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D E C I S I O N
of 13 November 2002

Case Number: T 0770/01 - 3.4.2
Application Number: 96305593.4
Publication Number: 0762215
IPC: G03F 9/00, G03F 7/20

Language of the proceedings: EN

Title of invention:

Surface position detecting method and apparatus and scanning
exposure method and apparatus

Applicant:

CANON KABUSHIKI KAISHA

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 56, 56

Keyword:

"Main request - novelty (yes, after amendment)"

"Main request - inventive step (yes)"

Decisions cited:

-

Catchword:

-



Case Number: T 0770/01 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 13 November 2002

Appellant: CANON KABUSHIKI KAISHA
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Tokyo (JP)

Representative: Beresford, Keith Denis Lewis
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 16 January 2001
refusing European patent application
No. 96 305 593.4 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: A. G. Klein
Members: A. G. M. Maaswinkel
G. E. Weiss

Summary of Facts and Submissions

I. The appellant (applicant) lodged an appeal against the decision of the examining division refusing European patent application No. 96 305 593.4 (publication No. 0 762 215).

In the decision under appeal, the examining division referred *inter alia* to the following documents:

D2: US-A-5 194 893

D3: US-A-5 118 957

D4: EP-A-0 585 041

and held that the subject matter of claim 1 of the main request then on file, and on which the appellant had expressly requested a decision, was not new (Articles 52(1) and 54 EPC) over the implicit disclosure of document D2 and in any case did not involve an inventive step (Articles 52(1) and 56 EPC) with regard to the combination of the disclosure of any of documents D3 or D4 with the teaching of document D2.

II. In reply to a communication from the board annexed to summons to attend oral proceedings, the appellant filed a new set of claims according to a main and a first and a second auxiliary request and subsequently replaced the documents according to the main request by a new set of amended claims 1 and 2 and a new set of description pages 1 to 34 filed with the letter dated 25 September 2002, the text of claim 1 on page 36 according to the main request being then replaced by an amended page 36 filed with the letter dated 4 November

2002. The appellant requested that the decision under appeal be set aside and a patent be granted on the basis of the main request or, alternatively, on the basis of the first or the second auxiliary request. The appellant also requested cancellation of the oral proceedings in the event that the board considered the main request to be allowable.

III. The wording of claims 1 and 2, the only claims according to the main request, reads as follows:

" 1. An exposure method for transferring a pattern from a reticle (2) to regions of a planar wafer (4) by means of a projection optical system (1), the wafer (4) having a plurality of regions and each region having a surface pattern in which areas of that region are relatively offset in a direction (Z) perpendicular to the plane of the wafer, the method comprising the steps of:

performing initial measurements of the surface position (Zjk) of the wafer in said direction (Z) at a plurality of corresponding measurement points (j, k) within each of a number of regions;

determining the position of a best exposure image plane for said surface pattern;

calculating a correction amount (Cjk) representing the difference between each measured surface position (Zjk) and the corresponding best image plane position;

storing positional information relative to said plurality of measurements points (j, k) and their respective calculated correction amounts (Cjk);

performing further surface position measurements (Zjk) at said plurality of measurement points (j, k) in each region during exposure of that region;

correcting said further surface position

measurements at each measurement point (j, k) on the basis of the stored correction amount (Cjk) corresponding to the respective measurement point; and moving the wafer in the said direction (Z) to the best exposure image plane on the basis of the corrected further surface position measurements;

wherein:

said exposure step is a scanning exposure step;

said initial measurements (Zjk) and said further surface position measurements are performed at a number of measurement points (k) which during scanning are positioned within the corresponding region at different scanning positions (j) arrayed along the scan direction;

the correction amounts (Cjk) are based on at least the difference in pattern structure among the measurement points, and the wafer motion in the said direction (Z) at each measurement point during the scan exposure of the same is performed while correcting the further surface position measurement at that measurement point on the basis of the stored correction amount (Cjk) corresponding to that measurement point (j, k);

and said best image plane position is determined taking into account the initial measurements (Zjk)."

" 2. A method of fabricating a semiconductor device comprising performing the exposure method of claim 1, and fabricating a semiconductor device from the exposed wafer."

The wording of the claims according to the auxiliary requests is not relevant for the present decision.

IV. The appellant's argumentation in support of the main

request is essentially the following:

The invention relates to a surface position detecting method and, more particularly, to a surface position detecting method applicable to a slit-scan type or scanning type exposure method for continuously detecting the position or tilt of the surface of a wafer with respect to the direction of an optical axis of a projection optical system. In the claimed invention, offset values, i.e. correction values at different points disposed along the scan direction within a shot area are detected beforehand by a surface position measurement, these offset values differing in dependence upon the pattern structure of the shot area and on the positions within the shot area at which the measurements are made. Subsequently, during the scanning exposure, the surface position at these points is measured, the measurements are corrected according to the corresponding correction values and the wafer is then moved on the basis of these corrected measurements. These features are neither disclosed in, nor rendered obvious by the prior art. In particular, document D2 discloses a scanning exposure method and teaches adjusting the wafer height on the basis of the surface position measurements, but fails to disclose correction of the surface position measurements as a function of the scan position. Document D3 concerns stepwise motion of the wafer and does not concern a scanning exposure method. It teaches producing height information at each point on the basis of which the wafer height for the next shot is then adjusted. Document D4 mentions the difference in pattern structure, but relates to a stationary exposure technique. Even the combination of these documents would not suggest the sequential correction of the

surface position measurements during the scanning exposure of the wafer according to the claimed subject matter.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request - Compliance of the amendments with Article 123(2) EPC*
 - 2.1 Claim 1 derives from a combination of the features of independent claim 4 and dependent claims 5 and 6 as originally filed, wherein the feature defining the scanning movement of the reticle and the wafer relative to the projection optical system is now expressed in the amended claim by the reference to the scanning exposure step. In addition, the resulting combination has been clarified and supplemented with features from the original disclosure, and in particular with features based on the embodiment originally disclosed with reference to the flow chart shown in Figure 7.

Amended method claim 2 includes the method of amended claim 1 and is supported by claim 8 as originally filed which was appended to original claim 4.

Accordingly, the board is satisfied that amended claims 1 and 2 of the main request comply with the requirements of Article 123(2) EPC.

- 2.2 The description has been brought into conformity with the amended claims and supplemented with a brief summary of the relevant content of documents D2, D3

and D4 to comply with the requirements of Rules 27(1) (b) and (c) EPC. Other amendments concern the correction of obvious minor errors. The board is satisfied that these amendments are not objectionable under Article 123(2) EPC.

2.3 Accordingly, the application documents as amended according to the main request meet the requirements of Article 123(2) EPC.

3. *Main request - Novelty*

3.1 Document D2 discloses an exposure method of the scanning type for transferring a pattern from a reticle to a plurality of exposure regions of a planar wafer by means of a projection optical system (column 3, lines 1 to 37 and Figure 1), each exposure region having a surface pattern (column 6, lines 63 and 64 and Figure 3B). The surface position of the wafer at a plurality of measurement points within each of the exposure regions is measured during the scanning exposure of the wafer to determine the inclination and the position of the exposure region being exposed (column 6, lines 28 to 37, and column 6, line 57 to column 7, line 19, and Figures 3A and 3B). The inclination of the wafer and its position along the optical axis of the projection optical system is then controlled during exposure so as to bring the wafer exposure region to be exposed into coincidence with the best exposure image focal plane (Figures 4A to 4C and column 3, lines 38 to 54, column 6, lines 41 to 56, and column 7, line 33 to column 8, line 13).

The document, however, does not disclose the features of the subject matter of claim 1 relating to the

calculation of the correction amounts on the basis of a surface position measurement performed on the wafer prior to exposure of the same, the correction during exposure of the wafer of a further surface position measurement on the basis of the correction amounts previously calculated, and the surface position measurement at measurement points which during scanning are positioned within each exposure region at different scan positions arrayed along the scan direction.

- 3.2 Documents D3 and D4 disclose methods for precisely detecting surface positions in a patterned wafer. A number of steps defined in claim 1 (*performing initial measurements of the surface position, determining the position of a best exposure image plane, calculating a correction amount, storing positional information, performing further surface position measurements, correcting the further surface position measurements, and moving the wafer*) are also included in the methods disclosed in these documents (see document D3, abstract and the disclosure with reference to Figures 1, 4 to 8 and 12, and in particular column 6, lines 27 to 68, column 9, line 18 to column 10, line 55, and column 12, lines 22 to 33; and document D4, abstract and the embodiment disclosed on page 14, line 3 to page 21, line 53 with reference to Figures 22 to 29).

However, while in claim 1 the surface position measurement and the corrected exposure process are both carried out *while scanning the wafer*, in both documents D3 and D4 they are carried out following a *step-and-repeat technique*.

- 3.3 The remaining documents on file do not come closer to the subject matter of claim 1 than documents D2, D3

and D4.

3.4 Accordingly, the subject matter of claim 1 according to the main request is novel within the meaning of Article 54 EPC over the prior art documents on file. The same conclusion applies to claim 2 according to the main request since the claim is directed to a method of fabricating a semiconductor device comprising, *inter alia*, performing the exposure method of claim 1.

4. *Main request - Inventive step*

4.1 The invention is primarily directed to the correction of the exposure process in a mask-to-wafer transfer exposure method of the scanning type (page 1 of the application, lines 5 to 14). Since document D2 already concerns the correction of the exposure process in a mask-to-wafer transfer exposure method of the scanning type and the exposure methods disclosed in documents D3 and D4 are not of the scanning but of the step-and-repeat type, in accordance with established practice of the Boards of Appeal (see "Case Law of the Boards of Appeal of the European Patent Office", 4th edition, 2001; Chapter I, section D-3, and in particular subsection 3.4), the board considers document D2 to represent the most appropriate starting point for the assessment of inventive step according to the problem-solution approach.

4.2 The exposure method defined in claim 1 differs from the exposure method disclosed in document D2 essentially in the features identified in the second paragraph of point 3.1 above. According to the disclosure of the application, these distinguishing features have the effect of correcting the defocus of portions of the

exposure regions of the wafer (Figure 4A and page 3, line 13 to page 4, line 1, and page 4, line 22 to page 6, line 1) caused by the presence of surface steps in the pattern structure of the exposure regions or shots already present in the wafer before exposure (Figure 3 and page 12, lines 11 to 13, and page 14, lines 5 to 7), thus improving the operation of continuously determining and correcting during scanning exposure the position of the portion of the exposure region being exposed with respect to the best exposure image plane (page 2, lines 15 to 22, and page 6, lines 11 to 16).

Accordingly, the objective problem solved by the exposure method defined in claim 1 with regard to document D2 may be seen in bringing the portion of the wafer surface to be exposed into registration with the exposure image plane when the wafer includes a plurality of exposure regions or shots previously formed thereon all having the same stepped surface pattern structure.

- 4.3 Although the problem formulated above is apparent in the disclosure of D2, this document explicitly teaches to carry out the correction of the position of the wafer during exposure *without* influence from the wafer surface pattern (see column 6, lines 60 to 64).

On the other hand, the problem formulated above has been considered in document D3 (column 2, lines 17 to 62, column 4, lines 34 to 36, column 6, lines 3 to 18, and column 13, lines 46 to 61) and in document D4 (page 2, lines 36 to 40, and page 3, lines 4 to 7) and solved in both documents according to a correction method similar to that of the method

defined in claim 1 and involving in particular an initial process of surface position measurement and of correction calculation carried out before exposure and a process of correction of the surface position measurement performed on the wafer during exposure of the same (see the respective passages of these documents cited in point 3.2 above).

However, in the step-and-repeat exposure method according to each of documents D3 and D4 the position of the wafer during exposure of each of the exposure regions previously formed on the wafer is corrected so that the whole exposure region to be exposed is brought into registration with the exposure image plane (D3, column 10, lines 38 to 55 and flow chart shown in Figures 12A and 12B, and D4, page 21, lines 10 to 18). In addition, contrarily to these prior art documents, in claim 1 the measurements are performed at points which during scanning are positioned within the corresponding exposure region at different scan positions arrayed along the scan direction and the position of the wafer in the direction perpendicular to the wafer surface at each of the measurement points is corrected during scanning exposure on the basis of the corrected further surface position measurement at that measurement point, so that the position of the wafer is sequentially corrected as the exposure region is being exposed and the exposure image area reaches the measurements points arrayed within the exposure region along the scan direction. Therefore, even if it were assumed that the skilled person seeking to solve the problem formulated above would have considered the application of the correction method disclosed in any of documents D3 and D4 to the scanning exposure method disclosed in document D2, he would not have arrived at

the method defined in claim 1. On the contrary, the application of the teaching of any of documents D3 and D4 to the exposure method of document D2 would result in an exposure method in which each exposure region previously formed in the wafer is brought into position for exposure and is then kept in such a position during the scanning exposure of the same, and not to an exposure method as claimed requiring during scan exposure the sequential correction of the position of the exposure region at each of a set of positions arrayed along the scan direction.

In addition, no teaching or suggestion can be found in any of documents D2, D3 and D4 that would have prompted the skilled person to further improve the combination of document D2 with any of documents D3 or D4 so as to arrive at the exposure method of claim 1.

For this reason, the method defined in claim 1 involves an inventive step over prior art documents D2, D3 and D4.

The remaining citations on file do not come closer to the claimed subject matter than documents D2, D3 and D4 and in the board's view they offer no reason to question the inventive step of the subject matter of claim 1.

- 4.4 In view of the foregoing, the board is of the opinion that the subject matter of claim 1 of the main request involves an inventive step within the meaning of Article 56 EPC with regard to the prior art on file. The same conclusion applies to claim 2 of the main request as the method defined in this claim includes the exposure method of claim 1.

5. Accordingly, the board concludes that the application documents according to the appellant's main request meet the requirements of the EPC and a patent can be granted on the basis thereof.

6. *Subsidiary requests*

Since the application documents according to the main request are allowable, the scheduled oral proceedings were cancelled. In addition, consideration of the application documents amended according to the appellant's auxiliary requests is not necessary.

Order

For these reasons it is decided:

1. The decision under appeal is set aside.
2. The case is remitted to the examining division with the order to grant a patent on the basis of the following application documents:
 - claim 1 (first part) on page 35 and claim 2 according to the main request as filed with the letter dated 25 September 2002, and claim 1 (second part) on page 36 as filed with the letter dated 4 November 2002;
 - description pages 1 to 34 as filed with the letter dated 25 September 2002; and
 - drawing sheets 1/10 to 10/10 as originally filed.

The Registrar:

The Chairman:

P. Martorana

A. G. Klein