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File Number: T 490/89 - 3.3.3

Application No.: 82 108 699.8

Publication No.: 0 076 426

Title of invention: Multiple chamber deposition and isolation system and
method

Classification: G23C 16/54

D E C I S I O N
of 14 February 1992

Proprietor of the patent: ENERGY CONVERSION DEVICES, INC.

Opponent: LEYBOLD AKTIENGESELLSCHAFT

Headword:

EPC Articles 56, 117

Keyword: "Inventive step - affirmed" -
"Usefulness of written evidence where alleged facts cannot be
established by reference to prior art documents."

Headnote

Case Number : T 490/89 - 3.3.3

D E C I S I O N
of the Technical Board of Appeal 3.3.3
of 14 February 1992

Appellant :
(Proprietor of the patent)

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Decision under appeal :

Decision of Opposition Division of the European
Patent Office dated 18 May 1989 revoking
European patent No. 0 076 426 pursuant to
Article 102(1) EPC.

Composition of the Board :

Chairman : F. Antony
Members : R. A. Lunzer
W. Moser

Summary of Facts and Submissions

I. European patent No. 0 076 426 was granted on 26 November 1986 on the basis of application No. 82108699.8 filed on 21 September 1982, having a priority date of 28 September 1981 derived from U.S. Application No. 306 146.

II. On 7 August 1987 an opposition was lodged by the Respondent on the grounds of Article 100(a), alleging lack of novelty (Article 54 EPC), and/or lack of inventive step (Article 56 EPC). The Opponent relied in particular on the following documents:

- (1) US-A-3 652 444
- (3) DE-A-1 282 411, and
- (4) The Western Electric Engineer, Volume VII, No. II, April 1963 pp. 9 to 17: "Acontinuous vacuum processing machine" byCharschan et al.

while the Opposition Division also made reference in its decision to

- (5) JP-A-56-114 387,

which was prior art acknowledged by the patentee in the introductory part of the specification.

III. By its decision given in writing on 18 May 1989, the Opposition Division revoked the patent. It regarded document (5) as being the closest prior art, and held that although the alleged invention was novel in the light of all the above citations, nevertheless it lacked any inventive step. In particular it found that documents (3) and (4), taken individually, both made it obvious to provide a gas flow from the second deposition chamber into

the first deposition chamber with a view to avoiding contamination in the second chamber by an element present in the atmosphere of the first, but absent from the atmosphere of the second.

IV. Claims 1 and 4 of the patent as granted, and as before the Opposition Division, were in the following terms:

"1. Method of depositing a body of material consisting of at least two layers upon a substrate (12), wherein a first layer of material is deposited on the substrate in a first deposition chamber (14) by establishing a glow discharge in a first mixture of gases and a second layer of material having a composition differing from the composition of said first layer by the absence of at least one element being present in said first gas mixture but not in a second gas mixture in a second deposition chamber (16) in which the deposition of the second layer takes place by establishing a glow discharge in said second gas mixture, wherein the substrate (12) is moved from the first deposition chamber (14) into the second deposition chamber (16), and wherein the first gas mixture is at least partially hindered from entering from the first deposition chamber (14) into the second deposition chamber (16), characterised therein that a substrate (12) is continuously transferred from the first deposition chamber (14) into the second deposition chamber (16) and that a stream of gas flows from the second deposition chamber (16) into the first deposition chamber (14), and that the gas flow is controlled in such a manner that the concentration ratio of said one element in the first deposition chamber (14) to its concentration in the second deposition chamber (16) is at least 10 000.

4. Apparatus (10) for depositing a body of material upon a substrate (12), said body having at least two layers of different composition, said apparatus comprising:

a first deposition chamber (14) housing means for depositing, by establishing a glow discharge in a first mixture of gases, a first layer of material on said substrate (12);

a second deposition chamber (16) housing means for depositing, by establishing a glow discharge in a second mixture of gases, a second layer of material on said first layer, said second layer of material having a composition differing from the composition of said first layer by the absence of at least one element, said element being present in said first gas mixture, but not in said second gas mixture; a slot (62) interconnecting said first and second chambers (14, 16);

transferring means (20, 22) for transferring said substrate (12) from said first chamber (14) to said second chamber (16) through said slot (62); and isolation means for limiting diffusion of said at least one element from said first chamber (14) to said second chamber (16),

characterised in that said isolation means comprises means for maintaining the pressure of said second gas mixture in said second chamber (16) higher than the pressure of said first gas mixture in the first chamber (14) to establish a gas flow from said second chamber (16) to said first chamber (14) through said slot (62) at a rate to maintain a concentration ratio of said at least one element in said first

chamber (14) to its concentration in said second chamber (16) of at least 10 000 and that the transferring means (20,22) transfer a continuous substrate (12) from the first chamber (14) into the second chamber (16)."

- V. An appeal against that decision was lodged on 28 July 1989, the appeal fee was paid on the same day, and the Grounds of Appeal were filed on 19 September 1989. In the Statement of Grounds of Appeal, the Appellant challenged the interpretation of document (3) adopted by the Opposition Division as the basis for its adverse decision, and it sought to distinguish its alleged invention from the prior art by reference to the diffusion behaviour of gases, especially when under low pressure. It sought to have the patent upheld on the basis of an amended Claim 1, which emphasized that the invention resided in particular in preventing diffusion of molecules of gas in one direction, against the flow of gas in the interconnecting slot between the first and second chambers in the opposite direction.
- VI. A communication from the Board dated 19 June 1991 questioned the allowability of the proposed amended Claim 1, both on the ground that it did not arise out of the opposition, and further on the ground that it was not admissible having regard to the provisions of Article 123(2) EPC. Further, the Board drew attention to the absence of any Request for the patent to be upheld as granted.
- VII. By its response dated 23 July 1991 to the Board's communication, the Appellant filed a main request directed to the patent as granted, and an auxiliary request, directed to the amended Claim 1 filed on 19 September 1989.

VIII. The Respondent, who had until that stage played no part in the appeal, filed a letter dated 4 September 1991 which amounted to a counterstatement to the Grounds of Appeal, and requested oral proceedings which were fixed for 26 February 1992. With that letter it made reference to:

- (6) Thin Film Processes, edited by J.L. Vossen Academic Press Ltd., 1978, (pp. 12 - 14 and 24-29) and
- (7) US-A-4 204 942.

By a subsequent letter dated 31 January 1992 it indicated that it would not attend the oral proceedings, with the consequence that they were cancelled.

IX. In its late filed counterstatement, the Respondent argued that no clear dividing line could be drawn between a glow discharge process, and a cathode sputtering process, both of which fall within the range of gas pressures at which viscous flow of gases can occur, with the consequence that any prior art teaching in the field of cathode sputtering would be understood by the skilled reader to be equally applicable to a glow discharge process. It challenged the Appellant's arguments to the effect that some valid distinction could be based on the distinction between normal gas flow and reverse diffusion phenomena, and contended that the only possible ways for regulating gas flow between two chambers connected by a passage were either by controlling the size of the passage, or by controlling the pressure differential between the two chambers.

X. The Appellant requested that the patent should be upheld as granted, and by way of auxiliary request, that it should be upheld with the amended Claim 1 filed on 19 September 1989. The Respondent requested that the appeal should be dismissed.

Reasons for the Decision

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC, and is admissible.

2. Late filed documents

Although the Respondent's counterstatement was filed long after the time limit for filing this document, the Board has considered all the arguments there presented, and formally admits it into the proceedings because of its relevance.

Documents (6) and (7) are late filed, and consequently may be excluded by the Board in the exercise of its discretion under Article 114(2) EPC. The Board has considered these two documents. Document (6) illustrates common general knowledge, and to that extent there is no reason for its exclusion. Document (7) is a further patent specification which is concerned with the problem of cross contamination between various stages of cathode sputtering. The solution proposed is in principle indistinguishable from the solution to be found in documents (1) and (4), viz. the use of an intermediate chamber at lower pressure between two coating chambers, for the purpose of avoiding cross-contamination. The Board finds this document no more relevant than the previously cited prior art, and accordingly, in the exercise of its discretion, the Board excludes document (7) from consideration in the appeal.

3. Novelty

The alleged invention, which relates exclusively to a continuous process, is clearly novel in comparison with the discontinuous process disclosed in document (5).

Furthermore, novelty exists with respect to documents (1), (3), and (4), because the alleged invention requires a flow of gas from a second deposition chamber into a first deposition chamber, which flow is not disclosed in any of these documents. Accordingly, the Board is satisfied that the alleged invention is novel for the purposes of Article 52 EPC.

4. The closest prior art

The Board agrees with the Opposition Division in regarding document (5) as being the closest prior art, because, unlike any of the other prior art documents which have been brought to light, it relates to a process for making a multiple layer film device of the kind in which a number of layers of silicon are deposited. More specifically, there is a pure non-doped silicon layer 6, between a P type layer 5, and an N type layer 7, each of which layers is deposited in turn onto a glass substrate. Deposition is effected in separate chambers, while the substrate is stationary. Between the successive deposition steps the vacuum is released, and the substrate moved from one chamber to the next. Cross contamination during deposition is prevented by shutters 29a to 29d, which isolate one deposition chamber from another. Because shutters are used, the process is necessarily non-continuous.

5. Problem

The patent-in-suit is concerned with the problem of finding a continuous process for the deposition of a number of layers for the manufacture of a composite, such as that made in accordance with document (5), in which the contamination of the pure silicon layer by dopants from adjacent chambers is avoided to a very large degree. The

adoption of a continuous process normally entails deposition onto a substrate which is moving continuously, such as on a conveyor, from one deposition chamber to another. This precludes the use of separating shutters to isolate successive chambers, and thus gives rise to the problem of avoiding contamination of one deposit by another.

6. Solution and its effectiveness

The solution proposed by the patent in suit is to pass the substrates through slots between successive chambers which are so dimensioned that there is just sufficient clearance to allow the substrate to pass from one chamber to another. Such a small clearance is termed a "calibrated leak" in document (4). The use of such calibrated leaks is to be seen in each of documents (1) to (4) inclusive. However, the alleged invention involves the further feature that an element, such as a dopant in a first deposition chamber, is substantially prevented from entering a second deposition chamber by the provision of higher gaseous pressure in the second chamber. The Board sees no reason to doubt that this extremely simple expedient affords an effective solution to the problem of making such a deposition process continuous, while overcoming the risk of contamination of the pure silicon layer, deposited in the second deposition chamber, by dopant coming from the first deposition chamber, and the contrary was not suggested by the Appellant. Furthermore, although the Respondent attacked the limit of 10 000 as being an arbitrarily chosen limit, the Board can see no reason why that limit should be unattainable.

7. Inventiveness

- 7.1 The issue of inventiveness turns on whether a skilled person, having as his starting point the disclosure of document (5), and confronted with the problem of making the process there disclosed capable of operating continuously, while avoiding contamination of the pure silicon layer by dopant present in the atmosphere of an adjacent chamber, would have appreciated that this problem was capable of being solved by the adoption of a series of deposition chambers, separated by slots so dimensioned as to give rise to calibrated leaks between one chamber and the next, coupled with the extremely simple expedient of providing an adequate overpressure in the second chamber, so as to hinder gas flow from the first chamber to the second.
- 7.2 Continuous deposition processes are disclosed in each of documents (1), (3), and (4), in which the undesirable flow of gas from one deposition chamber to the next adjacent chamber is hindered by the use of slots associated with calibrated leaks. Furthermore, documents (1) and (4) show the provision of intermediate chambers, at lower pressure than in the deposition chambers, located between successive deposition chambers. Thus, if a contaminant emerges from an earlier deposition chamber, it is likely to be removed from the system by the lower pressure in an intermediate chamber, before it has a chance of reaching the next deposition chamber.
- 7.3 Referring to the details of construction disclosed in the cited documents, document (1) describes a series of isolation chambers 22A to 26A, between successive deposition chambers (col. 3, line 10 and Figs. 1 and 4), which are maintained at a selective pressure lower than

that of the adjacent processing chambers 22 to 26 (col. 2, lines 7 to 9). This serves to eliminate contamination between one depositing chamber and the next (col. 4, lines 25 to 27).

Document (4) describes at page 11 right hand column, and in Fig. 1 on the same page, a system involving nine chambers numbered 1 to 9, and two larger process chambers, which are separated from each other by chamber 5, which is at the same pressure as its following process chamber, which pressure, 10^{-6} Torr, is much lower than that of the processing chamber before it which is held at 10^{-2} Torr in an argon atmosphere.

As the Opposition Division placed particular reliance on document (3), the Board observes that it is concerned with the disclosure of a particular aspect of a deposition apparatus, i.e. the design of carriers suited for passing from one chamber to the next through calibrated leaks. It does not describe any complete deposition process, nor a complete deposition apparatus. The very brief process description (col. 4, lines 4 to 12 and Fig. 4) indicates that there could be some gas flow in the opposite direction to the direction of travel of the substrates, from chamber 12 back to chamber 11. However, it emerges from column 4, lines 6 to 9 that sputtering does not take place in chamber 12, but instead in a further chamber which follows 12, but is not illustrated in Fig. 4.

- 7.4 Because documents (1) and (4) are concerned with situations in which there is a possibility of mutual contamination between the substances deposited in successive chambers, there is no hint of allowing the "clean" atmosphere in one deposition chamber to be at a higher pressure than that which prevails in an adjacent chamber containing a contaminated atmosphere, and thus avoiding the need for an intermediate chamber at a lower pressure.

- 7.5 Consequently, neither of these documents suggests the extremely simple expedient, which is the basis of the present alleged invention. The Board is well aware of the everyday common general knowledge that, where there is a risk of an impure fluid contaminating a pure fluid, this can often be avoided by ensuring that the pure fluid is maintained at a higher pressure than the impure, so that any flow of fluid is in the harmless direction of pure into impure, and not the reverse. A simple illustration of this is to be seen in the fume cupboards, which are to be found in any general purpose chemical laboratory.
- 7.6 The Board notes with surprise that despite the fact that multiple layers, which at times include layers of undoped high purity silicon, have been the subject of vacuum deposition now for a considerable number of years, the Respondent has been unable to identify any single prior art document which proposes the simple solution, for avoiding contamination of the pure silicon layer, which is proposed by the alleged invention. As was indicated in the earlier decision T 106/84, OJ EPO 1985, 132, care is needed where it appears surprising that no one had ever hit upon a simple solution before.
- 7.7 Where, in a case such as the present, no directly relevant prior art can be found, opponents should not lose sight of the fact that their case might be capable of support by reference to prior art taken from analogous fields, or by written evidence from a suitably qualified person, giving a fully reasoned statement as to why he would have adopted the solution proposed by the patent in suit if he had been confronted with the problem tackled by the present alleged invention. Such evidence may carry weight with a Board, depending on the extent to which it is convincingly challenged.

7.8 In the circumstances of the present case, in the absence of either published prior art, or of any evidence pointing in the direction of the invention, the Board is bound to conclude that this extremely simple invention nonetheless involves an inventive step.

8. Conclusion

The Board is satisfied that the invention as defined in Claim 1 as granted involves an inventive step, as is required by Article 56 EPC. Claims 2 and 3 are dependent on Claim 1, and derive their inventive character from Claim 1. Claim 4 is an independent apparatus claim, defining an apparatus suitable only for carrying out a process in accordance with Claim 1. In the view of the Board, it therefore covers subject matter which is both new and inventive, and Claims 5 and 6 which are dependent thereon stand with Claim 4. As the Board considers the main request allowable, the allowability of the auxiliary request need not be considered.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.
2. The opposition is rejected.

The Registrar:

The Chairman:


E. Gorgmaier


F. Antony