motivation in document E7 to combine it with the teachings of documents E3 or E6. Furthermore, the processing of wafers according to document E7 is sequential. On the contrary, the system according to claim 1 allows that a semiconductor wafer be transferred from one processing chamber into any of the other processing chambers by the robot located in the second wafer transfer chamber.

- On the other hand, the essence of the equipment disclosed in document E1 is the flexibility in the processing of wafers. The removal of the flat finder opening which communicates the two wafer transfer chambers reduces the versatility of the equipment and would, therefore, be avoided by the skilled person. For this reason, this document cannot be combined with the document E5.

Reasons for the Decision

1. The appeal is admissible.
2. *Late filed amendments*
 - 2.1 The appellant patent proprietor filed new claims 1 for the main and auxiliary requests during the oral proceedings before the Board. These claims were submitted after a long discussion in the oral proceedings on the issues of added subject-matter and novelty having regard to the processing system disclosed in document E7.
 - 2.2 Claim 1 according to the main request was amended with respect to claim 1 of the second auxiliary request filed on 9 January 2003 by the inclusion of the subject-matter of the granted dependent claim 8, ie the presence of a robot in each one of the wafer transfer chambers.

Claim 1 according to the auxiliary request further comprises the subject-matter of the granted dependent claim 3.
 - 2.3 The Board is of the view that these amendments are not of a nature that they could have taken the appellant opponent by surprise, since the provision of a single second wafer transfer chamber enabling the use of a robot for transferring the wafers within the processing system as now claimed was discussed as an important feature of the invention during the written procedure (cf. appellant patent proprietor's letter dated 6 September 1999, page 5, first paragraph and the appellant opponent's letter dated 7 July 2000, page 3, first paragraph). Moreover, the amendments were necessary to overcome the objection of lack of novelty

based on a new interpretation of the system according to document E7 which was only elaborated during the oral proceedings.

Also, contrary to the circumstances in case T 95/83, the amendments to the independent claim did not shift the essence of the invention (cf. T 95/83, point 7 of the reasons), but were a *bona fide* attempt directed to restore the novelty of the claimed subject-matter.

In decision T 231/95 a new auxiliary request containing amendments to the claims was filed at the end of the oral proceedings before the Board, although the objections against the claims were already raised during the written procedure and no surprising new aspects were raised at the oral procedure. (cf. T 231/95, point 6 of the reasons). In contrast, as stated above, in the present case although the lack of novelty was disputed in the written submissions, during the oral proceedings a new analysis of the disclosure of the prior art document E7 was presented in the consideration of the issue of novelty.

- 2.4 The Board concurs with the appellant opponent in that amendments which are not clearly allowable should not in principle be admitted if filed at a late stage of the proceedings (cf. T 1148/97). However, as mentioned above, the amendments made to the main and auxiliary requests in the present case are a *bona fide* attempt to overcome the objection of lack of novelty based on the new arguments elaborated during the oral proceedings before the Board, do not give raise to any formal objections and do not create a fresh case. Moreover, one of the issues raised by the appellant opponent in the present appeal is that of inventive step in the amended subject-matter of claim 1 as maintained by the Opposition Division in its decision. Although claim 1 of the new main request submitted during the oral

proceedings is limited in its scope in relation to claim as maintained by the Opposition Division, it does not shift the core of the invention, ie the provision of a second wafer transfer chamber which is isolatable from the first wafer transfer chamber, as defined in claim 1 as maintained. In view of the above, in the present case, a strict formal application of the criterion that to be admissible late filed amendments must be clearly allowable, would deprive the parties of a decision by the Board on the issue of inventive step. Moreover, in the present case in view of the nature of the amendments the filing of the new requests has not caused any delay in the proceedings.

2.5 For these reasons, the Board exercises its discretion and admits the new main and auxiliary requests into the proceedings.

3. *Amendments*

The Board is satisfied that the amendments made to the independent claim of the main and auxiliary requests fulfill the requirements of Articles 123(2) and (3) EPC. These amendments, however, will not be discussed here in detail, as the subject-matter of these claims is not allowable for the reasons which follow.

4. *Main and auxiliary request - Novelty*

4.1 Document E1 discloses a non-serial semiconductor wafer processing system in which different processing steps can be carried out simultaneously on different wafers. This results in an increased throughput when compared to sequential processing systems (cf. page 2, lines 48 to 49 and lines 56 to 57; page 3, lines 21 to 25 and page 4, lines 35 to 36).

The processing system disclosed in this document comprises a first wafer transfer chamber 20a connected to the two loading/unloading stations 40a and 40b, a second wafer transfer chamber 20b connected to the two processing chambers 30g and 30f and two intermediate processing chambers 30b and 30c. Each one of the two intermediate processing chambers communicates with the first and second wafer transfer chambers and forms, respectively, a first and second transfer path from the first to the second wafer transfer chamber. The second wafer transfer chamber 20b is separated from the processing chambers 30g, 30f and from the intermediate processing chambers by valves. Similarly, the first transfer chamber 20a is separated from the intermediate processing chambers and from the loading/unloading stations 40a, 40b by valves. A flat finder module 50a is located between the two wafer transfer chambers 20a and 20b interconnecting them (cf. Figure 3; page 3, lines 46 to 64).

Vacuum means are implicitly disclosed in document E1, since they are required for achieving the operating vacuum level of the processing chambers. A vacuum gradient arises across the system from the loadlock chambers, which are open to the ambient, up to the processing chambers.

A robot arm is provided in each one of the wafer transfer chambers. In a first step, the first robot arm 201c transfers the semiconductor wafers from the loading/unloading stations 40a and 40b either to one of the intermediate wafer processing chambers 30c, 30b or to the flat finder 50a. In a second step, the second robot arm 201d in the second wafer transfer chamber transfers the wafers from these positions to the wafer processing chambers 30g and 30f. The order of these steps is reversed when removing the processed wafers from the system (cf. page 4, lines 6 to 29).

In contrast to the processing system according to claim 1 of the main and auxiliary requests, the first and second wafer transfer chambers are not isolated from each other, but are permanently connected to each other via the flat finder module 50a, thus forming a single vacuum chamber (cf. page 3, line 54 to 55).

4.2 The sequential wafer processing system disclosed in document E7 does not disclose the use of robot arms for transferring the wafers within the processing system in contrast to the system according to the independent claim of the main and auxiliary requests.

4.3 For these reasons, the processing system according to claim 1 of both requests is novel over the disclosure of documents E1 and E7.

5. *Main request - Inventive step*

The only remaining issue is that of inventive step.

5.1 In the Board's view, document E1 represents the closest state of the art, since the system disclosed in document E7 involves a sequential processing of the wafers, ie a system in which a wafer traverses one processing chamber after the other. A skilled person would not start from a known sequential processing system to design a non-sequential system, since this involves a complete change in its working concept.

5.2 The processing system according to claim 1 differs from the system disclosed in document E1 only in that the first and second wafer transfer chambers are isolatable from each other through selective operation of the valve means situated along the transfer paths.

According to the patent in suit, the provision of multiple isolated chambers (i) minimizes the pump down time of the system after the loading of wafers, (ii) decreases the contamination in the high vacuum regions and (iii) increases the throughput of the system by providing separate, isolatable wafer transport paths (cf. column 2, lines 8 to 25 of the published patent).

- 5.3 Only the first two effects, however, are related to the possibility of isolating the first and second wafer transfer chambers from one another. In fact, in document E1 the flat finder 50a connects the two wafer transfer chambers whereby the wafers which are not to be processed in the intermediate processing chambers 30c and 30b may be directly transferred through the flat finder into the second wafer transfer chamber and from there into the processing chambers 30g and 30f. The presence of the flat finder's opening, therefore, increases the overall throughput of the system of document E1 with respect to the one of the patent in suit, since it provides a third transfer path between the two wafer transfer chambers.

In consequence, the objective problem addressed by the patent in suit is to minimize the pump down time and to decrease the contamination of the high vacuum regions of the processing system disclosed in document E1.

- 5.4 According to the appellant patent proprietor, the essential teaching of document E1 is the versatility of the processing system, since the wafers can be transferred between the two wafer transfer chambers through three different paths. This document further discloses that when flat orientation is not required, the flat finder can be bypassed (cf. page 4, lines 19 to 22). However, the removal of the processed wafers follows a path that always goes through the flat finder (cf. page 4, lines 27 to 29). For these reasons, this

document's teaching prevents the skilled person from removing the flat finder and isolating the two wafer transfer chambers from one another, since this would lead to a less versatile processing system.

5.5 The Opposition Division followed this line of reasoning in their interlocutory decision. On page 10 of this decision it is argued that it is the fundamental teaching of document E1 to provide a system affording non-serial processing, ie a system where any wafer entering the loadlock chamber may be transferred to a selected process chamber without passing through any other process chamber and any wafer may be transferred from a selected process chamber to any other process chamber or to the loadlock chamber without passing through any intermediate process chamber (cf. also E1, page 3, lines 21 to 25). Moreover, the statement in document E1 that the flat finder can be bypassed could not be construed as a hint to the omission of the flat finder, since the flat finder also acts as a support element that is essential for transferring wafers between the two wafer transfer chambers. Thus the omission of the flat finder would require a substantial modification of the whole transport concept and would go beyond what is obvious to the skilled person.

5.6 The Board, however, does not share this interpretation of document E1. As the appellant opponent pointed out, the problem addressed by the patent is not the improvement of the versatility, but the avoidance of contamination of the high vacuum regions and the reduction of the pump down time of the known processing system. It is with these objectives in mind that the skilled person consults the state of the art.

5.7 Document E5 relates to a substrate processing system comprising multiple processing chambers, ie the same technical field as the one of document E1 and the

patent in suit. The processing system disclosed in this document comprises a central separation chamber 4 surrounded by several wafer processing chambers 1, 2, 3, 11 and 31. The central separation chamber serves for transferring the wafers between the processing chambers. This document discloses that the central chamber can be subdivided by one or more partition walls provided with gate valves to reduce the interference between the processing chambers and to improve the independence in processing (cf. E5, column 4, lines 42 to 52; Figures 4 and 5).

5.8 In the processing system according to document E1 cross contamination between the two wafer transfer chambers cannot be avoided, since they form a single vacuum chamber which is interconnected by the opening of the flat finder. Every time the loading/unloading station is operated some residual gas will enter the first wafer transfer chamber and propagate through the flat finder into the second wafer transfer chamber. Once this drawback has been recognized by the skilled person, it is only logical that he would reflect on the modifications needed to avoid cross contamination between the chambers. He would also realise that the teaching of document E5, namely to provide a further partition wall to close the flat finder's opening, would reduce the cross contamination between the two wafer transfer chambers.

5.9 For these reasons, it is the Board's judgement that the subject-matter of claim 1 according to the main request does not involve an inventive step in the sense of Article 56 EPC.

6. *Auxiliary request - Inventive step*

In relation to claim 1 of the main request, claim 1 according to the auxiliary request specifies further that at least one of the processing chambers includes a physical vapor deposition chamber.

In the processing system of document E1, however, the processing chamber 30b is a sputter module, ie a physical vapor deposition module as in claim 1 of the auxiliary request (cf. E1, page 3, lines 61 to 62 and column 2, lines 20 to 21 of the published patent). Claim 1 according to the auxiliary request differs, therefore, from the processing system disclosed in document E1 only by the same feature as claim 1 of the main request.

The subject-matter of claim 1 according to the auxiliary request does not involve an inventive step for the reasons given with respect to the main request.

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:

M. Zawadzka

R. K. Shukla