The opinion in support of the decision being entered today was **not** written for publication and is **not** precedent of the Board.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte HUNG YIP NG

Appeal No. 2005-0585
Application No. 09/821,478

ON BRIEF

Before GARRIS, OWENS, and PAWLIKOWSKI, **Administrative Patent Judges**.

PAWLIKOWSKI, **Administrative Patent Judge**.

DECISION ON APPEAL

This is a decision under 35 U.S.C. § 134 from the examiner's final rejection of claims 1, 3, 4-8, 10-14, and 16-20.

Claims 1 and 4 are representative of the subject matter on appeal, and are set forth below:

> 1. A method of forming a semiconductor device, comprising:
>
> lithographically patterning a structure having a first critical dimension, wherein said structure includes nested features and an isolated feature;
>
> etching said structure with an O_2-containing material to trim said first critical dimension to a

second critical dimension to correct an offset between said nested features and said isolated feature created by said lithographic patterning.

4. The method of claim 1, wherein said structure comprises a negative photoresist; and

wherein said etching comprises a surface charging technique in combination with a plasma etch, such that said nested feature is etched faster than said isolated feature.

On page 5 of the brief, appellant states that there are two groups of claims, and that one of the groups of claims stands or falls with claim 1, and the other group of claims stands or falls with claim 4. We therefore consider claims 1 and 4 in this appeal.

Claims 1, 3-8, 10-14, and 16-20 stand rejected under 35 U.S.C. § 103 as being unpatentable over Tao in view of Ma, and further view of Horak.[1]

The examiner relies upon the following references as evidence of unpatentability:

Ma et al. (Ma)	5,783,101	Jul. 21, 1998
Tao et al. (Tao)	6,147,818	Jan. 16, 2001
Horak et al. (Horak)	6,297,166	Oct. 21, 2001

[1] We note that on page 5 of the answer, the examiner indicates that claims 1-20 are rejected in this rejection. However, we believe that the examiner intended to indicate that claims 1, 3-8, 10-14, and 16-20 stand rejected under this rejection because appellants indicate that these claims are the only claims pending (brief, page 3), and the examiner agreed with appellants' summary of the status of the claims (answer, page 2).

OPINION

I. The rejection of claims 1, 3-8, 10-14, and 16-20 under 35 U.S.C. § 103 as being unpatentable over Tao in view of Ma and further view of Horak

We limit our consideration to claims 1 and 4, as stated supra.

A. The Examiner's Position

The examiner's position for this rejection is set forth on pages 5-8 of the answer. The examiner's position is summarized below.

The examiner states that the claimed subject matter is directed to a method of compensating for nested-to-isolated pattern bias. Answer, pages 5-6. The examiner states that positive bias is compensated for by adding a sputtering component to the etch chemistry, while negative bias is adjusted for by the electrical bias on the substrate ("space charge" effect). Answer, pages 5-6.

The examiner states that the instant claims recite providing a structure with a first critical dimension (CD) and lithographically reducing the CD by an O2-containing trimming etch. The claims further recite correcting the CD-bias between nested and isolated features during a plasma-etch, and also the etching parameters for the process. Answer, page 6.

The examiner finds that Tao teaches a method for narrowing gate electrodes on a device. The steps comprise (a) forming a stack layer and patterning the photoresist, (b) optionally trimming the resist pattern, (c) etching the anti-reflection coating (ARC) and hardmask and trimming the hard mask to a sub-lithographic dimension (if not trimmed by the photoresist), and (d) etching the gate to the desired sub-lithographic dimension. These steps are shown in Figs. 2-6. The examiner finds that Tao

uses an O_2-containing gas in the plasma etching process (col. 3, lines 43-52). Answer, page 6.

The examiner states that Tao does not teach correcting for the CD-bias, and does not specify positive or negative resists. Answer, page 7. The examiner states that Tao's layers include an oxide layer, and an ARC, but not TEOS. Answer, page 7.

The examiner finds that Ma teaches that CD-bias or "profile microloading" is known (col. 1, lines 60- col. 2, line 21). The examiner states this prior art process corrects for the microloading effect by adjusting the RF power (and hence the space charge). The examiner states that the resist sputtering effect is also adjustable by adjusting the frequency of the RF power (col. 2, lines 32-64). Answer, page 7.

The examiner also finds that Ma discloses further adjusting the etch parameters to correct for the CD bias. These include lowering the frequency (Fig. 5) and increasing the RF power (col. 3, lines 10-27). The system is operated at 0-100mT (col. 5, lines 45-49). Answer, page 7.

The examiner states that Ma does not specify positive or negative photoresists (claim 4). However, the examiner states that the choice of a type of photoresist is uniquely determined by the process.[2] Answer, page 7.

With respect to the claimed "trim" aspect of the etching step of claim 1, the examiner finds that Horak teaches the concept of trimming the resist and ARC (anti-reflective coating) to compensate for a nested-isolated *etching bias* of the gate (col. 6, lines 49-col. 7, lines 44). The examiner also finds that Horak teaches that nested-iso *print bias* is also corrected

[2] We find that Horak specifically teaches that the type of resist chosen is a design variable. See column 10, lines 7-10 of Horak. Hence, we agree with this statement made by the examiner.

by this process (col. 7, lines 45-67). The etch chemistries are adjusted between the sputtering and etching species to bring about the variable etch rates (fig. 5-8). Answer, page 7.

The examiner states that Horak, Ma and Tao solve the problem of etch bias, and attempt to form narrow gates with consistent CDs. Answer, pages 7-8.

The examiner concludes that it would have been obvious to one of ordinary skill in the art to have compensated for the etch bias of nested and isolated lines by biasing the etch-masks, as taught by Horak, using the teachings of Ma and Horak, to set the etching parameters in Tao's trimming process, because Ma teaches that varying the above-discussed parameters reduces microloading, and increases the process window (col. 3, lines 15-27), while Horak teaches that this facilitates the design process for producing consistent products (col. 2, lines 45-65). Answer, pages 7-8.

B. Appellant's Position

Appellant's position regarding the examiner's rejection is set forth on pages 4-12 of the brief.

Appellant first argues that Tao, Ma, and Horak would not have been combined as alleged by the examiner because the references are directed to completely different matters and problems. Brief, page 8.

Appellant argues that Tao is directed to forming a very narrow polysilicon gate line (col. 1, lines 65-67) using a consumable hard mask of silicon oxynitride covered by a thin layer of silicon oxide during the etching of the polysilicon (col. 2, lines 6-9). Appellant states that Tao combines the functions of the anti-reflection coating function, and the

substitution of a hard mask, during the etching step (col. 2, lines 8-12). Brief, page 8.

Appellant states that, in contrast, Ma is specifically directed to reducing a power frequency in a plasma etch reactor so that the plasma source power level may be increased which provides complete residue removal and prevents etch microloading (col. 3, lines 10-28). Appellant states that, thus, Tao and Ma would not have been combined, absent hindsight. Brief, page 8.

Appellant also argues that Horak is specifically directed to performing a reactive ion etching process which compensates for a subsequent normal etching process, to prevent a nested/isolated feature offset (col. 6, line 49-col. 7, line 2). Appellant states that Ma teaches entirely avoiding any such "profile microloading." Appellant concludes that one of ordinary skill in the art would not have been motivated to modify the teachings of Ma with a reactive ion etching process which compensates for a subsequent etching process, as disclosed by Horak, because Ma discloses a method which entirely avoids any such problem. Brief, pages 8-9.

Appellant also argues that the combination of applied references does not teach or suggest each and every element of the claimed invention. Brief, page 9.

Appellant argues that the present invention recites etching a structure to correct an offset between isolated and nested structures which were created by a lithographic process. Appellant states that, in other words, his invention corrects for the isolated/nested offset from a previous lithographic formation, as opposed to correcting for any isolated-feature, nested-feature offset, which would otherwise result from a subsequent lithographic formation. Brief, page 9. Appellant discusses his assertions as to why the applied references do not

teach this claimed feature, and we refer to the discussion in the brief, therein. Brief, pages 10-12.

In summary, appellant states that none of the applied references acknowledge correcting an existing offset. Appellant states that the applied references concentrate on preventing any offset which may occur from a subsequent etching. Appellant states that clearly the applied references are incapable of teaching or suggesting compensating for an existing offset. Brief, pages 11-12.

C. The Examiner's Rebuttal

The examiner's response to appellant's arguments is set forth below, and is found on pages 8-16 of the answer.

With regard to appellants' first line of argument (references would not have been combined), the examiner states that Tao, Ma, and Horak are analogous art, and solve the same problem as the appellant's, i.e., using resist trimming (Tao and Horak) and space charge effect (Horak and Ma). Answer, page 8.

The examiner explains that appellant recognizes (instant specification: p.1-p.2, line 8) the criticality of controlling gate "length" (the *width* of the polysilicon conductive line below the gate oxide) of a transistor, and notes that in achieving a higher density of transistors on a substrate with smaller dimensions (referred to as "scaling path"), this is even more critical (instant specification: p.4, line 11-14). The examiner states that appellant's invention is directed to a process to reduce variations in the gate CD in nested and isolated areas. Answer, page 8-9.

The examiner finds that Tao addresses the same problem of gate CD control (col. 1, lines 9-14), and teaches that as device density increases, the criticality of controlling the gate CD

increases (col. 1, lines 15-20). The examiner states that Tao teaches that photoresist *trimming* to achieve gate CD control becomes difficult to implement (col. 1, lines 26-29). The examiner states that Tao teaches that the prior art shows that polymer deposition during etching (from organic materials such as photoresists and anti-reflective coatings (ARC)) contributes to etch rate differences (col. 1, lines 44-51). Tao's solution comprises an inorganic ARC, which also serves as one layer of a hard mask (col. 2, lines 6-9), and trimming the photoresist with an O-plasma (col. 2, lines 14-17). The photoresist is removed after transferring the trimmed pattern to the hard mask layers. The examiner states that, thus, Tao clearly addresses gate CD control in nested features. Answer, page 9.

The examiner states that Tao does not *explicitly* address differential etching between nested and isolated features. The examiner states, however, that the CD of isolated features is controlled by the same etch as used for nested features, and it would be illogical to control one feature dimension at the expense of another. The examiner states that one of ordinary skill in the art would recognize the inconsistency of the logic. The examiner states that this has also been *explicitly stated* by Horak. The examiner states that Horak teaches that it would be deleterious to the device to trim only isolated features without considering nested features (col. 6, lines 31-35). This is further explained, stating “the nested to isolated etch bias cannot be adjusted without causing the nested etch bias to also decrease” (col. 6, lines 43-46). The examiner finds that Horak states “In addition, both nested and isolated lines will be etched at the same time the isolated lines are etched faster than are nested lines, but both are etched” (col. 2, lines 17-20). Answer, pages 9-10.

The examiner further states that appellant's argument that Tao does not teach reducing the bias between nested and isolated features, is unconvincing because it is not possible to etch one without etching the other. The examiner states that appellant's selective reading of Tao's teachings leads to incorrect conclusions, and states that Tao's Figs. 3-5 are similar to instant Figs. 2A-2B. The examiner states that it would be misleading to suggest that the *instant invention* is directed to the trimming of an isolated line based on instant Figs. 2A-2B. Answer, page 10.

The examiner states that Ma, admittedly, does not address gate CD control; but is directed to an analogous problem; namely, *linewidth variations* in *conductor lines* in nested and isolated features, when using photoresist masks. The examiner states that the etching process is the same as that of the instant invention, using oxygen reactive ion etching (O-RIE). The examiner states that the phenomenon of space charge effect in etching a metal and polysilicon are the same is evidenced by comparing Ma (col. 2, lines 8-21) and the instant specification (instant specification: p.13, lines 9-18). The examiner states that both describe the charge build up and lateral etching of the layers <u>above</u> the conductor layer. The examiner states that Ma compensates for the space charge effect by adjusting the RF frequency of the RIE unit (Ma: abstract). The examiner states that a person of ordinary skill in the art would recognize that etching <u>*conductive underlayers*</u> such as polysilicon gates, would pose the same problems as Ma's etching of nested and isolated <u>*metal lines*</u>. The examiner points out that Ma and Tao are both related to device fabrication by the same lithographic processes, and states that appellant has selectively interpreted

Ma's teachings to suggest divergent subject matter. Answer, page 10.

The examiner states that Horak deals with the same problems as Tao and Ma: etching nested and isolated lines on semiconductor devices (col. 2, lines 51-65). The examiner states that Horak teaches the basic phenomenon of etching bias in Tao's plasma etching (col. 1, lines 34-54) as well as Ma's RIE-etching (col. 1, lines 55-col.2, line 20). The examiner states that Horak uses Ma's O-RIE etching to trim the etch masks prior to etching the underlying polysilicon layer (col. 3, lines 11-15). The examiner states that the space charge effect is mitigated by adjusting the "etching" and "sputtering" species in the gases (col. 3, lines 20-27). The examiner states that this is the same technique used in the instant invention. The examiner notes further that Horak teaches the *equivalence* of metal conductor etching and polysilicon etching to control gate CD using O-RIE (col. 8, lines 44-50). Answer, pages 10-11.

The examiner also states that appellant argues (instant brief: p.8) that Ma teaches "avoiding microloading" (col. 3, lines 10-28), while Horak teaches "compensating for subsequent normal etching process to prevent a nested/isolated offset-effect" (col. 6, lines 49-col. 7, line 2), and thus, the two references are incompatible. The examiner disagrees for the following reasons.

The examiner states that Ma solves the problem of nested/isolated offset in etching a *conductor* layer using a photoresist mask. The examiner states that Ma does so by adjusting the RF power and frequency such that the sputtering phenomenon and etching phenomenon are balanced ("space charge effect"). This leads to little or no re-deposition of the photoresist ("profile microloading") during the conductor etch.

The reduction of microloading permits faster etching of nested features. Answer, page 11.

The examiner states that Horak similarly solves the problem of nested/isolation offset in etching an underlayer using a photoresist mask (the resist mask is not shown in figures; see col. 5, lines 3-4). The examiner states that Horak uses the space charge effect in O-RIE similar to Ma and the instant invention. The examiner states that Horak adjusts the reactive components to balance the sputtering and etching phenomenon; this adjustment is similar to the instant invention. This etching step provides a mask layer with no *print bias and thus subsequent normal etching* of the conductor layer becomes feasible (col. 6, lines 49-col. 7, line 2); this serves the same function as mask trimming. The examiner states that Horak clarifies the term *"normal etching"* to include differential etching of nested/iso features *under the mask* (col. 6, lines 21-36 & col. 9, lines 6-33). Answer, page 12.

The examiner ultimately concludes that appellant's argument that the references teach unrelated subject matters, and are therefore not combinable, is not convincing. Answer, page 12.

With regard to appellant's contention that the applied references do not teach each and every element of the instant claims, on page 13 of the answer, the examiner states that it has been shown, supra, that the combination of references teaches each and every element of the instant claims. We refer to pages 13-16 of the answer regarding the examiner's additional statements in this regard.

C. Our Analysis

With regard to appellant's assertions that (1) the applied references are not combinable, and (2) the combination does not

teach the claimed invention, we note that "the consistent criterion for determination of obviousness is whether the prior art would have suggested to one of ordinary skill in the art that this process should be carried out and would have a reasonable likelihood of success, viewed in the light of the prior art." In re Dow Chemical Co., 837 F.2d 469, 5 USPQ2d 1529, 1531 (Fed. Cir. 1988) (citing Burlington Industries v. Quigg, 822 F.2d 1581, 583, 3 USPQ2d 1436, 1438 (Fed. Cir. 1987); In re Hedges, 783 F.2d 1038, 1041, 228 USPQ 685, 687 (Fed. Cir. 1987)); Orthopedic Equipment Co. v. United States, 702 F.2d 1005, 1013, 217 USPQ 193, 200 Fed. Cir. 1983); In re Rinehart, 531 F.2d 1048, 1053-54, 189 USPQ 143, 148 (CCPA 1976). It is thus the position of the court that, where claimed subject matter has been rejected as obvious in view of a combination of prior art references, a proper analysis under § 103 requires, inter alia, consideration of two factors: (1) whether the prior art would have suggested to those of ordinary skill in the art that they should make the claimed composition or device, or carry out the claimed process; and (2) whether the prior art would also have revealed that in so making or carrying out, those of ordinary skill would have a reasonable expectation of success. Both the suggestion and the reasonable expectation of success must be founded in the prior art, not in the applicant's disclosure. Dow Chem., supra.

In the instant case, the examiner has explained, in detail, **(1)** how the applied art suggests carrying out appellant's claimed process, and **(2)** how the applied art reveals a reasonable expectation of success in carrying out the claimed process. We refer to the above-described examiner's position in this regard.

With specific regard to appellant's repeated and emphasized argument that the claimed invention corrects offset from a **previous** lithographic formation [emphasis added], and that the applied art does not do so, we find that Horak discusses the formation of a lithographic film (col. 7, lines 4-5) that is subsequently subjected to a special etch (col. 7, lines 3-10). Hence, Horak teaches etching a structure from a **previous** lithographic formation. Hence, we agree with the examiner's statement, made on page 16 of the Answer, that the applied art teaches every element of the claims.

We also add that Horak explains that "the amount of lithographic film or other etch mask added" to a nested line will decrease angle 2002 (depicted in Figure 10 of Horak). Horak thus recognizes how offsets, **created** [emphasis added] by a lithographic film, are formed. In this manner, the art has recognized the need to compensate for an offset created by a lithographic film or other etch mask.

In view of the above, we therefore affirm the rejection of claims 1, 3-8, 10-14, and 16-20 under 35 U.S.C. § 103 as being obvious over Tao in view of Ma, and further view of Horak.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a)(1)(iv)(effective September 13, 2004; 69 Fed. Reg. 49960 (August 12, 2004); 1286 Off. Gaz. Pat. Office 21 (September 7, 2004)).

AFFIRMED

BRADLEY R. GARRIS Administrative Patent Judge	)
TERRY J. OWENS Administrative Patent Judge	)BOARD OF PATENT) APPEALS AND) INTERFERENCES
BEVERLY A. PAWLIKOWSKI Administrative Patent Judge	)

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