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Datasheet for the decision of 16 December 2014

Case Number: T 1468/10 - 3.4.01

Application Number: 02748067.2

Publication Number: 1402542

IPC: G21K1/06, G02B5/28, G02B1/10

Language of the proceedings: EN

Title of invention:
PASSIVATING OVERCOAT BILAYER

Patent Proprietor:
EUV Limited Liability Corporation

Opponent:
Carl Zeiss SMT GmbH

Headword:

Relevant legal provisions:
EPC Art. 123(2)
EPC 1973 Art. 84

Keyword:
Amendments - added subject-matter (yes) (main request)
Claims - clarity (no) (subsidiary requests)

Decisions cited:

Catchword:

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Case Number: T 1468/10 - 3.4.01

D E C I S I O N
of Technical Board of Appeal 3.4.01
of 16 December 2014

Appellant: (Patent Proprietor)	EUV Limited Liability Corporation 2200 Mission College Boulevard Santa Clara, CA 95052 (US)
Representative:	Richards, John Ladas & Parry LLP Temple Chambers 3-7 Temple Avenue London EC4Y 0DA (GB)
Respondent: (Opponent)	Carl Zeiss SMT GmbH Rudolf-Eber-Strasse 2 73447 Oberkochen (DE)
Representative:	Schultz, Jörg Martin Carl Zeiss AG Patentabteilung Carl-Zeiss-Strasse 22 73447 Oberkochen (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 15 April 2010 revoking European patent No. 1402542 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman	G. Assi
Members:	H. Wolfrum
	C. Schmidt

Summary of Facts and Submissions

I. The contested European patent No. 1 402 542 arises from European patent application EP 02 748 067.2, published as international application WO-A-03/005377.

II. The opposition was based on the grounds of Articles 100(a) EPC 1973 for lack of novelty and inventive step as well as on Article 100(c) EPC 1973.

III. By decision dispatched on 15 April 2010 the opposition division revoked the patent under Article 100(c) EPC 1973 with regard to the claims of the patent as granted and under Article 101(3)(b) EPC 1973 for the reasons of added subject-matter (Article 123(2) EPC) as well as lack of novelty and inventive step (Articles 52(1), 54(1) and (2) and 56 EPC 1973) of the claims of a subsidiary request then on file.

IV. The appellant (patent proprietor) lodged an appeal against this decision. The notice of appeal was received on 14 June 2010 and the prescribed fee was paid on the same day. On 24 August 2010 a statement of grounds of appeal was filed, in which the appellant requested that the contested decision be set aside and the patent be maintained in amended form. To this effect, the appellant filed a new set of claims 1 to 8 as sole request.

V. The respondent (opponent) announced by letter of 3 February 2011 that it did not intend to comment any further on the matter. The respondent did not submit any requests.

VI. Making use of the discretion conferred by Article 116(1) EPC 1973, the Board summoned the parties on 23 July 2014 to oral proceedings. In an annex to the summons pursuant to Article 15(1) RPBA, the Board noted that before the matters of novelty and inventive step (Articles 52(1), 54(1) and (2) and 56 EPC 1973) could be addressed, questions concerning the basis of disclosure (Article 123(2) EPC) and clarity (Article 84 EPC 1973) required attention.

VII. In response, the appellant filed by letter of 6 November 2014 amended sets of claims according to a main request and two subsidiary requests.

VIII. Oral proceedings were held on 16 December 2014 in the absence of the respondent. The sole point of debate for the main request was the question of added subject-matter (Article 123(2)). For the subsidiary requests questions of clarity (Article 84 EPC 1973) of the amendments made were discussed.

IX. The appellant requested that the decision under appeal be set aside and that the patent be maintained in amended form on the basis of the main request or one of the two subsidiary requests, as filed on 6 November 2014.

X. Claim 1 of the appellant's **main request** reads as follows :

"*1. A passivating overcoat bilayer on a multilayer reflective coating designed for use in extreme ultraviolet or soft x-ray applications, comprising:*

a multilayer reflective coating comprising a plurality of alternating layers of a spacer material (44) and an absorber material (46), wherein said multilayer reflective coating comprises a topmost layer (44) having

a top surface and a bottommost layer having a bottom surface, wherein said topmost layer (44) comprises said spacer material, said spacer material being silicon;

a substrate, wherein said bottom surface of said multilayer reflective coating is deposited on said substrate;

a bottom overcoat layer (40) deposited on said top surface of said multilayer reflective coating; and

a top overcoat layer (42) deposited on said bottom overcoat layer, wherein said bottom overcoat layer comprises a first material that prevents diffusion of said top overcoat layer into said topmost layer of said multilayer reflective coating, wherein said first material is B4C, the bottom overcoat layer of B4C being at least 0.6 nm thick to prevent diffusion of said top overcoat layer into said top layer of said multilayer reflective coating, wherein said top overcoat layer comprises a second material that resists oxidation and corrosion and protects said multilayer reflective coating from oxidation, wherein said second material is Ru, wherein said top overcoat layer and said bottom overcoat layer of said overcoat bilayer have optimum thicknesses selected such that reflectance of extreme ultraviolet or soft x-ray wavelengths is optimized at the wavelength range of operation by adjusting the thickness of the overcoat bilayer to provide the best phase matching with the underlying multilayer coating in order to achieve the highest EUV reflectance while maintaining the highest oxidation resistance, and resistance to oxidation and corrosion as well as the prevention of diffusion of said top overcoat layer into said topmost layer made of silicon of said multilayer reflective coating are selected to preserve such reflectance."

Independent claim 6 is directed to a "*method for forming a passivating overcoat bilayer on a multilayer*

reflective coating designed for use in extreme ultraviolet or soft x-ray applications", the bilayer and coating being provided with the structure and properties defined in claim 1.

Claims 2 to 5, 7 and 8 are dependent claims.

Claim 1 of the **first subsidiary request** differs from claim 1 of the main request only in that the phrases "*comprises said spacer material*" and "*comprises a first material*" the term "*comprises*" has been replaced by the expression "*consists of*". A corresponding amendment has been made to method claim 6.

Claim 1 of the **second subsidiary request** differs from claim 1 of the first subsidiary request by the addition of the feature "*and said absorber material being molybdenum*" as complement to the phrase "*said spacer material being silicon*". A corresponding amendment has been made to method claim 5.

Reasons for the Decision

1. In the light of the entry into force of the EPC 2000, reference is made to Article 7(1), 2nd sentence of the Revision Act of 29 November 2000 ("Act revising the Convention on the Grant of European Patents (European Patent Convention) of 5 October 1973, last revised on 17 December 1991") and the transitional provisions for the amended and new provisions of the EPC (Decision of the Administrative Council of 28 June 2001), from which it may be derived which Articles of the EPC 1973 are still applicable and which Articles of the EPC 2000 shall apply.

2. The appeal is admissible.

3. Although having been duly summoned, the respondent did not attend the oral proceedings. In accordance with Rule 115(2) EPC and Article 15(3) RPBA, the proceedings were continued without that party.

4. Appellant's main request - added subject-matter

4.1 In the present case, the only pieces of disclosure in the originally filed application documents which refer to a "*passivating overcoat bilayer*" on a "*multilayer reflective coating*" having the exact sequence of layers and their respective properties as defined in claim 1 under consideration are provided by Figures 4A and 6 and their corresponding description.

Figure 4 shows a layer "*40*" of B_4C as the "*bottom overcoat layer*" of the "*passivating overcoat bilayer*" underlying the "*top overcoat layer*" "*42*" of Ru and overlying the topmost layer "*44*" of the "*multilayer reflective coating*", which is a layer that consists of Si and is named "*spacer layer*".

Figure 6 shows the results of reflectance measurements over a wavelength range of operation around 13.4 nm for a Ru - B_4C - Si layer system in comparison to those for a Ru - Mo layer system.

4.2 In distinction thereto, claim 1 of the main request on file specifies that the "*bottom overcoat layer*" of the "*passivating overcoat bilayer*" "*comprises a first material ..., wherein said first material is B4C*" [emphasis added].

This definition allows for the presence of additional materials (or even of supplementary sub-layers) making up the said "*bottom overcoat layer*" of the

"*passivating overcoat bilayer*" and includes for instance a material mix of which B_4C could be but one component.

Similarly, claim 1 defines that "*said topmost layer (44) comprises said spacer material, said spacer material being silicon*" [emphasis added] and thus allows for other materials than the "*spacer material*" Si to be present.

4.3 Therefore, the definitions in question constitute generalizations of the specific arrangement of a passivating overcoat bilayer on a multilayer reflective coating structure as it is disclosed by the originally-filed description.

4.4 According to the appellant, the use of the term "*comprises*" for both the B_4C layer and the Si layer was justified in view of claim 12 as originally filed, which reads :

"*12. The overcoat bilayer of claim 1 or 2, wherein said bottom layer comprises B4C, wherein said top layer of said multilayer coating comprises silicon.*" and thus provided a proper basis of disclosure for the claim definitions in question. Moreover, according to page 5, lines 16 to 18, of the originally-filed and published description, other materials apart from B_4C and even compounds could form the bottom overcoat layer.

In fact, the application documents as a whole had to be taken into consideration, including all the implicit information which a skilled person would have immediately gathered from reading the application.

4.5 Of course, when assessing the basis of disclosure for an amendment made to a claim, all elements of the originally-filed application documents (*i.e.* claims, description and drawings) have to be taken into

consideration. This does not mean however, that separate pieces of information can be combined arbitrarily. Rather, it has to be ascertained, whether combining information from one part of the application documents with that given in another part would at least be implicit to a skilled reader of the application documents.

Thus, contrary to the appellant's view, although the originally-filed claims certainly form part of the original disclosure, the bits of information provided therein cannot necessarily and unconditionally be applied to other pieces of disclosure contained for instance in the description or in the drawings.

In the specific circumstances of the present case, it has therefore to be ascertained whether the aforementioned generalizations would have readily occurred to a skilled person when reading those parts of the original description on which the subject-matter of present claim 1 is based, *i.e.* that of Figures 4A and 6.

It is apparent from the description of the said figures that each of the individual layers defined in claim 1 serves a specific purpose but at the same time inevitably interacts chemically (*eg* via diffusion) and physically (by influencing the reflectance) with its neighbouring layers. In fact, the choice of Ru for the top layer of the overcoat bilayer to resist oxidation and corrosion (which choice is not the subject of original claim 12, to which the appellant has made reference as justification for the claimed generalisation) ensues a loss in reflectance due to diffusion of Ru and Si and the formation of ruthenium silicide (page 7, lines 18 to 20 of the application as filed and published). This problem is overcome by the provision of an intervening layer of

B_4C having a minimum thickness of 0.6 nm (page 8, line 21 to page 9, line 2 of the application). The skilled reader of the application as originally filed thus realizes immediately that a top layer of Ru causes a specific problem with a spacer layer of Si as the topmost layer of the multilayer reflective coating and that this problem is solved by the provision of a layer of B_4C acting as a diffusion barrier between Ru and Si. It is correct that the presence of other materials than B_4C and Si for the bottom overcoat layer and the spacer layer, respectively, is formally comprised in the definition of original claim 12. However, once the choice of Ru has been made for the top layer of the overcoat bilayer, there is no disclosure that materials other than B_4C and Si may also be considered for preventing the formation of ruthenium silicide.

A corresponding consideration applies to claim 6 of the main request on file.

Consequently, the main request does not comply with the requirement of Article 123(2) EPC and is therefore not allowable.

5. Appellant's subsidiary requests

5.1 Amendments

The further amendments made to the independent claims of each of the subsidiary requests overcome the objections of added subject-matter raised for the main request.

In fact, the Board is satisfied that the subject-matter of the subsidiary requests has a proper basis of

disclosure in the description of Figures 4A and 6 of the application.

5.2 Clarity

In comparison to claim 1 of the patent as granted, claim 1 of each of the subsidiary requests on file contains an amendment which provides instructions having regard to the proper selection of layer thicknesses :

"*... wherein said top overcoat layer and said bottom overcoat layer of said overcoat bilayer have optimum thicknesses selected such that reflectance of extreme ultraviolet or soft x-ray wavelengths is optimized at the wavelength range of operation by adjusting the thickness of the overcoat bilayer to provide the best phase matching with the underlying multilayer coating in order to achieve the highest EUV reflectance while maintaining the highest oxidation resistance, and resistance to oxidation and corrosion as well as the prevention of diffusion of said top overcoat layer into said topmost layer made of silicon of said multilayer reflective coating are selected to preserve such reflectance.*"

5.2.1 There is consent with the appellant that, in order to select suitable layer thicknesses for the passivating overcoat bilayer, two requirements have to be met with regard to resistance to oxidation and corrosion as well as prevention of diffusion, on the one hand, and EUV reflectance based on proper phase matching, on the other hand. These requirements happen to be in conflict with each other because a selection of layer thicknesses which improves resistance to oxidation and corrosion at the same time reduces EUV reflectance and vice versa, so that a trade-off has to be found (see page 9, lines 4-5 of the application).

However, instead of providing some guidance as to how the necessary trade-off between requirements that cannot be optimized simultaneously should be established, the systematic use of the superlative form in the cited claim passage for each requirement, *i.e.* "*optimum thicknesses selected ...*" to provide "*the best phase matching*" in order to achieve "*the highest EUV reflectance*" while maintaining the "*highest oxidation resistance*", causes confusion and renders the meaning of each one of these superlatives unclear.

Because of this ambiguity, the wording of the amendment covers virtually any situation ranging from mediocre EUV reflectance (in case the "*highest*" possible oxidation resistance was desired) to meagre oxidation resistance and high diffusion (in case the "*highest*" achievable EUV reflectance was desired). Therefore, the claim wording does not allow establishing clearly which arrangements of a passivation overcoat bilayer consisting of the same sequence of layers and materials as defined in present claim 1 would fall under the terms of the patent.

5.2.2 In addition, several of the phrases and terms of the amendment under consideration are unclear in themselves.

For instance, it is unclear from the wording of the amendment whether the thickness of each of the layers of the overcoat bilayer should be selected individually (as would be suggested by the term "*thicknesses*") or whether it would suffice to select a value for the overall thickness of the bilayer.

Moreover, the instruction of a "*phase matching with the underlying multilayer coating*" [emphasis added] is not understood. It seems plausible to assume that the

multilayer reflective coating has a given reflectance for itself (which would depend on the thicknesses of and the degree of absorption by its various layers as well as the degree of phase matching of all of the partial waves reflected at the respective layer boundaries). However, apart from the fact that no information is provided in this respect, it is not clear which consequences such information would have for a phase matching of the layers of the overcoat bilayer and, at any rate, whether such phase matching should be established for each layer of the overcoat bilayer separately or for both layers in combination.

Still further, it is unclear how "*resistance to oxidation and corrosion as well as the prevention of diffusion*" can constitute possibly selectable variables.

5.2.3 Finally, it is noted that confusion is further increased by the circumstance that the patent description provides contradictory information concerning the selection of thickness values for the overcoat bilayer so as to obtain optimum phase matching.

According to paragraph [0028] of the patent specification it would appear that optimum phase matching is achieved by a so-called "*quarter-wave stack*" for which "*the optical thickness of each layer* [which is the geometrical thickness of the layer multiplied by the refractive index n of the material concerned] *is equal to a quarter of the wavelength of interest at normal incidence*".

Such guidance as to the selection of proper layer thicknesses is however at variance with experimental results for the reflectance in a three-layer capping structure Ru - B_4C - Si (which would be followed by a

layer of Mo) as displayed in Figure 6 of the patent. For the example illustrated by Figure 6 the respective optical thicknesses of the three layers involved (*i.e.* about 1.96 nm for Ru; about 0.58 nm for B_4C; and about 3.5 nm for Si) differ substantially from the value of 3.35 nm which is the quarter of the wavelength of interest of 13.4 nm at which Figure 6 shows a maximum of reflectance.

5.2.4 To the extent that is relevant for the above lack of clarity, the appellant argued that the amendment in question had to be understood as establishing in a first step a minimum thickness, or even a thickness range, for each of the chosen materials of the overcoat bilayer to respectively achieve optimum corrosion protection and prevent diffusion. Subsequently, the reflectance at the wavelength range of operation was determined for the established thickness or thickness range of the overcoat bilayer. Finally, reflectance was optimized within the given thickness range by reducing the thickness of the overcoat bilayer until an optimum trade-off was established (see also the declaration by Mr. Eberhard Spiller, one of the inventors of the present patent, annexed to the appellant's letter of 6 November 2014).

Moreover, there was no contradiction between what was described in paragraph [0028] of the patent and what was shown by Figure 6 because paragraph [0028] made merely reference to prior art and Figure 6 concerned an unclaimed Ru/Mo capping layer structure.

5.2.5 These arguments are not convincing.

Apart from the fact that neither the patent nor the application documents as originally filed provide any information which would at least hint at the alleged

sequence of actions taken for designing the passivating overcoat bilayer, the appellant's argumentation cannot provide any clarification since determining a minimum thickness of the overcoat bilayer for corrosion resistance would not be in conformity with the claimed requirement of "*maintaining the highest oxidation resistance*" [emphasis added].

Likewise, the appellant's arguments cannot explain or resolve the inconsistencies of the patent description.

The beginning of paragraph [0028] of the patent description reads : "*As discussed in U. S Patent No. 3,887, 261, titled "Low-loss reflection coatings using absorbing materials", the best reflecting multilayer geometry is usually a quarter-wave stack, where the optical thickness of each layer is equal to a quarter of the wavelength of interest at normal incidence. (The optical thickness of a layer is the product of the geometrical or metric thickness and the refractive index of the material.) In the quarter-wave stack, the beams reflected from each interface are in phase and add constructively.*"

Thus, although a prior art document is mentioned, the paragraph describes the physics to be considered for obtaining optimum reflectance by a multilayer geometry.

Moreover, contrary to the appellant's assertion, except for the unclaimed Ru/Mo capping layer structure the three-layer capping structure Ru - B_4C - Si according to Figure 6 falls under the terms of claim 1 of each of the subsidiary requests on file, since there are no limitations as to the actual thickness of the topmost Si spacer layer.

5.2.6 For the above reasons, amended claim 1 according to each of the first and the second subsidiary request on

file does not comply with the requirement of Article 84 EPC 1973.

6. In conclusion, the Board has found that none of the appellant's requests for maintenance of the patent in amended form is allowable.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

R. Schumacher G. Assi

Decision electronically authenticated