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D E C I S I O N
of 15 December 2005

Case Number: T 0582/04 - 3.4.03

Application Number: 00903195.6

Publication Number: 1149412

IPC: H01L 21/312

Language of the proceedings: EN

Title of invention:

Dielectric films from organohydridosiloxane resins

Applicant:

Alliedsignal, Inc.

Opponent:

-

Headword:

Dielectric film/ALLIEDSIGNAL

Relevant legal provisions:

EPC Art. 54, 56

RPBA Art. 10b(3)

Keyword:

"Inventive step (yes, after amendment)"

"Admissibility of belated requests submitted at the oral proceedings (no)"

Decisions cited:

T 0150/82

Catchword:

-



Case Number: T 0582/04 - 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 15 December 2005

Appellant: Alliedsignal, Inc.
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 29 October 2003
refusing European application No. 00903195.6
pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: R. G. O'Connell
Members: V. L. P. Frank
T. Bokor

Summary of Facts and Submissions

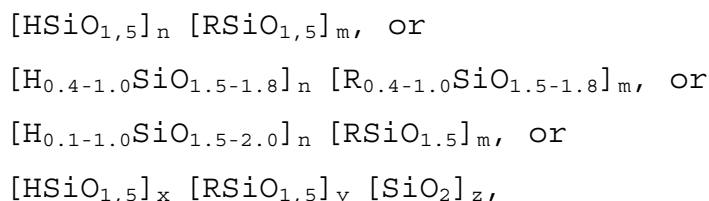
- I. This is an appeal from the refusal of European patent application 00 903 195.6.

Grounds for the refusal were *inter alia* lack of clarity leading to apparent lack of novelty of the *product defined by process* claims

- II. At oral proceedings before the board the appellant submitted new first to fourth auxiliary requests. Having considered these requests, the board announced that they were not admitted into the proceedings, since they raised issues which could not be dealt with without adjourning the proceedings (Article 10b(3) RPBA).
- III. The appellant then filed an amended request comprising a single claim worded as follows:

"A dielectric film formed on a substrate, said dielectric film having a thickness variation over a single substrate of less than 1% and a dielectric constant of less than 3, said dielectric film being obtainable by the following method:

forming a solution of a solvent and an organohydridosiloxane resin comprising a polymer having a general formula:



wherein the sum of n and m is from about 8 to about 5000, the sum of x, y and z is from about 8 to about 5000, and R, in any general formula, is selected from substituted and unsubstituted normal and branched alkyl groups, cycloalkyl groups, substituted and unsubstituted aryl groups, and mixtures thereof, wherein the organohydridosiloxane resin has a cage conformation;
dispensing the solution on the substrate;
spinning the substrate to form an organohydridosiloxane resin coated substrate;
baking the organohydridosiloxane resin coated substrate at least two times to remove any residual solvent, cause the polymer to flow, and partially convert the resin to the dielectric film wherein each baking step is at a higher temperature than the proceeding step; and
curing the organohydridosiloxane resin coated substrate, wherein the conversion to the dielectric film is completed."

IV. The following prior art documents *inter alia* were cited in the examination procedure:

D1: WO 98/47944

D2: EP 727 817 A

D4: US 5 747 381 A

The following postpublished copy of a webpage was submitted at the oral proceedings by the appellant:

D5: "Elektronenstrahlolithographie und CMP zur Herstellung von subµm-großen SIS-Junctions", pages 1 to 8, http://www.ph1.uni-koeln.de/workgroups/astro_instrumentation/sis/deutsch/siseblcmp_d.html

V. The appellant argued essentially as follows:

- The objective technical problem addressed by the invention was to provide dielectric films having very high thickness uniformity as well as a low dielectric constant. This was evidenced by the examples which disclosed films having less than 1% in thickness variation. This amounted for a 900 nm thick film to a variation in thickness of less than 9 nm, even less for thinner films. Document D5 disclosed, however, that "perfectly planar surfaces" obtained by chemical mechanical polishing (CMP) possessed a planarity of merely ± 20 nm.

- Although document D4 did not disclose any specific value for the planarity of the obtained dielectric films, it disclosed that the thickness of these films was uniform over across the wafer but tended to be lightly thinner towards the edge. Moreover, as these films were a sacrificial layer etched back in a reactive ion etching (RIE) step, its planarity was not a relevant feature. A skilled person therefore would not have considered that the baking steps disclosed in this document would be useful for attaining high thickness uniformity.

- In contrast thereto, the dielectric films obtainable by the present invention did not require any further planarization steps for achieving the low thickness variation specified in the claim.
- VI. The appellant requests that the decision under appeal be set aside and that a patent be granted with the following documents:

Claim 1 and description pages 1, 1A, 2 to 24, submitted as sole request during the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.
2. *Admissibility of the first to fourth auxiliary requests submitted during the oral proceedings*
 - 2.1 The appellant submitted at the start of the oral proceedings new first to fourth auxiliary requests. Claim 1 of all these requests was directed to a method of making a dielectric film on a substrate and comprised features that were not present in any of the original claims and were taken from the description. It was therefore uncertain if these features had been considered when drawing up the search report. To examine the amended claims, it would have been necessary to remit the case to the department of first instance.

2.2 Article 10b(3) RPBA states, however, that "Amendments sought to be made after oral proceedings have been arranged shall not be admitted if they raise issues which the Board or the other party or parties cannot reasonably be expected to deal with without adjournment of the oral proceedings".

2.3 The board decided therefore not to admit these requests into the proceedings.

3. A new request comprising a single claim was then submitted by the appellant, replacing his previous requests.

4. *Amendments*

4.1 This claim is based on a combination of original claims 15, 19 and 20. Moreover, the two baking steps at successively higher temperatures were disclosed *inter alia* in original method claims 2 and 3, while films with a dielectric constant of less than 3 were disclosed *inter alia* on page 4, lines 4 to 5.

The description has been adapted to the claim.

For these reasons, the board is satisfied that the requirement of Article 123(2) EPC is met.

4.2 The dielectric film specified in the claim is defined partly by product parameters including thickness variation and dielectric constant and partly by the steps of the method by which it is obtainable. According to the jurisprudence of the EPO Boards of Appeal this claim form is justified if the product

itself is novel and if there is no other information available in the application to define the product by reference to its composition, structure or other testable parameters (cf T 150/82, OJ 1984, 309).

In the present case the dielectric film consists of a polymer having the general formula given in the claim. It is, however, difficult to characterize polymers, as these materials possess a wide range in molecular weight and chain lengths and vary considerable from each other depending on their specific fabrication method. In the view of the board, therefore, the most suitable way of characterizing the polymer forming the dielectric film is by the method by which it is obtainable, as done in the claim.

5. *Novelty (Article 54 EPC)*

5.1 Document D1, the closest state of the art, discloses dielectric films formed from a solution containing an organohydridosiloxane resin which corresponds to the formula of the claim. To obtain the dielectric film, the solution is spin-coated on a substrate and cured by a heat treatment at 380 to 450°C. Films having dielectric constants of less than 3 and a thickness of about 400 nm were obtained (cf page 3, line 17 to page 4, line 9; page 28, lines 8 to 19; page 29, Table 1). The thickness variation of the films is however not disclosed in D1.

5.2 The dielectric films according to the claim differ therefore from the ones disclosed in document D1 in that they have a thickness variation over a single substrate of less than 1% and that the method by which

- these films are obtainable comprises baking the resin coated substrates at least two times at successively higher temperatures.
- 5.3 It has been argued by the appellant that a thickness variation of less than 1% was previously not attainable. Document D5, a copy of a web page from a research group of the University of Köln submitted by the appellant during the oral proceedings, discloses that the chemical mechanical polishing method (CMP) was introduced in the 80's by IBM. This method enabled perfectly planar surfaces to be achieved, a key feature in the fabrication of VLSI integrated circuits. The document further discloses that with CMP a planarity of about ± 20 nm was attainable (cf bottom of page 3 and page 7, last paragraph).
- 5.4 The present application discloses however dielectric films with a thickness between about 300 and 700 nm and having a thickness variation of less than 1% (cf eg Table 7). This implies a thickness variation in the range of 3 to 7 nm, a value well below the one disclosed in D5.
- 5.5 The board is therefore satisfied that, absent evidence to the contrary, document D1 does not even implicitly disclose a thickness variation of less than 1%.
- 5.6 Documents D2 and D4, on the other hand, disclose neither dielectric films obtained from an organohydridosiloxane resin nor the thickness variation of these films.

5.7 It follows from the above that the dielectric film of the claim is new.

6. *Inventive step (Article 56 EPC)*

6.1 The board agrees with the appellant that, having regard to the differences indicated in point 5.2 above, the objective technical problem addressed by the invention is to provide low dielectric constant films having a high degree of planarity.

6.2 Document D4 discloses spin-coating a solution of siloxane in alcohol on a substrate, baking the substrate at three successively higher temperatures (100°C, 160°C and 250°C) and then curing it in an inert atmosphere at about 420°C. The cured dielectric film had typically a thickness of about 300 nm. Although neither the thickness variation nor the planarity of these films is explicitly disclosed, it is stated that the upper surface of the films is essentially planar. However, although the overall thickness of the layer is uniform across the semiconductor wafer, it tended to be slightly thinner towards the edge. After the film had been cured, the wafer was mounted in an RIE tool for a planarization etchback (cf column 3, line 62 to column 4, line 11; column 4, lines 19 to 23; column 4, lines 24 to 25).

6.3 A 1% thickness variation for the typically 300 nm thick films disclosed in document D4 would be about ± 3 nm. This value is well below the ± 20 nm disclosed in D5 for the CMP method disclosed therein which enabled 'perfectly planar' surfaces to be obtained. Moreover, the mention in document D4 that the films were merely

'essentially planar' and that they were slightly thinner towards the edge suggests strongly that such an extreme degree of planarity was not achieved and even not required, since the films thus obtained were etched back by RIE. For this application the planarity required had to be sufficient to allow the RIE process to start, but not necessarily a planarity of about ± 3 nm.

6.4 The board concludes therefore that document D4 does not disclose a way of obtaining dielectric films having a thickness variation of less than 1%. The person skilled in the art would not have considered its disclosure as relevant for solving the problem posed at point 6.1 above.

6.5 Consequently, the board judges that the dielectric film according to the claim involves an inventive step within the meaning of Article 56 EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent with the following documents:

Claim 1, description pages 1, 1A, 2 to 24, submitted as sole request during the oral proceedings.

Registrar:

Chair:

D. Meyfarth

R. G. O'Connell