

The opinion in support of the decision being entered today is *not* binding precedent of the Board.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte PARY BALUSWAMY

Appeal 2007-3372
Application 10/651,351
Technology Center 1700

Decided: September 11, 2007

Before BRADLEY R. GARRIS, CHARLES F. WARREN, and
PETER F. KRATZ, *Administrative Patent Judges*.

KRATZ, *Administrative Patent Judge*.

DECISION ON APPEAL

This is a decision on an appeal from the Examiner's final rejection of claims 1-4, 6-12, 14-22, and 24-30, the only claims that remain pending in this application. We have jurisdiction pursuant to 35 U.S.C. §§ 6 and 134.

Appellant's claimed invention is directed to a method for producing a pattern on a photoresist disposed on a substrate using a mask and wherein a mask pattern image is altered with a nonzero spherical aberration value.¹ The altered mask pattern image is focused at approximately mid-depth of the photoresist. Claims 1 and 11 are illustrative and reproduced below:

1. A method of producing a pattern on a photoresist, comprising:
providing a mask having a pattern defined thereon;
disposing the mask between an illumination source and a substrate having a photoresist disposed thereon;
irradiating the mask with light from the illumination source to produce a mask pattern image;
altering the mask pattern image with nonzero spherical aberration value selected to at least partially compensate for spherical aberration induced by the photoresist; and
focusing the altered mask pattern image at approximately a mid-depth of the photoresist on the substrate.

11. A method of producing a pattern on a photoresist, comprising:
disposing a mask having a pattern defined thereon between an illumination source and a substrate having a photoresist disposed thereon;
irradiating the mask with light from the illumination source to produce a mask pattern image;

¹ Appellant explains that “[s]pherical aberration is caused by using spherically shaped lenses and mirrors because truly spherical surfaces do not form sharp images” (Specification ¶ 0005). Appellant's drawing Figure 2 illustrates a prior art Example of a spherical aberration.

selecting a nonzero spherical aberration value using the equation:

$$a = \frac{(n^2 - 1) \cdot t}{8 \cdot n^3 \cdot s^4}$$

where a is the nonzero spherical aberration value of the mask pattern image, n is a refractive index of the photoresist, t is a thickness of photoresist, and s is a focal distance into the photoresist;

introducing the nonzero spherical aberration value to the mask pattern image; and

irradiating the photoresist with the mask pattern image including the nonzero spherical aberration value.

The Examiner relies on the following prior art references as evidence in rejecting the appealed claims:

Takahashi	US 5,831,715	Nov. 3, 1998
Yasuzato	US 5,935,738	Aug. 10, 1999
Nozue	US 5,432,587	Jul. 11, 1995

Claims 1-4, 9-12, 14, 15, 19-22, 24, 25, 29, and 30 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Takahashi in view of Yasuzato. Claims 6-8, 16-18, and 26-28 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Takahashi in view of Yasuzato and Nozue.

We affirm the Examiner's rejections. Our reasoning follows.

Under 35 U.S.C. § 103, the factual inquiry into obviousness requires a determination of: (1) the scope and content of the prior art; (2) the differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) secondary considerations. *See Graham v. John Deere of Kansas City*, 383 U.S. 1, 17-18, 148 USPQ 459, 467 (1966).

The analysis supporting obviousness should be made explicit and should “identify a reason that would have prompted a person of ordinary skill in the art to combine the elements” in the manner claimed. *KSR Int’l Co. v. Teleflex, Inc.*, 127 S. Ct. 1727, 1731, 82 USPQ2d 1385, 1389 (2007).
§ 103(a) Rejection over Takahashi taken with Yasuzato.

Appellant argues claims 1, 2, 4, 9 and 10 together as a group. We select claim 1 as the representative claim for this claim grouping.

The Examiner has determined that Takahashi discloses much of the representative claim 1 method step requirements but that “[t]he difference between the claims and Takahashi is that Takahashi does not disclose that the projected pattern image is focused at approximately mid-depth of the photoresist on the substrate” (Answer 4 and 5).

The Examiner further relies on Yasuzato as evidence of the obviousness of the subject matter of representative claim 1. The Examiner contends that it would have been obvious to one of ordinary skill in the art at the time of the invention “to modify Takahashi by employing the method of focusing the light to ... mid-depth of the photoresist as suggested by Yasuzato because Yasuzato, in col. 5, lines 46-54, and in col. 6, lines 1-13, discloses that increasing the depth of focus enables the precision of the pattern dimension to be enhanced” (Answer 5).

Appellant does not dispute that Takahashi taught or would have suggested the representative claim 1 method but for the focus location (approximately mid-depth of the photoresist) of the step of focusing the altered image pattern as required by appealed claim 1 (Br. 5-9; Reply Br. 2-

4).² Appellant contends that Takahashi alone or together with Yasuzato would not have taught or suggested the method of representative claim 1 to one of ordinary skill in the art at the time of the invention in light of the required approximately mid-depth photoresist focus location of the focus step.

Thus, the principal issue before us with respect to the propriety of the Examiner's obviousness rejection of claims 1, 2, 4, 9 and 10 is: Has Appellant identified reversible error in the Examiner's obviousness rejection of claims 1, 2, 4, 9, 10 by the assertions in the Briefs that Takahashi taken alone or with Yasuzato would not have taught or suggested the photoresist approximate mid-depth location for the focusing of the altered mask pattern image?

We answer this question in the negative and affirm the Examiner's obviousness rejection of claims 1, 2, 4, 9, and 10 over Takahashi taken with Yasuzato for substantially the reasons stated in the Answer. We offer the following for emphasis.

Appellant acknowledges that Yasuzato teaches a depth of focus for focusing a mask pattern image on a photoresist that is "the range in which the deviation from the focus position is permissible." (Reply Br. 3 quoting from Yasuzato, col. 1, ll. 45-49). In other words, Yasuzato teaches an increased range of deviation from an ideal focus position of a mask pattern image on a photoresist for permissible or acceptable results that allows for the precision of the pattern dimensions to be enhanced (Yasuzato, col. 5, l. 25 - col. 6, l. 7). Consequently, we are not persuaded by Appellant's

² Arguments not made in the Briefs are considered to be waived. See 37 C.F.R. § 41.37(c)(vii) (2006).

argument that one of ordinary skill in the art would not have been led to combine Yasuzato with Takahashi in a manner to arrive at the subject matter of representative claim 1 for substantially the reasons stated by the Examiner (Answer 6-8). Indeed, Takahashi's disclosure of a focus position correction means to allow for adjustment of the focus position to a best (optimum) focus position would have reasonably led one of ordinary skill in the art to an approximately mid-depth of the photoresist layer focus position upon routine experimentation by itself, much less as a result of the combined teachings of Yasuzato therewith. In this regard, we note that Takahashi recognized that the resist material should be taken into account in adjusting the spherical aberration (Takahashi, col. 1, ll. 27-48).³ This would reasonably have suggested adjusting to a focus position for the altered image projection at the photoresist that would include focus positions in the photoresist layer, including positions proximate the middle of the photoresist. After all, Takahashi's purpose in adjusting the focus position is to produce a mask pattern image in a photoresist via projection exposure. Hence, one of ordinary skill in the art would have recognized that the photoresist location of Takahashi, including a mid-depth location thereof, is clearly within the locus where the focus position of the altered mask pattern

³ Also, we note Appellant's admissions in the Specification and drawing Figures with regard to the prior art projection (focus) of an altered mask image at a resist coated substrate for compensating for spherical aberration (Specification ¶¶ 0004 -0007; Figs. 1 and 2). It is axiomatic that admitted prior art in an applicant's Specification may be used in determining the patentability of a claimed invention and that consideration of the prior art cited by the Examiner may include consideration of the admitted prior art found in an applicant's Specification. *In re Nomiya*, 509 F.2d 566, 570-571, 184 USPQ 607, 611-612 (CCPA 1975).

image best focusing position and corrections thereof taught or suggested by Takahashi would have been directed at.

Moreover, we are not persuaded by Appellant's contention that Yasuzato is not combinable with Takahashi because Yasuzato alters the wavelength of light using a mask whereas Takahashi alters the light source to modify the wave length of the light employed (Reply Br. 4; Br. 8 and 9). Appellant has not buttressed this argument with persuasive evidence establishing that one of ordinary skill in the art would have possessed less than the level of skill required to select either one or both of these known methods of light wavelength adjustment for use in photoresist pattern formation wherein the mask pattern image applied to the photoresist is adjusted for spherical aberration given the combined teachings of these references. In this regard, Yasuzato discloses that the phase shifting mask embodiments thereof are "applicable with no restriction on the exposure light and the exposing system" (Yasuzato, col. 12, ll. 38-40).

On balance, we determine that the evidence of obviousness presented by the Examiner outweighs the arguments in favor of an unobviousness holding furnished in the Briefs for the rejected claims 1, 2, 4, and 6-10.

Concerning claims 3, 11, 12, 14, 15, 19-22, 24, 25, 29, and 30, Appellant presents substantially the same argument against the Examiner's obviousness holding.⁴ Hence, we select claim 11 as the representative claim for rejected claims 11, 12, 14, 15, 19-22, 24, 25, 29, and 30 with claim 3 being separately considered in so far as the arguments made for claim 1. However, we do not find the arguments made against the Examiner's

⁴ For dependent claims 3, this argument is in addition to the arguments made with regard to the Examiner's rejection of claim 1, the claim from which claim 3 depends.

rejection of claim 3, which are based on the features thereof common with claim 1, to be persuasive for the reasons we stated above with respect to the rejection of claim 1. Thus, we focus on representative claim 11 in considering Appellant's arguments regarding rejected claims 3, 11, 12, 14, 15, 19-22, 24, 25, 29, and 30. These arguments are directed at the alleged non-obviousness of the claimed process based on the use of a specified equation for selection of a nonzero spherical aberration value that is introduced or added to the mask pattern image used in treating the photoresist (Br. 10-16; Reply Br. 4-8). This equation can be found in claim 11, reproduced above.

Regarding representative claim 11, the Examiner basically takes the position that the equation is an expression of an optimization of three known result effective factors or variables; that is, the photoresist refractive index (n), the thickness of the photoresist layer (t), and the focal distance into the photoresist (s) with the equation representing an optimization expression for assessing the spherical aberration value to be applied or introduced into the mask pattern image as a correction to the image so as to take spherical aberration of the projected mask image into account (Answer 5, 9, and 10, Takahashi, col. 3, l. 34 –col. 4, l. 5 and col. 6, ll. 25-30).

Appellant does not dispute that the photoresist refractive index and thickness would have been known or suggested to one of ordinary skill in the art as result effective variables for determining a nonzero spherical aberration correction value based on the disclosure of Takahashi. Nor does Appellant dispute that it would have been obvious for one of ordinary skill in the art to derive a nonzero spherical aberration adjustment formula, as required by representative claim 11, if the focal distance into the photoresist

was a known result effective variable like the other two result effective variables used in the equation. Rather, Appellant contends that the focal distance (amount of defocus, or focal depth) into the substrate (s) is not recognized as a result effective variable by Takahashi (Br. 10-16; Reply Br. 4-8). We are not persuaded of reversible error in the Examiner's obviousness determination based on this line of argument, as furnished in the Briefs.

At the outset, we note that the question raised by this line of argument as presented in the Briefs may be more properly asked as follows. Has Appellant established reversible error in the Examiner's obviousness rejection of representative claim 11 (as well as separately considered claim 3) by the contention that the applied references, including Takahashi, would not have taught, suggested or otherwise led one of ordinary skill in the art to the determination or recognition that the focal distance into the substrate is a result effective variable (in addition to the other two claimed factors) for optimizing the amount of correction to be applied to the mask pattern image of Takahashi that is to be projected into a photoresist. We answer this question in the negative on this record.

Here, the thrust of Appellant's argument is that:

The Final Action argues that Takahashi recognizes a relationship between the line width change relative to the degree of defocus, which allegedly satisfies the requirement that the focal distance is recognized by Takahashi as a result-effective variable. This is not the case. In particular, the graph in Figure 2 of Takahashi represents "a relationship between a line width of the resist image and the focus position provided as a result of projecting the reticle 6 pattern onto the wafer 8 with a certain spherical aberration." *See, Takahashi* at col. 3, lines 44-47 (emphasis added). The focus position has no effect on the line width; rather, the spherical aberration applied to the

projection of the reticle pattern alters the resist image dimension for a given amount of defocus. The difference in the two images in the graph of Figure 2 of Takahashi result from differences in the spherical aberration applied to a projection rather than to the focus position of a projection. Thus, Takahashi does not recognize an amount of defocus, or focal depth, as a result-effective variable which affects spherical aberration of a projected image. The lack of such recognition precludes a *prima facie* obviousness rejection because the determination of an optimum working range for a variable is not within one of ordinary skill in the art if the variable is not recognized as a result-effective variable.

The combination of Takahashi with [Yasuzato] also fails to make obvious claim 3 because [Yasuzato] does not teach or suggest the equation recited in claim 3. *See, In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Br. 11 and 12 (emphasis omitted).

This argument is not persuasive of any reversible error. In particular, Takahashi's Figure 2 "is a graph showing a relationship between a line width of the resist image and the focus position..." for a particular photoresist (Takahashi; col. 3, ll. 44-52). The line width change (resist image dimension change) at differing focus positions with a spherical aberration of zero (solid line of Figure 2) is greater than the line width change when a predetermined spherical aberration is applied (Takahashi; col. 3, ll. 53-65; Fig. 2, broken line).

However, we note that the incident light would be expected to defocus or experience differing refractions while traveling through the resist material to a focal location or point therein as evidenced by the differing angles that the incident light would be expected to arrive with (Admitted Prior Art, Fig. 2). Thus, the focal distance into the resist would have been recognized by one of ordinary skill in the art as a result effective variable for determining a

nonzero spherical aberration correction value for the mask image to be projected into a particular photoresist. This is in accord with the Examiner's position that Takahashi (with or without Yasuzato) reasonably teaches or would have suggested that the focal distance to be traveled in a medium (resist material) is a result effective variable for determining the optimum corrective spherical aberration value to be applied to a mask image that is to be projected into a particular photoresist (Answer 8-10). In this regard, Appellant's acknowledgement that refraction of incident light would occur in differing amounts (defocusing) in correlation with Snell's Law (Specification ¶ 0008) appears to undercut Appellant's argument for the patentability of these claims based on an asserted lack of result effectiveness of the focal distance into the photoresist (s) parameter. In other words, the result effectiveness of this variable in setting a corrective spherical aberration value would be predictable to one of ordinary skill in the art familiar with Snell's Law. Thus, the Examiner's determination that the focal distance (focal position in the resist) is a result effective variable for the determination of an optimum corrective spherical aberration value appears to be reasonable on this record.

It follows that we shall sustain the Examiner's obviousness rejection over Takahashi taken with Yasuzato.

As for the separate obviousness rejection of dependent claims 6-8, 16-18, and 26-28 under 35 U.S.C. § 103(a) as being unpatentable over Takahashi in view of Yasuzato and Nozue, we note that Appellant rests on the arguments made with respect to the independent claims. Appellant does not furnish any additional arguments against the Examiner's additional application of Nozue to these claims Br. 16-17; Reply Br. 9).

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For the reasons set forth above, it follows that we shall sustain the Examiner's obviousness rejection as it pertains to the above-identified dependent claims.

CONCLUSION

The decision of the Examiner to reject claims 1-4, 9-12, 14, 15, 19-22, 24, 25, 29, and 30 under 35 U.S.C. § 103(a) as being unpatentable over Takahashi in view of Yasuzato; and to reject claims 6-8, 16-18, and 26-28 under 35 U.S.C. § 103(a) as being unpatentable over Takahashi in view of Yasuzato and Nozue is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED

tc/ls

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