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Datasheet for the decision of 17 October 2007

Case Number: T 0892/05 - 3.4.03

Application Number: 02258293.6

Publication Number: 1318431

IPC: G03F 7/20

Language of the proceedings: EN

Title of invention:
Lithographic apparatus, device manufacturing method, and method of manufacturing an optical element

Applicant:
ASML Netherlands B.V.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 54

Keyword:
"Novelty (yes)"
"Inventive step (yes)"

Decisions cited:
T 0943/93, T 0464/94

Catchword:
-

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Case Number: T 0892/05 - 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 17 October 2007

Appellant: ASML Netherlands B.V.
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Representative: Leeming, John Gerard
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 7 December 2004 refusing European application No. 02258293.6 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: E. Wolff
Members: V. L. P. Frank
U. Tronser

Summary of Facts and Submissions

I. This is an appeal from the refusal of European patent application 02 258 293 for lack of novelty (Article 54 EPC).

II. In oral proceedings before the board the appellant applicant filed an amended main claim request and an adapted description.

The independent claims of this request are as follows:

"1. A lithographic projection apparatus comprising:

- a radiation system (IL) for providing a projection beam of radiation;
- a support structure (MT) for supporting patterning means, the patterning means serving to pattern the projection beam according to a desired pattern;
- a substrate table (WT) for holding a substrate;
- a projection system (PL) for projecting the patterned beam onto a target portion of the substrate;

characterized in that at least one component in said apparatus that in use experiences a heat load is made of a low-CTE material having a coefficient of thermal expansion having a zero-crossing at a temperature (B) between the temperature (A) of the final polishing and figure-checking step and the mean operating temperature (C) of that component."

"8. A device manufacturing method comprising the steps of:

- providing a substrate (W) that is at least partially covered by a layer of radiation-sensitive material;
- providing a projection beam (PB) of radiation using a radiation system (IL);
- using patterning means (MA) to endow the projection beam with a pattern in its cross-section;
- projecting the patterned beam of radiation onto a target portion of the layer of radiation-sensitive material,

characterized in that at least one component in said apparatus experiencing a heat load has a mean operating temperature (C) and is made of a low-CTE material such that the CTE zero crossing temperature (B) of said low-CTE material is between the temperature (A) of the final and figure-checking step of said component and said mean operating temperature (C)."

"9. A method of manufacturing an optical element that will, in use, experience a heat load and will be operated at a mean operating temperature (C), the method comprising the steps of:
selecting a low-CTE material having a zero-crossing of its coefficient of thermal expansion at a first temperature (B);
manufacturing at least said optical element using said selected low-CTE material and performing a final polishing and figure-checking step at a second temperature (A);
characterized in that:
said first temperature (B) is between said second temperature (A) and said mean operating temperature (C) so as to minimize surface deformation of said optical

element due to a change in temperature thereof from said second temperature (A) to said mean operating temperature (C)."

Claims 2 to 7 are dependent on claim 1.

III. The following prior art document was cited in the examination procedure:

D6: WO 01/07967 A

IV. In the decision under appeal the examining division found that the apparatus of claim 1 was not new over the disclosure of D6. This document disclosed a photolithography apparatus in which a component was made of a material having its coefficient of thermal expansion (CTE) centred about zero at the operating temperature. The "centred about zero" condition comprised a zero-crossing of the CTE. As the mean operating temperature and the manufacturing temperature could only be determined within a margin of error, the implementation of D6 would inevitably lead in a high percentage of cases to an apparatus having optical components which could have been manufactured at a temperature slightly above the CTE zero-crossing temperature and which could have been operated at a temperature slightly below said CTE zero-crossing temperature.

V. The appellant applicant argued essentially as follows:

– According to the present invention, a component of a lithography apparatus that experiences a heat load in use was made of a material having a low

coefficient of thermal expansion chosen such that its coefficient of thermal expansion had a zero crossing at a temperature (B) that was between the temperature (A) at which the component was made and the mean operating temperature (C) of the component in use. Thus the thermal distortion that occurred as the temperature of the component went from A to B was (at least partly) reversed as the temperature went from B to C, thereby minimising the net distortion at the mean operating temperature. This was neither disclosed nor suggested in the cited prior art.

– In D6, the desirable thermal properties of the glass to be used for the mask substrate were such that the glass wafer had a coefficient of thermal expansion centred about zero at the operating temperature. The phrase "centred about zero" was not entirely clear, as it could mean that at the operating temperature the CTE had a zero crossing or a maximum or a minimum at zero.

– The only relevant teaching that could be clearly and unambiguously derived from D6 was that the coefficient of thermal expansion of the glass used in the mask substrate should be zero (or within a narrow range of zero) at the operating temperature of the mask. There was no clear and unambiguous disclosure that the CTE should have a zero crossing nor that the zero crossing should be at a temperature between the temperature referred to as the manufacturing temperature of the component and the mean operating temperature of that component.

The teaching of D6 was therefore contradictory to that of the present invention.

VI. The appellant applicant requests that the decision under appeal be set aside and that a patent be granted on the basis of:

Claims: 1 to 9 as submitted during the oral proceedings,

Description: pages 1 to 4 and 7 to 10 as originally filed,
pages 5 and 6 as filed with the letter dated 10 September 2007,

Drawings: sheet 1/1 as originally filed.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

2.1 The expression "temperature of the final polishing and figure-checking step" replaces the expression "manufacturing temperature" originally used in the claims (column 9, lines 24 to 29 of the published application).

2.2 In claim 9 the erstwhile expression "selecting a low-CTE material having a zero coefficient of thermal expansion" is replaced by "selecting a low-CTE material having a zero-crossing of its coefficient of thermal

expansion" (column 4, lines 27 to 31 of the published application), so that this claim is properly supported by the description.

2.3 The board is satisfied that the requirements of Article 84 and 123(2) EPC are fulfilled.

3. *Novelty (Article 54 EPC)*

3.1 Document D6 discloses, in the words of claim 1, the features of its preamble, namely a lithographic projection apparatus 20 comprising a radiation system 40, a support structure for a mask 22, a substrate table 48 and a projection system 46 (pages 5 to 7 and Figure 1). It further discloses that the mask support structure is made of a Ti doped high purity SiO_2 glass wafer, a material having a low coefficient of thermal expansion (CTE), and that the Ti dopant is adjusted such that the glass wafer has a CTE centred about zero at the operating temperature. The choice of adjusting the Ti concentration so that the CTE is zero at the operating temperature has the effect that the mask support structure does not deform when subjected to small temperature variations about the operating temperature. The mask support structure therefore does not require cooling (page 7, lines 11 to 14; page 8, lines 11 to 25; page 10, lines 1 to 8; Figure 8).

3.2 In contrast, the present application requires that the material of which an optical component of the lithographic apparatus is made has a CTE having a zero-crossing at a temperature lying between the temperature of the final polishing and figure-checking step, in the following called for short "the manufacturing

temperature", and the mean operating temperature of the component. If, as will generally be the case, the CTE is negative below the zero-crossing temperature and positive above, then as the temperature of the component changes from its manufacturing temperature to its operating temperature, the component will deform initially but those deformations will be reversed on the other side of the zero-crossing temperature (page 5, 2nd paragraph of the originally filed application and Figures 2 and 3). A CTE which is positive below the zero crossing temperature and negative above it would provide the same compensatory effect. Therefore, by choosing a material with a CTE having a zero crossing between the manufacturing and operating temperatures, the thermal deformation of the component when in operation is minimized or eliminated.

3.3 The board is satisfied that, as argued by the appellant applicant, the manufacturing temperature and the mean operating temperatures are both well defined temperatures for a particular photolithographic apparatus. The manufacturing temperature, i.e. the temperature at which the final polishing and figure-checking step of the optical component is carried out, can be determined by checking the surface roughness of the component at different temperatures. The overall surface roughness will be at a minimum at the manufacturing temperature, since due to inevitable inhomogeneities in the material's composition, each region of its surface will expand or contract differently depending on its composition, leading to an increased roughness at temperatures other than the one of the final polishing step. In respect of the mean operating temperature of the component, the appellant

applicant had argued that this meant the spatial temperature average over the given component. The board accepts that owing to the large mass and heat capacity of the glass of which the component is made, its operating temperature is for practical purposes fixed as different operating conditions would cause it to vary very little, if at all. The board therefore concludes that both these temperatures can be accepted as apparatus features characterizing the photolithographic apparatus of claim 1.

3.4 The argument used by the examining division to establish lack of novelty was essentially this: The manufacturing and mean operation temperatures of a photolithographic apparatus could only be determined within corresponding ranges. Even though D6 explicitly disclosed that the component's CTE was chosen to be zero at the operating temperature this had to be construed such that in fact this temperature could be above or below the operating temperature due to the unavoidable variations of the operating temperature. This would lead, in a high percentage of cases, to an apparatus having optical components which could have been manufactured at a temperature slightly above the CTE zero-crossing temperature and which could have been operated at a temperature slightly below said CTE zero-crossing temperature (reasons, point 7; emphasis added by the board)

However, this line of reasoning leads to the conclusion that the explicit disclosure of D6 takes away the novelty of any situation in which the CTE's zero is set deliberately either above or below the operating temperature, ie at another temperature than the one

explicitly disclosed. Thus the disclosure of A=B would take away the novelty of A>B and A<B. This is clearly an absurd consequence showing that this argument cannot be followed.

3.5 Moreover, the disclosure in document D6 that the component's material should be chosen so that its CTE is centred about zero at the operating temperature of the component encompasses, as the appellant applicant correctly argued, not just a zero-crossing of the CTE, but also a maximum or minimum of the CTE touching zero at the operating temperature. Although the examining division acknowledged this, the division failed to follow the principle that a generic disclosure does not take away the novelty of a specific example (decision under appeal, reasons point 6; Guidelines C-IV.7.4). Thus, even if the board were to accept the argument, which it does not, that the apparatus of D6 might inadvertently be operated at a temperature which did not coincide with the CTE zero such that the zero fell between the manufacturing temperature and the operating temperature, thereby depriving the claim of novelty, the absence of any indication in document D6 whether the zero was a crossing or a maximum or a minimum means that the choice of a material having a CTE with a zero crossing is in this sense a specific selection from among three possible alternatives.

3.6 It is moreover the established jurisprudence of the boards of appeal that for an invention to lack novelty its subject-matter must be clearly and directly derivable from the prior art (Case Law of the Boards of Appeal, 5th ed. 2006, I.C.2 and 2.1). It is not justified to decide whether a document is prejudicial

to novelty on the basis of probability (T 464/94, reasons point 16) and "a hypothetical possibility of operating within the claimed region *per se* is legally not sufficient to destroy the novelty of this region, particularly if the skilled person has no technical motive and there exists no practical necessity to work within this region" (T 943/93, reasons point 2.5).

3.7 The board judges therefore that the photolithographic apparatus of claim 1 is new over the disclosure of document D6. As claims 8 and 9 are directed to a manufacturing method and a method of manufacturing an optical element, respectively, in which the relations between the CTE's zero-crossing, the "manufacturing" and the operating temperatures are the same as in claim 1, the subject-matter of each of these claims is also new for the same reasons.

4. *Inventive step (Article 56 EPC)*

4.1 As already explained above, document D6 discloses the use of a material having a CTE which is centred about zero at the operating temperature so that variations about this temperature do not alter the component's shape. The present application, on the other hand, goes another way by allowing deformations of the component when going from the "manufacturing" to the operating temperature. Choosing the zero-crossing of the CTE to lie between the manufacturing temperature and the mean operating temperature has the effect that the deformations below and above the zero-crossing temperature compensate each other at least in part. This allows the component to have the same or at least nearly the same shape at the operating temperature and

at the temperature at which it was polished and figure-checked.

4.2 Although the general problem of achieving components with a high precision shape is always present in the mind of the skilled person in the field of photolithography, the specific solution of employing a material with a CTE zero-crossing point chosen to result in consecutive, at least partly compensating deformations is not suggested in the prior art.

4.3 For this reason it is the judgement of the board that the photolithographic apparatus of claim 1 involves an inventive step. For the reasons set out in connection with assessing novelty, the same applies with respect to the methods claimed in claims 8 and 9.

Order

For these reasons it is decided that:

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:

Claims: 1 to 9 as submitted during the oral proceedings,

Description: pages 1 to 4 and 7 to 10 as originally filed,
pages 5 and 6 as filed with the letter dated 10 September 2007,

Drawings: sheet 1/1 as originally filed.

Registrar Chair

S. Sánchez Chiquero E. Wolff