UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte THOMAS J. SONDERMAN and RICHARD J. MARKLE

Appeal 2007-2669
Application 10/209,585
Technology Center 1700

Decided: December 14, 2007

Before BRADLEY R. GARRIS, PETER F. KRATZ, and
MICHAEL P. COLAIANNI, *Administrative Patent Judges*.

COLAIANNI, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellants appeal under 35 U.S.C. § 134 the final rejection of claims 1-66 and 88-95. We have jurisdiction over the appeal pursuant to 35 U.S.C. § 6(b).

We AFFIRM-IN-PART.

INTRODUCTION

Appellants disclose a method of plasma state monitoring to control etching processes and across wafer uniformity (Specification 1). The method is used in the semiconductor industry where a plasma is used to etch

the surface of a wafer (Specification 1 and 4). The method comprises monitoring a characteristic of the plasma that is indicative of a feature on the wafer (claim 1).

Claims 1 and 58 are illustrative:

1. A method, comprising:
generating a plasma within an etching tool having at least one wafer disposed therein;
monitoring at least one characteristic of said generated plasma, said at least one characteristic being indicative of at least one physical aspect of at least one feature formed on the wafer; and
controlling at least one parameter of a plasma etching process performed in said tool based upon said monitored at least one characteristic of said plasma.

58. A method, comprising:
generating a plasma in an etch tool;
providing a substrate having a process layer formed thereabove to said etch tool, said process layer having a thickness that varies across said substrate;
monitoring at least one characteristic of said generated plasma; and
controlling at least one parameter of a plasma etching process performed in said etch tool based upon said monitored at least one characteristic of said plasma so as to perform an etch process in said etch tool that exhibits a desired across-substrate etch pattern that compensates for said across-substrate thickness variations in said process layer.

The Examiner relies on the following prior art references as evidence of unpatentability:

Le	6,153,115	Nov. 28, 2000
Pasadyn	WO 02/23289 A2	Mar. 21, 2002
Davidow	6,455,437 B1	Sep. 24, 2002

The rejections as presented by the Examiner are as follows:

1. Claims 1-3, 6, 7, 11-20, 24-34, 38-57 and 88-95 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Davidow.
2. Claims 1-3, 6-8, 11-21, 24-34, 38-57 and 88-95 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Le.
3. Claims 1-66 and 88-95 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Pasadyn.

The Examiner finds that Davidow or Le discloses all that is in claim 1, except that Davidow or Le does not expressly state that the method allows one to determine a physical attribute of a feature formed upon a substrate (Ans. 6 and 7). However, the Examiner determines that when forming a trench on a wafer, for example, a skilled artisan need only know the thickness of a layer to use the endpoint as a means to determine the depth of the trench (Ans. 6 and 7). The Examiner concludes that it would have been obvious for one skilled in the art to know the thickness of the layer being etched because the thicknesses of layers are tightly controlled and of critical concern such that Davidow or Le discloses the plasma indication of the endpoint is indicative of a physical aspect (i.e., layer thickness) of a feature (Ans. 7 and 8).

Regarding claim 1, the Examiner finds that Pasadyn discloses a method of monitoring an optical emission spectrum and etching depth (Ans. 18). But Pasadyn does not disclose using the characteristic of the plasma as indicative of at least one feature (e.g., etching depth) on the wafer. The Examiner determines that since emission spectroscopy is the usual tool for detecting endpoints (i.e., monitoring etch depth), it would have been obvious

to one skilled in the art to rely on the emission characteristic of the plasma as being indicative of etching depth (Ans. 18).

Regarding claim 58, the Examiner finds that Pasadyn does not explicitly disclose the following claim features: (1) generating a plasma in an etch tool, (2) providing a substrate having a process layer formed thereabove to said etch tool, (3) monitoring at least one characteristic of said generated plasma, and (4) controlling a parameter of a plasma etching process performed in said etch tool (Ans. 14). However, the Examiner determines that Pasadyn's disclosure regarding monitoring an optical emission spectrum indicates that Pasadyn generates a plasma (Ans. 15-16). Regarding features (2) through (4), the Examiner finds that Pasadyn implicitly discloses the features (Ans. 14-16).

Appellants separately argue independent claims 1 and 58. Accordingly, claims 2-57 and 88-95, and 59-66, stand or fall with claims 1 and 58, respectively.

OPINION

35 U.S.C. § 103 REJECTIONS OVER DAVIDOW OR LE[1]

Appellants argue that there is no suggestion or motivation to use the plasma detection method to measure a layer thickness (i.e., "at least one physical aspect of at least one feature formed on the wafer" as claimed) (Br. 7 and 10). Appellants contend that the Examiner admits that Davidow and

[1] The Examiner refers to Grimbergen 6,081,334, Grimbergen 6,129,807, and O'Neill 5,308,414 in the Answer as evidence that endpointing is used to indicate etch depth (Ans. 12-13). As none of these references were included in any statement of rejection, we have not considered these references in rendering our decision. *In re Hoch*, 428 F.2d 1341, 1342 n.3 (CCPA 1970).

Le fail to teach or suggest controlling at least one parameter of an etching process based upon the determined at least one plasma characteristic (Br. 7 and 9). Appellants argue that in the endpoint detection disclosed by Davidow and Le the thicknesses are of no concern because they operate by detecting the presence of the underlying material such that the absolute thickness is irrelevant (Br. 8 and 10). Appellants argue that endpointing techniques usually are not used to form trenches on semiconductor wafers (Br. 8 and 10). Appellants contend that the Examiner used impermissible hindsight to modify Davidow or Le to include measuring a layer thickness (Br. 8 and 11).

We have considered all of Appellants' arguments and are unpersuaded for the reasons below.

Davidow discloses a method for monitoring the process state of a semiconductor device by measuring "attributes" of the plasma (Davidow, col. 1, ll. 66-67; col. 2, ll. 1-21). Davidow discloses that it is known to etch vias (i.e., holes in layers) in the semiconductor industry and that monitoring the plasma to determine the endpoint is an improvement to the etching processes conventionally used in the semiconductor industry (Davidow, col. 1, ll. 11-18, 61-63). Davidow monitors, for example, the optical emission spectrum of the plasma to determine when a layer has been etched through (i.e., the endpoint of the layer has been reached) (Davidow col. 7, ll. 7-19, 62-63).

Le discloses a method for monitoring plasma processes to detect various stages in semiconductor circuit manufacturing (Le, col. 1, ll. 6-9). Le discloses analyzing the intensity of the radiation emitted by the plasma during an etch to determine a correlation between the intensity and the

detection of the endpoint of etching (i.e., once a layer has been etched through) (Le, col. 1, ll. 45-50; col. 5, ll. 55-67; col. 6, ll. 1-9; col. 7, ll. 51-52; col. 8, ll. 9-19).

Appellants argue that there is no motivation or suggestion to modify Davidow or Le to include measuring the thickness of a layer using a characteristic of the plasma and that the Examiner's modification is based on impermissible hindsight (Br. 7 and 10). However, we do not interpret the Examiner's rejections over Davidow or Le as requiring any modification of Davidow or Le. Rather, we interpret the Examiner's rejections over Davidow or Le as stating that, by Davidow or Le determining the endpoint of an etching phase using a plasma characteristic, such determination would indicate that the etching has reached to a particular thickness of a layer (i.e., a physical aspect of a feature as claimed) and that one would already know the thickness of the layers because semiconductor manufacturing is tightly controlled. Stated differently, no modification of Davidow or Le is required to satisfy the claim feature "at least one characteristic [of the plasma] being indicative of at least one physical aspect of at least one feature formed on the wafer" because such claim feature is implicitly contained in Davidow's or Le's disclosure. Accordingly, Appellants' motivation and hindsight arguments are unpersuasive because no modification is required of Davidow or Le to meet the argued claim feature which is implicitly contained in the references.

We further note that Appellants argue that the thicknesses of the various layers are of no concern to Davidow or Le because all that matters is that the endpoint has been reached. Appellants appear to be arguing that there would be no need to know the numerical thickness of the layer because

such is not important when determining an endpoint. However, we interpret the argued claim 1 feature, "at least one characteristic [of the plasma] being indicative of at least one physical aspect of at least one feature formed on the wafer," as not requiring any numerical value. Rather, as noted by the Examiner (Ans. 10), "the mere indication (via plasma characteristics) that an etching process has reached an interface is sufficient to satisfy . . ." the argued claim 1 feature. In other words, no numerical value or known thickness of the layer is required to satisfy the argued claim feature. Instead, when Davidow's or Le's plasma monitoring process indicates that an endpoint of a layer has been reached, the argued claim feature would be satisfied because a physical aspect (i.e., the endpoint of the layer) of at least one feature (i.e., the layer) on the wafer would be indicated.

Regarding Appellants' argument that the Examiner admits that Davidow and Le do not disclose controlling a parameter based on a plasma characteristic, we agree with the Examiner that no admission was ever made (Ans. 9). In fact, the Examiner finds the exact opposite of the alleged admission. Specifically, the Examiner finds that Davidow and Le disclose controlling, for example, the etching process based on detection via the optical emission of the of the plasma that the endpoint has been reached (Davidow, col. 7, ll. 7-15; Le, col. 2, ll. 44-51; col. 18, ll. 14-17) (Ans. 6 and 7).

Appellants' argument that endpoint techniques are not usually used to form trenches on semiconductor wafers is refuted by Davidow's and Le's disclosures. Davidow discloses that semiconductor processes usually involve forming vias (i.e., holes) through various layers (Davidow, col. 1, ll. 11-18). Davidow further disclose that the endpoint monitoring method is an

improvement for monitoring semiconductor device fabrication processes (e.g., forming vias) (Davidow, col. 1, ll. 61-63). Similarly, Le discloses that the plasma monitoring to detect endpoints is used in situations where there is a large masking area and a small exposed area (e.g., as when forming vias or lines (i.e., trenches) on semiconductor surfaces) (Le, col. 1, ll. 63-67; col. 2, ll. 1-36).

For the above reasons, we affirm the following rejections: (1) the § 103 rejection of claims 1-3, 6, 7, 11-20, 24-34, 38-57, and 88-95 over Davidow, and (2) the § 103 rejection of claims 1-3, 6-8, 11-21, 24-34, 38-57, and 88-95 over Le.

35 U.S.C. § 103 REJECTION OVER PASADYN

CLAIM 1

Appellants argue that Pasadyn fails to teach or suggest determining at least one plasma characteristic that is indicative of at least one feature formed on the wafer (or as semiconducting substrate) as required by claim 1 (Br. 12). We agree.

The Examiner indicates that Pasadyn discloses monitoring the optical emission spectrum and etching depth (Ans. 18). Based on Pasadyn's disclosures, the Examiner determines that since optical spectroscopy is the usual tool for detecting endpoints, it would have been obvious to rely on the emission characteristic of the plasma as being indicative of etching depth and to stop or change the process when the desired depth (i.e., endpoint) is reached (Ans. 18).

We find that Pasadyn discloses that optical emission spectrum or etching depth may be monitored (Pasadyn 18). However, Pasadyn does not

provide any relationship between the optical emission spectrum and the etching depth. The Examiner has not provided any evidence from Pasadyn for finding that optical spectroscopy is used to measure etching depth. Rather, the Examiner uses a conclusory statement that optical spectroscopy is the usual tool used to determine etching depth to provide a relationship between the two parameters (Ans. 18).

Because the argued claim 1 feature is not taught or suggested by Pasadyn, we reverse the Examiner's § 103 rejection of claims 1-57 and 88-95 over Pasadyn.

CLAIM 58

Appellants argue that Pasadyn fails to teach or suggest controlling at least one parameter of a plasma etching process performed in an etch tool based upon the monitored at least one plasma characteristic (Br. 12). Appellants contend that Pasadyn only discloses selecting an etch tool based on the properties of the polishing tool (Br. 12). Appellants do not dispute that Pasadyn discloses using plasma to process the semiconductor material.

We have considered all of Appellants' arguments and are unpersuaded for the reasons below.

The Examiner provides a detailed explanation of how Pasadyn teaches or suggests Appellants' claim 58 (Ans. 14-18). We adopt the Examiner's reasoning as our own.

We add that Pasadyn discloses that the optical emission spectrum may be monitored in an adaptive sampling processing model to modify processing performed in a processing step (Pasadyn 17 and 18). Pasadyn discloses monitoring a variable and using the monitored variable in the

adaptive sampling processing model to modify the processing performed in the processing step (Pasadyn 3, ll. 23-24).

Pasadyn further discloses an embodiment that involves monitoring an etch process of a series of etch tools and matching the wafer having the surface profile that complements the etch process of one of the etch tools (e.g., a wafer with a high middle and low edge profile with a tool operating center-fast, edge-slow etching rate) (Pasadyn 53; Figure 30). Pasadyn further discloses that in any of the embodiments parametric measurements are sent from measuring tools to make supervisory processing adjustments to improve the yield of the device (Pasadyn 53, ll. 34-36).

We understand Pasadyn's above disclosures to indicate two specific features. First, as the Examiner finds (Ans. 17), Pasadyn discloses using a variable, such as optical emission spectrum, to control processing performed (e.g., etching) in the processing step. Second, in the Figure 30 embodiment, once the series of tools are controlled based on the particular sensed variable (e.g., optical emission spectrum) to achieve a particular etch profile, then the wafers having complementary profiles are matched with the particular tools.

Contrary to Appellants' argument, Pasadyn discloses that the etch tools are controlled based on a monitored variable (e.g., optical emission spectrum). The wafer profile is used to determine which etch tool, operating at the particularly desired profile, receives the particular wafer.

From the above disclosures, we determine that Pasadyn discloses "controlling at least one parameter of a plasma etching process performed in said etch tool based upon said monitored at least one characteristic of said plasma," Appellants' only argued distinction.

We affirm the Examiner's § 103 rejection of claims 58-66 over Pasadyn.

DECISION

We AFFIRM the Examiner's § 103(a) rejection of claims 1-3, 6, 7, 11-20, 24-34, 38-57, and 88-95 over Davidow.

We AFFIRM the Examiner's § 103(a) rejection of claims 1-3, 6-8, 11-21, 24-34, 38-57, and 88-95 over Le.

We REVERSE the Examiner's § 103(a) rejection of claims 1-57, and 88-95 over Pasadyn.

We AFFIRM the Examiner's § 103(a) rejection of claims 58-66 over Pasadyn.

The Examiner's decision is affirmed-in-part.

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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