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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte KENJI SAKAMOTO and MASAYUKI TSUJI

Appeal 2019-002707
Application 13/395,677
Technology Center 1700

Before JEFFREY T. SMITH, JAMES C. HOUSEL, and GEORGE C. BEST, *Administrative Patent Judges*.

SMITH *Administrative Patent Judge*.

DECISION ON APPEAL

Pursuant to 35 U.S.C. § 134(a), Appellant[1] appeals from the Examiner's decision to reject claims 1–3, 5, 7–9, and 17–20. We have jurisdiction under 35 U.S.C. § 6(b).

We REVERSE.

STATEMENT OF THE CASE

Appellant's invention is generally directed to a method and apparatus for successively producing epitaxial wafers in which an epitaxial growth

[1] We use the word "Appellant" to refer to "applicant" as defined in 37 C.F.R. § 1.42. Appellant identifies the real party in interest as SUMCO Corporation. Appeal Br. 1.

layer is formed on a surface of a semiconductor wafer using a single wafer processing growth furnace. (Spec. ¶ 2.)

Claim 1 illustrates the subject matter on appeal and is reproduced below:

> 1. A method for producing epitaxial wafers using a single wafer processing epitaxial growth furnace, comprising the steps of:
>
> cleaning for removing deposit on a susceptor in the epitaxial growth furnace, wherein the epitaxial growth furnace includes a layer formation chamber which is substantially partitioned into an upper space and a lower space by the susceptor;
>
> after the step of cleaning, performing first wafer processing for obtaining a first epitaxial wafer by mounting a first wafer on the susceptor and growing an epitaxial layer on the first wafer based on first control parameters;
>
> without a step of cleaning for removing deposit on the susceptor in the epitaxial growth furnace after the first wafer processing, performing second wafer processing after transferring the first epitaxial wafer from the susceptor, for obtaining a second epitaxial wafer by mounting a second wafer on the susceptor and growing an epitaxial layer on the second wafer based on second control parameters set such that the second epitaxial wafer has approximately the same film thickness profile as the first epitaxial wafer;
>
> without a step of cleaning for removing deposit on the susceptor in the epitaxial growth furnace after the second wafer processing, performing at least third wafer processing after transferring the second epitaxial wafer from the susceptor, for obtaining a third epitaxial wafer by mounting a third wafer on the susceptor and growing an epitaxial layer on the third wafer based on the second control parameters set such that the third epitaxial wafer has approximately the same film thickness profile as the first and second epitaxial wafers; and
>
> wherein the first control parameters and the second control parameters each include a flow rate of reactive gas

> supplied to the upper space of the layer formation chamber and a flow rate of inert gas supplied to the lower space of the layer formation chamber, and the flow rate of the inert gas supplied to the lower space in the second control parameters is lower than the flow rate of the inert gas supplied to the lower space in the first control parameters, and
>
> wherein the first and the second control parameters are set such that a difference in epitaxial layer film thickness between the first wafer and the second wafer at a position 2 mm from each respective wafer's edge toward a center of the wafer (ROA2 difference) is 5 nm or less over the peripheries of the first and second wafers.

Appeal Br. 22–23, Claims Appendix.

The following rejections are presented for our review:[2]

I. Claims 1–3, 5, 7–9, and 17–19 are rejected under 35 U.S.C. § 103(a) as unpatentable over Zojaji (US 2006/0169669 A1; published Aug. 3, 2006), and further in view of Miyashita (US 2010/0029066 A1; published Feb. 4, 2010) and Takizawa (US 7,340,320 B2; issued Mar. 4, 2008).

II. Claim 20 rejected under 35 U.S.C. § 103(a) as unpatentable over Zojaji, Miyashita, Takizawa and further in view of Arai (US 2001/0001384 A1; published May 24, 2001).

OPINION

After review of the respective positions provided by Appellant and the Examiner, we REVERSE the Examiner's rejections under 35 U.S.C. § 103(a). The Examiner has reproduced the rejections on appeal in the Examiner's Answer. (Ans. 3–19.)

[2] The complete statement of the rejection on appeal appears in the Final Office Action. (Final Act. 4–12.)

The Examiner finds Zojaji teaches a method of producing epitaxial wafers using a single wafer processing epitaxial growth furnace. (Final Act. 4.) The Examiner finds Zojaji discloses a step of cleaning for removing deposit from the furnace that is repeated after processing of multiple epitaxial substrates. (Final Act. 4; Zojaji ¶ 60.) The Examiner recognizes Zojaji does not suggest that the susceptor disposed within the furnace chamber partitions the furnace's layer formation chamber into an upper space and a lower space. (Final Act. 4.) The Examiner finds Miyashita teaches a process of manufacturing epitaxial wafers, wherein a reaction chamber is divided into an upper space and a lower space by a susceptor. (Final Act. 4; Miyashita Fig. 3, ¶¶ 65–66.)

The Examiner recognizes Zojaji and Miyashita do not disclose successively growing an epitaxial layer on the second and third wafers based on a second control parameters, which are different than the control parameters for a first wafer, such that the second and third wafers have approximately the same thickness profiles as the first epitaxial wafer. (Final Act. 5.) The Examiner finds Takizawa teaches a method of producing epitaxial multiple wafers using processing control parameters, including gas flow rate, controlled and adjusted in order to eliminate inconsistency, e.g., thickness inconsistency, that occurs as the number of process wafers changes. (Final Act. 5–6; Takizawa cols. 2 and 10.) The Examiner finds Zojaji, Miyashita, and Takizawa teach flowing reactive gas and inert gas into the processing chamber having the upper space and the lower space for film deposition meeting the limitations recited in claim 1. (Final Act. 6–7.) The Examiner concludes:

> Based on the factual teachings of Zojaji/Miyashita/Takizawa, it would have been obvious to one ordinary skill in the art that the

> control parameters of the deposition recipe comprising the flow rate of reactive gas and the flow rate of the inert gas for epitaxial layer growth for each wafer of the multiple wafer[s] affect the properties or qualities of the resulting epitaxial wafers. Thus it would have been obvious that one of ordinary skill in the art at the time of invention would have modified/optimized the flow rates of the inert gas supplied to the lower space and the flow rate of the reactive gas for epitaxial layer growth for each wafer in the process of Zojaji/Miyashita/Takizawa, and obtained various gas flow rates including the instantly claimed "the flow rate of the inert gas supplied to the lower space in the second control parameter is lower than the flow rate of the inert gas supplied to the lower space in the first control parameter" as recited in claim 1.

(Final Act. 7.)

The Examiner further determines:

> [I]t would have been obvious that one of ordinary skill in the art at the time of invention would have modified and/or optimized the flow rates of the inert gas and the reactive gas (the first and the second control parameters) in the process of Zojaji/Miyashita/Takizawa, and obtained wafers having a difference in epitaxial layer film thickness between the first wafer and the second as less as possible, including "a difference in epitaxial layer film thickness between the first wafer and the second wafer at a position 2 mm from each respective wafer's edge toward a center of the wafer (ROA2 difference) is 5 nm or less over the peripheries of the first and second wafers" as recited in claim 1, in order to control the thicknesses consistency of the resulting epitaxial film on the wafers and get epitaxial wafers as uniform as possible as suggested by Takizawa, by conducting routine experimentation of a result effective variable. See MPEP 2144.05 II A-B.

(Final Act. 8–9.)

The dispositive issue on appeal is:

Did the Examiner err in determining that the combination of Zojaji, Miyashita, and Takizawa teach or suggest controlling the flow rate of inert

gas in the lower chamber was known to effect epitaxial layer uniformity and for the purpose of ensuring that the ROA2 difference is 5 nm or less as recited in the method of independent claim 1?

We answer this question in the affirmative.

Appellant argues that one of ordinary skill in the art would not have been led by the teachings of Zojaji, Miyashita, and Takizawa to control the flow rate of inert gas in the lower chamber to effect epitaxial layer uniformity and for the purpose of ensuring that the ROA2 difference is 5 nm or less as recited in the method of independent claim 1. (Appeal Br. 18–20.)

The Examiner has not demonstrated that Zojaji, Miyashita, and Takizawa teach or suggest a relationship between the flow rate of inert gas supplied to the lower chamber of the furnace and the uniformity of film thickness at a position 2 mm from each respective wafer's edge toward a center of the wafer (ROA2 difference). Neither Zojaji nor Takizawa disclose a susceptor that partitions the reaction chamber into an upper and lower space wherein inert gas is flowed into the lower space. Takizawa discloses controlling the pressure, temperature and gas flow rate in the reactor chamber for the purpose of controlling the film is deposited on a wafer. (Takizawa col. 8.) Miyashita discloses the purpose of supplying the inert gas to the lower space is to keep the circumference of the wafer clean. (Miyashita ¶¶ 50, 66.) Miyashita does not teach the effect of the flow, or adjustments to the flow rate, on film thickness at the wafer periphery (ROA2 difference) as required by independent claim 1.

The Examiner's explanation that one having ordinary skill in the art would have arrived at the claimed ROA2 difference through routine experimentation (Final Act. 8–9) does not provide the requisite rational

underpinning explaining why a person of ordinary skill in the art would have arrived at the claimed invention through routine optimization of the flow rate to the lower space of the chamber. *See In re Stepan Co.,* 868 F.3d 1342, 1346 (Fed. Cir. 2017) (reversing a rejection based on a rationale of routine optimization because the rejection failed to explain why it would have been routine optimization to arrive at the claimed invention.) Miyashita does not teach the effect of the flow, or adjustments to the flow rate, on film thickness at the wafer periphery.

Accordingly, we do not sustain the rejection of claims 1–3, 5, 7–9, 17–19 (Rejection I) for the reasons presented by Appellant (Appeal Br. 18–20) and those given above.

Appealed Rejection II relies on the combination of Zojaji, Miyashita, and Takizawa to reject claim 20, in combination with the additional prior art reference Arai. The Examiner cited Arai to address limitations not included in the dispositive issue. Accordingly, because all rejections are based on the combined teachings of Zojaji, Miyashita, and Takizawa, we also do not sustain this rejection for the reasons presented by Appellant and given above.

CONCLUSION

In summary:

Claims Rejected	35 U.S.C. §	Reference(s)/Basis	Affirmed	Reversed
1–3, 5, 7–9, 17–19	103	Zojaji, Miyashita, Takizawa		1–3, 5, 7–9, 17–19
20	103	Zojaji, Miyashita, Takizawa, Arai		20
Overall Outcome				1–3, 5, 7–9, 17–20

REVERSED