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D E C I S I O N
of 22 June 2000

Case Number: T 0797/95 - 3.4.1

Application Number: 90304043.4

Publication Number: 0393957

IPC: C23C 14/35

Language of the proceedings: EN

Title of invention:

Method and apparatus for sputter coating stepped wafers -
case B

Applicant:

Tokyo Electron Limited

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 56

Keyword:

"Inventive step (yes)"

Decisions cited:

-

Catchword:

-



Case Number: T 0797/95 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 22 June 2000

Appellant: Tokyo Electron Limited
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 8 May 1995 refusing
European patent application No. 90 304 043.4
pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: G. Davies
Members: M. G. L. Rognoni
G. Assi

Summary of Facts and Submissions

I. The appellant (applicant) lodged an appeal against the decision of the Examining Division, dispatched on 8 May 1995, refusing the application No. 90 304 043.4 (publication No. 0 393 957). The notice of appeal was received on 10 July 1995, the prescribed fee being paid on the same day. The statement setting out the grounds of appeal was received on 18 September 1995.

II. In the decision under appeal, the Examining Division held that the subject-matter of the claimed invention did not involve an inventive step within the meaning of Article 56 EPC, having regard to the following document:

D1: GB -A - 2 157 715

and to the skilled person's general knowledge.

III. In response to a communication from the Board, the appellant filed a new set of claims 1 to 18 and new pages of the description 7, 7a, 11, 12, 17, 31 with a letter dated 21 December 1999, received on 27 December 1999.

IV. The appellant requested that the decision under appeal be set aside and a patent be granted on the basis of the following documents:

Claims: No. 1 to 18 as filed with the letter dated 21 December 1999;

Description: pages 7, 7a, 11, 12, 17, 31 as filed with the letter dated 21 December 1999, pages 1 to 6, 8 to 10, 13 to 16, 18 to 30 and 32 to 60 as originally filed;

Drawings: Sheets 1/7 - 7/7 as originally filed.

Furthermore, the appellant requested that oral proceedings be held if the Board were minded to decide against the appeal on the basis of the written submissions.

V. The wording of claim 1 reads as follows:

"1. A sputtering apparatus (10) for depositing a desired controlled distribution of coating material onto a substrate, said apparatus comprising a one-piece target (21) having a sputtering surface (22) on which there is defined a plurality of different sputtering regions including a first region (94) and a second region (95), control means (50) for establishing separate and different electrical operating parameters for each of said regions so as to cause the deposition of the sum of material sputtered from all of said regions to be of a desired distribution across the substrate surface (22), at least first and second individually activatable magnets (41a, 42a), each positioned so as to generate, when activated, a plasma supporting magnetic field corresponding to a respective one of the first and second regions (94, 95) to cause emission of sputtering material, and erosion of the target (21), at the target region when the target is energised, a timing circuit (53) for activating one of the magnets (41a, 42a) while the other is deactivated and a power supply (51) operable to energise the target

in accordance with the separate and different electrical parameters established for each region (94, 95) and in synchronism with the activation of the magnetic field corresponding to the respective target region".

The wording of claim 12 reads as follows:

"12. A method of depositing a desired distribution of sputtered material across the surface of a substrate and for controlling the deposition rates from different regions of the sputtering surface of a target which erode at different rates, comprising providing a one-piece target (21) having a sputtering surface (22) on which there is defined a plurality of different sputtering regions including a first region and a second region (94, 95); establishing separate and different electrical parameter values for each of said regions so as to cause the deposition of the sum of material sputtered from all of said regions to correspond to a prescribed desired distribution across the substrate surface (22); activating a first plasma supporting magnetic field adjacent said first target region (94) so as to cause the emission of sputtered material, and the erosion of said target (21), in said first target region (94) when said target (21) is energised; energising said target (21) in accordance with the separate and different electrical parameter value established for said first target region (94) while said first magnetic field is activated and other magnetic fields are deactivated; activating a second plasma supporting magnetic field adjacent said second target region (95) so as to cause the emission of sputtered material, and the erosion of said target (21), in said second region (95) when said target (21)

is energised; and energising said target (21) in accordance with the separate and different electrical parameter value established for said second target region (95) while said second field is activated and other magnetic fields are deactivated."

Claims 1 to 11 and 13 to 18 are dependent on claim 1 and 12, respectively.

VI. The appellant's arguments can be summarised as follows:

The apparatus according to the present invention had a one-piece target with two sputtering regions and separately controlled plasma supporting magnetic fields which operated at least partially alternately or in sequence so that a plasma was produced above each sputtering region alternately or in sequence. Furthermore, the emission rate of each target region was adjusted not only by controlling the plasma supporting magnets but also by setting the target voltage in synchronism with the activation of the magnets. Emission rate control had been effected in the past by controlling a target energisation level but this had been done with a target having separate and electrically isolated sections. The problem consequent on such arrangements, including the requirement for separate power supplies and an increased complexity of the target assemblage, were completely obviated with the invention, because energisation level control was effected on a one-piece target. The claimed invention had the advantage of providing for localised control of the sputtering amounts from specific known regions of a one-piece target and thus for localised control of the target erosion and of the resulting deposition distribution uniformity across the substrate surface.

Document D1 taught two alternative solutions to achieving control of the sputtering rate: firstly, by controlling the plasma supporting magnets and, secondly, by controlling the energisation level of the target when this comprised separate and electrically isolated sections. As the prior art provided no impetus to combine such alternate and distinct methods of control, the subject-matters of claims 1 and 12 were both novel and inventive.

Reasons for the Decision

1. The appeal is admissible.
2. Claims 1 to 18 correspond essentially to the claims of the main request considered in the contested decision. All amendments made to the claims and to the description find support in the application documents as originally filed and are, therefore, admissible under Article 123(2) EPC.
3. The present application seeks to control target erosion and sputtering power in a sputtering apparatus comprising a one-piece target by adjusting both the plasma discharge over each of the two target regions and the target voltage. Since the target is in one-piece, it is not possible to energise the two sputtering regions at different voltages. To overcome this intrinsic limitation of the one-piece target, the invention essentially proposes to operate the two sputtering regions alternately or sequentially while the voltage corresponding to the active sputtering region is applied to the target.

3.1 D1 relates to a sputtering apparatus which makes "possible an improved step-coating with unimpaired homogeneity of the thickness of the layer" (page 1, lines 120 to 122). A first embodiment disclosed in D1 (Figure 1) shows, or necessarily implies, the following features recited in claim 1 of the present application:

- a one-piece target (1) having a sputtering surface on which a first sputtering region (5) and a second sputtering region (14) are defined,
- control means for establishing separate and different electrical operating parameters for each region (cf. D1, page 2, lines 128 to page 3, line 3),
- first and second individually activatable magnets (4 and 10),
- a timing circuit for activating the magnets (page 3, lines 110 to 116),
- a power supply to energise the target (page 2, lines 121 and 122).

3.2 It is further specified in D1 (page 3, lines 111 to 116) that "it is advantageous to operate the individual sputtering zones alternately and to establish the setting of the powers of the individual sputtering zones, averaged over the coating time, by the respective times for which they are switched on" (emphasis added). This implies the provision of a timing circuit which switches on and off the first and second magnets to control the respective plasma supporting fields and, thus, the sputtering powers.

Though it may occur that the timing circuit activates one magnet while the other is deactivated, in the opinion of the Board, the cited passage of D1 refers essentially to the **simultaneous** operation of both magnets in an alternate manner, in order to control the emission rate of the corresponding sputtering regions (cf. contested decision page 5, third paragraph).

- 3.3 In the second embodiment (Figure 2) disclosed in D1, the target comprises two separate parts, each having a separate **static** magnetic field. The sputtering power is set by energising each zone at a certain voltage (page 3, lines 88 to 92).

There is no suggestion in D1 that the two modes of operation of the first and second embodiments might be combined so as to control the sputtering power by varying both the **intensity** of the electromagnetic field and the **voltage** across the cathode and the anode in a sputtering apparatus with a one-piece target.

- 3.4 Hence, the subject-matter of claim 1 differs from the apparatus shown in D1 in that:

- (a) the timing circuit activates one of the magnets while the other is deactivated;
- (b) the power supply is operable to energise the target in accordance with the electrical parameters established for each region and in synchronism with the activation of the magnetic field corresponding to the respective target region.

- 4.1 In the contested decision, the Examining Division

essentially argued that it would be obvious to the skilled person, wishing to improve the way sputtering performance of each zone was controlled, to consider the power supplied to the target as a parameter value to be individually set for the operation of each of the sputtering zones, and, accordingly, to provide the sputtering apparatus disclosed in D1 (first embodiment) with a power supply as specified in claim 1 of the present application.

4.2 It is known in the prior art to ensure uniform sputtering in a sputtering apparatus comprising **two electrically insulated annular targets** by controlling the currents supplied to the electromagnets and the voltages applied to the targets. However, none of the prior art documents cited in the European search report teaches to control the sputtering power in a sputtering apparatus comprising a **one-piece target** and two magnets, which generate corresponding plasma supporting magnetic fields and define corresponding target regions, by energising the target in accordance with the separate and different electrical parameters established for each region, and in synchronism with the activation of the corresponding magnetic field.

4.3 Since there is no suggestion in the prior art that it may be advantageous to operate a sputtering apparatus comprising a one-piece target like an apparatus with two separate, electrically insulated targets, in the opinion of the Board, the skilled person starting from D1 would have no incentive to develop an apparatus falling within the terms of claim 1.

Hence, the subject-matter of claim 1 involves an inventive step within the meaning of Article 56 EPC.

5. Claim 12 is based essentially on the same features of claim 1 expressed in terms of method steps.
6. Claims 2 to 11 and 13 to 18 are dependent and, therefore, their subject-matters also involve an inventive step.
7. Hence, the Board concludes that the appellant's request is allowable and that a patent can be granted on the basis thereof.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside,
2. The case is remitted to the department of first instance with the order to grant a patent on the basis of the following documents:

Claims: No. 1 to 18 as filed with the letter dated 21 December 1999;

Description: pages 7, 7a, 11, 12, 17, 31 as filed with the letter dated 21 December 1999, pages 1 to 6, 8 to 10, 13 to 16, 18 to 30 and 32 to 60 as originally filed;

Drawings: Sheets 1/7 to 7/7 as originally filed.

The Registrar:

The Chairman:

R. Schumacher

G. Davies