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 DAVID S. L. MUI, WEI LIU, and HIROKI SASANO

Appeal 2007-1269
Application 10/636,468[1]
Technology Center 2800

Decided: July 31, 2007

Before HOWARD B. BLANKENSHIP, ALLEN R. MACDONALD, and SCOTT R. BOALICK, *Administrative Patent Judges*.

BOALICK, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal under 35 U.S.C. § 134(a) from the final rejection of claims 1-11 and 14, all the claims pending in the application. We have jurisdiction under 35 U.S.C. § 6(b).

We affirm-in-part.

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[1] Application filed August 6, 2003. The real party in interest is Applied Materials, Inc.

STATEMENT OF THE CASE

Appellants' invention relates to techniques for monitoring chamber stability in a semiconductor substrate processing system and adjusting a process recipe to optimize substrate processing. (Specification 2, paragraph [0001].) In the words of the Appellants:

> [T]he invention measures the thickness of a material layer on a substrate using an integrated metrology tool that is coupled to a substrate processing chamber (e.g., a deep trench etch system). The measurement data are utilized and tracked by the substrate-processing chamber to adjust a process recipe in real time, and to detect process drift. As such, the real time adjustment of the process recipe facilitates accurate processing of the substrate. The real time process information also assists in shortening the process development cycle.

(Specification 6, paragraph [0022].)

Claim 1 is exemplary:

1. A method of monitoring a process performed by a processing chamber, comprising:

collecting pre-process measurement data prior to substrate processing using an integrated metrology tool;

processing the substrate in the processing chamber;

recording a total processing time;

collecting post-process measurement data after substrate processing using the integrated metrology tool; and

calculating a process rate by subtracting post-process measurement data from pre-process measurement data and dividing the result by the total processing time.

The prior art relied upon by the Examiner in rejecting the claims on appeal is:

Liu	US 2004/0117146 A1	Jun. 17, 2004 (filed Dec. 17, 2002)
Pasadyn	US 6,788,988	Sep. 7, 2004 (filed Dec. 17, 2001)

Claims 1-11 and 14 stand rejected under 35 U.S.C. § 103(a) as being obvious over Pasadyn and Liu.

Rather than repeat the arguments of Appellants or the Examiner, we make reference to the Briefs and the Answer for their respective details. Only those arguments actually made by Appellants have been considered in this decision. Arguments which Appellants could have made but chose not to make in the Briefs have not been considered and are deemed to be waived. *See* 37 C.F.R. § 41.37(c)(1)(vii) (2004).[2]

ISSUE

The issue is whether Appellants have shown that the Examiner erred in rejecting the claims under 35 U.S.C. § 103(a). That is, given the teachings of the prior art, have Appellants shown that the differences between the claims and the prior art are sufficient to render the claimed subject matter unobvious to a person skilled in the art at the time the invention was made?

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[2] Except as will be noted in this opinion, Appellants have not presented any substantive arguments directed separately to the patentability of the dependent claims or related claims in each group. In the absence of a separate argument with respect to those claims, they stand or fall with the representative independent claim. *See* 37 C.F.R. § 41.37(c)(1)(vii).

FINDINGS OF FACT

The record supports the following findings of fact (FF) by a preponderance of the evidence.

1. Pasadyn describes a method for controlling a semiconductor manufacturing process that uses pre-process and post-process metrology data gathered by an integrated metrology tool. (Pasadyn Abstract; col. 1, ll. 9-12.)

2. Pasadyn teaches that an integrated metrology tool may be incorporated into the flow of semiconductor wafers 105 through a processing tool 410. (Pasadyn col. 5, ll. 29-31.) The integrated metrology tool 310 acquires pre-process and post-process metrology data. (Pasadyn col. 5, ll. 45-46.) Also, the integrated metrology tool 310 may acquire metrology data from the processed semiconductor wafers prior to, during, or immediately following a manufacturing process. (Pasadyn col. 5, ll. 46-50.) Pasadyn teaches that:

> In one embodiment, the integrated metrology tool 310 sends metrology data (real-time or near real-time time data) to an integrated metrology data storage unit 330. The integrated metrology data storage unit 330 stores the metrology data such that it can be retrieved by the system 300 for further analysis during or after a manufacturing process cycle.

(Pasadyn col. 5, ll. 52-55.)

3. Pasadyn teaches that "[d]ata from the integrated metrology tool 310 may also be sent to the metrology data analysis unit 460." (Pasadyn

col. 6, ll. 1-2.) "The metrology data analysis unit 460 is capable of correlating particular metrology data to corresponding semiconductor wafers 105." (Pasadyn col. 6, ll. 2-4.) In addition:

> The real-time, or near real-time, metrology data stored in the metrology data storage unit 330 provides the system 300 access to immediate manufacturing data that can be used to further correct or enhance the accuracy of one or more processes performed on the semiconductor wafers 105. Pre-process and post-process data stored in the integrated metrology data storage unit 330 may be used by the system 300 to perform comparisons between the pre-process and post-process data to evaluate the accuracy of the processes performed on semiconductor wafers 105. Based upon the evaluation, modifications to subsequent processing of semiconductor wafers 105 may be performed by the system 300.

(Pasadyn col. 6, ll. 7-19.)

4. As taught by Pasadyn, a computer can "access the metrology data and perform analysis (e.g., comparison of the pre-process and post-process metrology data to evaluate the accuracy of the process operations performed on the semiconductor wafer 105) of processes performed by the processing tools 410 (block 690)." (Pasadyn col. 9, ll. 40-45.) "Results from the analysis of the metrology data may be used to modify one or more control input parameters that control the operations of the processing tools 410, such as feedback and/or feed-forward adjustments (block 695)." (Pasadyn, col. 9, ll. 46-49.)

5. Liu describes a metrology method of measuring film thickness in a semiconductor manufacturing process. (Liu, paragraph [0001].) The method may be used for determining the endpoint of a chemical mechanical polishing (CMP) process. (Liu, paragraph [0001].)

6. In one embodiment of Liu, a reference wafer with a reference oxide layer thickness is included in a polishing process. (Liu, paragraph [0026].) After a first polishing time period, the reference wafer is removed, a Fourier Transform Infra-Red (FTIR) measurement is taken, and both the removed oxide layer thickness and the remaining oxide layer thickness are determined. (Liu, paragraph [0026].) A polishing rate is determined so as to project the time period remaining to reach an endpoint of the polishing process. (Liu, paragraph [0026].) The reference wafer may then be returned for additional polishing time periods. (Liu, paragraph [0026].)

7. In one embodiment of Liu, a monitor wafer is "periodically removed following a CMP polishing period for at least one FTIR measurement to determine an oxide layer thickness and material removal rate." (Liu, paragraph [0027].) Liu explains that:

> A polishing rate may be determined following the first FTIR measurement after beginning the CMP polishing process with reference to an initial FTIR measurement made prior to beginning the CMP process to determine an initial thickness. For example, a removed thickness portion of the oxide layer is determined following an initial CMP polishing period and divided by an initial polishing time to determine a material removal rate. The

> material removal rate is then used to project a remaining polishing time to remove a remaining desired thickness portion of the oxide layer.

(Liu, paragraph [0027].)

PRINCIPLES OF LAW

All timely filed evidence and properly presented argument is considered by the Board in resolving an obviousness issue on appeal. *See In re Piasecki*, 745 F.2d 1468, 1472, 223 USPQ 785, 788 (Fed. Cir. 1984).

In the examination of a patent application, the Examiner bears the initial burden of showing a prima facie case of unpatentability. *Id.* When that burden is met, the burden then shifts to the applicant to rebut. *Id.*; *see also In re Harris*, 409 F.3d 1339, 1343-44, 74 USPQ2d 1951, 1954 (Fed. Cir. 2005) (finding rebuttal evidence unpersuasive). If the applicant produces rebuttal evidence of adequate weight, the prima facie case of unpatentability is dissipated. *In re Piasecki*, 745 F.2d at 1472, 223 USPQ at 788. Thereafter, patentability is determined in view of the entire record. *Id.* However, on appeal to the Board it is an appellant's burden to establish that the Examiner did not sustain the necessary burden and to show that the Examiner erred -- on appeal we will not start with a presumption that the Examiner is wrong.

"Section 103 forbids issuance of a patent when 'the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.'" *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727,

1734, 82 USPQ2d 1385, 1391 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including (1) the scope and content of the prior art, (2) any differences between the claimed subject matter and the prior art, (3) the level of skill in the art, and (4) where in evidence, so-called secondary considerations. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18, 148 USPQ 459, 467 (1966). *See also KSR*, 127 S. Ct. at 1734, 82 USPQ2d at 1391 ("While the sequence of these questions might be reordered in any particular case, the [*Graham*] factors continue to define the inquiry that controls."). "If a court, or patent examiner, conducts this analysis and concludes the claimed subject matter was obvious, the claim is invalid under § 103." *Id.*

The mere existence of differences between the prior art and the claim does not establish nonobviousness. *Dann v. Johnston*, 425 U.S. 219, 230, 189 USPQ 257, 261 (1976). The issue is "whether the difference between the prior art and the subject matter in question 'is a difference sufficient to render the claimed subject matter unobvious to one skilled in the applicable art.'" *Dann*, 425 U.S. at 228, 189 USPQ at 261 (citation omitted). To be nonobvious, an improvement must be "more than the predictable use of prior art elements according to their established functions." *KSR*, 127 S. Ct. at 1740, 82 USPQ2d at 1396.

In *KSR*, the Supreme Court emphasized "the need for caution in granting a patent based on the combination of elements found in the prior art," *id.* at 1739, 82 USPQ2d at 1395, and discussed circumstances in which a patent might be determined to be obvious. In particular, the Supreme Court emphasized that "the principles laid down in *Graham* reaffirmed the 'functional approach' of *Hotchkiss*, 11 How. 248." *KSR,* 127 S. Ct. at 1739,

82 USPQ2d at 1395 (citing *Graham v. John Deere Co.*, 383 U.S. 1, 12, 148 USPQ 459, 464 (1966) (emphasis added)), and reaffirmed principles based on its precedent that "[t]he combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results." *Id.* The Court explained:

> When a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one. If a person of ordinary skill can implement a predictable variation, §103 likely bars its patentability. For the same reason, if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

Id. at 1740, 82 USPQ2d at 1396.

"To facilitate review, this [obviousness] analysis should be made explicit." *Id.* at 1741, 82 USPQ2d at 1396 (citing *In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006)). However, the Court made clear that "the analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ." *Id.*

"Under the correct analysis, any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed." *Id.* at 1742, 82 USPQ2d at 1397. The Court noted that "[c]ommon sense teaches . . . that

familiar items may have obvious uses beyond their primary purposes, and in many cases a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle." *KSR*, 127 S. Ct. at 1742, 82 USPQ2d at 1397. "A person of ordinary skill is also a person of ordinary creativity, not an automaton." *Id.*

Furthermore, the Supreme Court explained that "[w]hen there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp." *KSR*, 127 S. Ct. at 1742, 82 USPQ2d at 1397. "If this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense," *id.* and, in such an instance "the fact that a combination was obvious to try might show that it was obvious under § 103" *id.*

The Court cautioned that "[a] factfinder should be aware, of course, of the distortion caused by hindsight bias and must be cautious of arguments reliant upon *ex post* reasoning." *KSR*, 127 S. Ct. at 1742, 82 USPQ2d at 1397.

The level of ordinary skill in the art may be evidenced by the prior art references. *In re GPAC Inc.*, 57 F.3d 1573, 1579, 35 USPQ2d 1116, 1121 (Fed. Cir. 1995) ("Although the Board did not make a specific finding on skill level, it did conclude that the level of ordinary skill in the art . . . was best determined by appeal to the references of record . . . . We do not believe that the Board clearly erred in adopting this approach."); *see also In re Oelrich*, 579 F.2d 86, 91, 198 USPQ 210, 214 (CCPA 1978) ("the PTO

usually must evaluate both the scope and content of the prior art and the level of ordinary skill solely on the cold words of the literature").

In sustaining a multiple reference rejection under 35 U.S.C. § 103(a), the Board may rely on one reference alone without designating it as a new ground of rejection. *In re Bush*, 296 F.2d 491, 496, 131 USPQ 263, 266-67 (CCPA 1961); *In re Boyer*, 363 F.2d 455, 458 n.2, 150 USPQ 441, 444 n.2 (CCPA 1966).

During examination of patent application, a claim is given its broadest reasonable construction consistent with the specification. *In re Prater*, 415 F.2d 1393, 1404-05, 162 USPQ 541, 550-51 (CCPA 1969). "[T]he words of a claim 'are generally given their ordinary and customary meaning.'" *Phillips v. AWH Corp.,* 415 F.3d 1303, 1312, 75 USPQ2d 1321, 1326 (Fed. Cir. 2005) (en banc) (internal citations omitted). The "ordinary and customary meaning of a claim term is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention, i.e., as of the effective filing date of the patent application." *Id.* at 1313, 75 USPQ2d at 1326.

ANALYSIS

Appellants contend that Examiner erred in rejecting claims 1-11 and 14 as being obvious over Pasadyn and Liu. Reviewing the findings of facts cited above, we do not agree that the Examiner erred in rejecting claims 1-5, 7-11, and 14. In particular, we find that the Appellants have not shown that the Examiner failed to make a prima facie showing of obviousness with respect to claims 1-5, 7-11, and 14. Appellants failed to meet the burden of overcoming that prima facie showing. However, we agree with Appellants

that the Examiner erred in rejecting claim 6[3] as being obvious over Pasadyn and Liu.

Regarding claim 1, Appellants argue that "Pasadyn does not teach or suggest calculating a process rate by subtracting post-process measurement data from pre-process measurement data and dividing the result by a total processing time, as recited by claim 1." (Br. 9.) Further, Appellants argue that "Liu teaches a mid-process measurement to determine a total processing time for each polished substrate" (Br. 10). Therefore, Appellants assert that:

> Liu does not teach or suggest ***calculating a process rate*** by subtracting post-process measurement data from pre-process measurement data and dividing the result by ***a total processing time***, as recited by claim 1, because the total processing time never [sic] calculated by Liu, and the remaining processing time is the resultant [sic] that is calculated by Liu using the mid-process measurement.

(Br. 10 (emphasis in original).) We disagree.

Liu discloses collecting a reference oxide layer thickness measurement prior to a polishing process, collecting an oxide layer thickness measurement after a first polishing time period, and calculating a process rate. (FF 6-7.) The Examiner correctly found that Liu is not limited to a

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[3] The Briefs and the Answer purport to argue claim 5, but instead quote and argue the substance of the language of claim 6. (*See, e.g.*, Br. 12; Answer 10.) Under these circumstances, we will treat the arguments as being directed to claim 6 and will consider the references to claim 5 to be typographical errors. To the extent that the Appellants meant to refer to claim 5, we agree with the Examiner's finding that Pasadyn discloses that both pre-process measurement data and post-process measurement data each include both thickness measurement and critical dimension information, as recited by claim 5. (Answer 10.)

mid-process measurement. (Answer 8.) In particular, we agree with the Examiner that the removal of the wafers after a polishing process may reasonably be considered the end of the process. (Answer 8.) Therefore, under a reasonable interpretation the first polishing time period of Liu meets the "total processing time" limitation of claim 1.

Moreover, Pasadyn discloses collecting both pre-process and post-process metrology data and then performing comparisons between the pre-process and the post-process data. (FF 3.) A "comparison" is an "estimation of similarities and differences." *Webster's New World Dictionary Third College Edition* 283 (1994). By teaching a comparison, Pasadyn teaches an estimation of similarities and differences. Therefore, the "subtracting post-process measurement data from pre-process measurement data" limitation of claim 1 (i.e., a difference) is met by the comparison between the pre-process and post-process data taught by Pasadyn.

In addition, the recited claim limitations of (1) "recording a total processing time" and (2) "dividing the result [i.e., the difference between the pre-process and post-process measurement data] by the total processing time" to calculate a process rate would have required no more than ordinary skill and common sense, and each limitation was within the level of ordinary skill in the art as demonstrated by the teachings of Liu. Therefore, the obviousness of claim 1 may be shown by Pasadyn alone. The process rate calculation teachings of Liu are merely cumulative to the express as well as the implied teachings already found in Pasadyn.

In their pre-*KSR* brief, Appellants argue that there must be a clear and particular showing of a motivation to combine and that there is no motivation to combine Pasadyn and Liu because they address different

problems and solutions. (Br. 11-12; *see also* Reply Br. 3-5.) *KSR* forecloses Appellants' arguments that a specific teaching is required and that the references must address the same problem for a finding of obviousness. *KSR*, 127 S. Ct. at 1741, 82 USPQ2d at 1396.

Appellants also argue that Pasadyn and Liu would be incompatible if combined and that the Examiner used impermissible hindsight. (Br. 11-12; *see also* Reply Br. 3, 5.) We do not agree. As previously discussed, the obviousness of claim 1 may be demonstrated by Pasadyn alone. In addition, the Examiner correctly found that Liu does not require more than one measurement to be made and that using the rate calculation teaching of Liu in the process of Pasadyn was within the level of ordinary skill in the art. (Answer 8.) Appellants have presented no evidence that using the rate calculation taught by Liu in the process of Pasadyn would be uniquely challenging or difficult for one of ordinary skill in the art.

We have considered Appellants' remaining arguments and find them unpersuasive. Accordingly, we conclude that the Examiner did not err in rejecting claim 1 under 35 U.S.C. § 103(a).

Claims 3-5, 7-8, 10-11, and 14 were not argued separately, and thus fall with claim 1.

Appellants separately argue the patentability of claims 2, 6,[4] and 9. With respect to claim 2, Appellants argue that neither Pasadyn nor Liu teach or suggest the recited limitations of computing a process rate trend, comparing the process rate trend to a limit level, and signaling detection of a

[4] As mentioned *supra*, although the Briefs and the Answer purport to argue claim 5, we will treat the arguments as being directed to claim 6 and will consider the references to claim 5 to be typographical errors.

performance drift when the process rate trend exceeds the limit level. (Br. 11; Reply Br. 6.) We do not agree.

The plain meaning of the claim term "trend" is "a general or prevailing tendency or course." *Webster's New World Dictionary Third College Edition* 1425 (1994). Therefore, the plain meaning of the claim term "process rate trend" is the general or prevailing tendency or course of the process rate.

Pasadyn teaches that data from an integrated metrology tool is correlated to corresponding semiconductor wafers. (FF 3.) Pasadyn also teaches that the pre-process and post-process data are analyzed to evaluate the accuracy of the process being performed on the semiconductor wafers, and that the data analysis results are used to modify the parameters that control the process. (FF 4.)

Although Pasadyn does not explicitly teach computing a process rate trend as part of the data analysis, this limitation would have required no more than ordinary skill and common sense, and was within the level of ordinary skill in the art as demonstrated by the teachings of Pasadyn and Liu. Pasadyn teaches data comparison and analysis, and Liu teaches computing a process rate. Pasadyn also teaches that a series of wafers are processed in sequence. (FF 2.) As the wafers were processed in sequence, it would have been common sense to also compute a process rate trend for the wafers by tracking the process rate for each individual wafer in the sequence.

Tracking the change in process rate over time as the wafers are processed -- i.e., a process rate trend -- would be within the level of ordinary skill in the art. We also agree with the Examiner that Pasadyn teaches

signaling detection of a performance drift when a limit level is exceeded. (Answer 10.) It would have been common sense and within the level of ordinary skill in the art to compare the process rate trend to the limit level and signal a performance drift when the limit level is exceeded. Therefore, we conclude that the Examiner did not err in rejecting claim 2 under 35 U.S.C. § 103(a).

With respect to claim 9, we agree with the Examiner that Pasadyn teaches adjusting a process recipe in real time and therefore renders obvious the claimed limitation of adjusting a process recipe based on the pre-process measurement data and a process rate. (Answer 10; *see also* FF 3-4.) Therefore, we conclude that the Examiner did not err in rejecting claim 9 under 35 U.S.C. § 103(a).

However, with respect to claim 6, we agree with Appellants that neither Pasadyn nor Liu teach or suggest the limitation of excluding a contribution of the critical dimension of a feature as a cause of the process drift if the pre-etch critical dimension information is within a pre-defined critical dimension specification, as claimed. In addition, there is no evidence that this limitation is a predictable variation of the prior art. Nor is there evidence that this limitation would be common sense or a creative step that a person of ordinary skill in the art would employ.

Therefore, we conclude that the Examiner erred in rejecting claim 6 under 35 U.S.C. § 103 because the differences between the prior art and claim 6 are sufficient to render claim 6 nonobvious to a person skilled in the art at the time the invention was made.

CONCLUSION OF LAW

Based on the findings of facts and analysis above, we conclude that:

(1) The Examiner did not err in rejecting claims 1-5, 7-11, and 14 for obviousness under 35 U.S.C. § 103.

(2) The Examiner erred in rejecting claim 6 for obviousness under 35 U.S.C. § 103.

DECISION

The rejection of claims 1-5, 7-11, and 14 for obviousness under 35 U.S.C. § 103 is affirmed.

The rejection of claim 6 for obviousness under 35 U.S.C. § 103 is reversed.

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-IN-PART

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