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D E C I S I O N
of 17 July 2001

Case Number: T 1048/96 - 3.4.3

Application Number: 87111722.2

Publication Number: 0268021

IPC: H01L 21/31

Language of the proceedings: EN

Title of invention:
Sloped contact etch process

Applicant:
MOTOROLA, INC.

Opponent:
-

Headword:
Sloped contact etch/MOTOROLA INC.

Relevant legal provisions:
EPC Art. 123(2), 51(2), 56

Keyword:
"Amendments - matter going beyond the contents of the application as filed (main request)"
"Inventive step - no (auxiliary requests A to E)"

Decisions cited:
G 0001/97

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1048/96 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 17 July 2001

Appellant: MOTOROLA, INC.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 20 March 1996 refusing European patent application No. 87 111 722.2 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: R. K. Shukla
Members: E. Wolff
M. B. Günzel

Summary of Facts and Submissions

I. This is an appeal against the decision of the Examining Division, posted 20 March 1996, to refuse European patent application No. 87 111 722.2 on the ground that the invention as claimed in claim 1 did not involve an inventive step in view of the following prior art documents:

D1: Solid State Technology, Vol. 27, pages 107-112, 1984,

D2: Solid State Technology, Vol. 24, pages 71-75, 1981

The Examining Division furthermore expressed doubts concerning the allowability of claim 1 under Article 123(2) EPC.

II. A notice of appeal was filed on 28 May 1996 and the appeal fee was paid on the same day.

The statement setting out the grounds of appeal was filed on 26 July 1996.

The appellant requested that the decision of the Examining Division be set aside in its entirety and that a patent be granted on the basis of the claims forming the basis of the decision under appeal (main request). On 2 May 2001 the appellant replied to a communication by the Board with further arguments and five sets of claims as auxiliary requests A to E.

III. Oral proceedings took place on 17 July 2001. In the course of the oral proceedings and with the agreement of the Board the appellant amended claim 1 of each of

the auxiliary requests.

IV. Independent claim 1 according to the main request reads as follows:

1. A process for providing a sloped contact via in a substrate (12) having a patterned mask (11) formed thereon and performed in a reactive ion etcher, the process comprising the steps of:

etching the substrate (12), wherein etching the substrate generates a polymer on the substrate which inhibits substrate etching;

introducing process gases which are selective to the polymer on the substrate and etching the polymer for a predetermined time;

performing at least one mask erosion step."

V. Claims 1 and 2 of auxiliary request A, as amended during the oral proceedings, read as follows:

"1. A reactive ion etching process is claimed for providing a sloped contact etch comprising the steps of

(a) etching the substrate (12) a first time in an area defined by a resist layer (11),

(b) removing a polymer produced on said substrate (12); during said step of etching said substrate (12) a first time;

(c) etching said resist layer (11) thereby increasing the area of said substrate (12) defined by said

resist layer (11); and

(d) etching the substrate (12) in the area defined by said resist layer 11.

2. The process of claim 1 further comprising, following step (b) the steps of: etching said substrate (12) a second time in said area defined by said resist layer (11); and removing a polymer produced on said substrate (12) during said step of etching said substrate (12) a second time."

Claim 1 of auxiliary request B, as amended during the oral proceedings, reads as follows:

"1. A reactive ion etching process for providing a sloped contact etch in a substrate (12), comprising the steps of:

(a) etching the substrate (12) a first time in an area defined by a resist layer (11),

(b) removing a polymer produced on said substrate (12); during said step of etching said substrate (12);

(c) etching said resist layer (11) thereby increasing the area of said substrate (12) defined by said resist layer (11); and

(d) etching the substrate (12) in the area defined by said resist layer 11."

Auxiliary requests C, D and E contain the same independent claim 1 as auxiliary request B, the

differences residing in the dependent claims and in the case of auxiliary request E in an additional product by process claim 11.

VI. The arguments put forward by the appellant can be summarised as follows:

Main request

In the decision under appeal the finding of lack of an inventive step is based on the contention that the problems of polymer formation and its removal from reactor surfaces were known from document D2. According to document D2, however, removal of polymer from the reactor vessel takes place only during reactor downtime, while the adverse effects of polymer formation during wafer etching are alleviated by taking measures to reduce polymer formation. Reducing polymer formation also reduces etch selectivity which admittedly gives the skilled person an incentive to look for alternative solutions. However, since cleaning a reactor vessel during downtime is a quite different process from removing polymer from a substrate during processing, it would not be obvious to the skilled person, without knowledge of the invention in suit, to choose the claimed solution.

It was also contended that the application as originally filed contained no indication that polymer removal is repeated any time after the first resist etching step. However, the description with reference to Figures 1 to 4 of the drawings shows that the substrate is etched by a series of processing steps which includes etching the substrate combined with periodic filament removal steps. Claim 1 therefore

complies with the requirements of Article 123(2) EPC.

The appellant had been notified in a written communication that the Board's preliminary view was that claim 1 did not comply with the requirements of Article 123(2) EPC, but provided no further arguments in support of the main request during the oral proceedings.

Auxiliary requests

The claims in auxiliary request A are identical with the claims as originally filed, and the independent claim 1 of each of the auxiliary requests B to E differs only editorially, but not in substance, from claim 1 of auxiliary request A. The requirements of Article 123(2) EPC are therefore fulfilled in respect of each of the auxiliary requests.

The essential aspect of the invention as claimed in auxiliary requests A to E is controllability of the etched slope, which in turn determines the contact area at the bottom of the resulting well. The main object of the invention from amongst those set out in the description (page 6 line 15 to page 7 line 10) is "to provide a sloped contact etch process that can be selectively varied to provide differing slopes" (page 6 lines 21 to 23). Selective controllability of the etched slope and polymer removal from the wafer are not considered in either document D1 or document D2.

Document D1 concerns multi step contour (MSC) etching in general without any mention of polymer filaments which become a significant problem only where the formation of narrow vias requires tight process

control.

Document D2 deals with polymer formation both on reactor vessels and on wafers. To remove polymer formed on the walls of the reactor vessel, etching with an oxygen plasma is proposed, but such removal takes place only during reactor downtime. To alleviate the problem of polymer formation on substrates, document D2 proposes measures such as variations in the gas composition, to reduce polymer formation. Document D2 acknowledges that varying the gas chemistry to reduce polymer formation has the effect of also reducing etch selectivity. There is no suggestion whatsoever that better controllability could be achieved by removing polymer formed on the substrate rather than reducing its formation. For these reasons, and especially in view of a substrate being much more susceptible to damage, the skilled person aiming improve controllability of via etching would not consider a process for removing polymer from reactor equipment to provide any assistance towards overcoming the problem of polymer formation on a substrate.

VII. Following the announcement, by the chairman of the Board, of the Board's decision to dismiss the appeal, the appellant requested to be given a further opportunity to amend his claims. The Chairman of the Board explained that with the announcement of the decision the proceedings before the Board had terminated, and that therefore no further submissions could be accepted by the Board. The Chairman also drew the appellant's attention to decision G 1/97 (OJ EPO 2000, 322) of the Enlarged Board of Appeal from which it is to be taken that decisions of the Boards of Appeal become final as soon as they are issued and that

thereafter the Board cannot reopen proceedings. Thereupon the oral proceedings were declared closed.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 Allowability of amendments (Article 123(2) EPC)

According to claim 1 as originally filed, the etching process involves four steps of which the third step is etching the resist layer to increase the area over which the substrate is etched and the fourth step is etching the substrate in the area defined by the resist layer. Claim 1 of the main request refers, instead, to "performing at least one mask erosion step".

As had already been indicated in the communication by the Board, the term "mask erosion" is not as such clearly limited to "etching the resist layer thereby increasing the area of the substrate defined by the resist layer". Mask erosion can be read to encompass the step of removing the photoresist altogether, for example, thereby clearly going beyond the contents of the application as filed.

Furthermore the wording of claim 1 permits the mask erosion step to be performed at any time during processing. In contrast the original application provides support only for a process in which the resist is etched for the purpose of increasing the exposed surface area of the substrate only after the substrate

has been etched in one or more cycles of substrate etching and polymer removal (see for example the process formula on page 10 line 13 of the application as filed, and the description of the essential steps of the process on pages 8 and 9 of the application as filed). Moreover, the application as filed nowhere refers to filament removal after the resist has been etched to enlarge the exposed surface area of the substrate.

For the foregoing reasons the Board concludes that as a result of the amendments to claim 1 of the main request new matter is included which goes beyond the contents of the application as filed, in contravention of Article 123(2) EPC.

3. *Auxiliary requests*

3.1 Amendments

The claims forming auxiliary request A are identical to the claims as originally filed.

Claim 1 of each of the auxiliary requests B to E differs from claim 1 of auxiliary request A only in the removal from the claim of the words "is claimed" and other minor editorial changes.

The dependent claims of each of the auxiliary requests concern features taken from the description or claims as originally filed.

The Board is therefore satisfied that the claims of the auxiliary requests A to E do not extend beyond the subject matter of the application as originally filed

and hence comply with the requirements of Article 123(2) EPC.

3.2 Inventive step

The differences in wording between claim 1 of auxiliary request A and each of the auxiliary requests B to E being merely editorial, auxiliary requests A to E can be dealt with together for the purposes of assessing whether the claimed invention involves an inventive step.

Document D1 is the closest prior art and it relates to a process for forming sloped vias by a technique referred to as multi-step contour (MSC) etching in which the desired profile of a slope is approximated by alternative steps of etching the substrate and increasing the area of the substrate exposed to the etch. (See page 108, left hand column, "MSC Example" and Figure 1). The process consists of two distinct steps. The first step, referred to as module 1 is a vertical etching step which is highly selective in respect of the mask and the underlying layer, and the second step, referred to as module 2, is a mask erosion step which is highly selective in respective of the film and the underlying layer (page 108 left hand column). As described, the MSC processing is performed in a reactive ion etching system configured for oxide etching. During the vertical etching step, a gas mixture of CHF_3 and CO_2 is used while the mask erosion step is performed in an oxygen atmosphere (page 110, Table 1).

In the wording of claim 1 the disclosure in document D1 thus provides a sloped contact etch comprising the

steps of etching the substrate the first time in an area defined by a resist layer (module 1 of document D1), etching the resist layer thereby increasing the area of the substrate defined by the resist layer (module 2 of document D1), and etching the substrate in the area defined by the resist layer (module 1). There is, however, no mention in document D1 of step (b) of claim 1, that is, removing a polymer produced on the substrate during the first step of etching the substrate.

Starting with document D1, the objective problem of the invention is to improve the controllability of the etching process.

Document D2 relates to ion-assisted plasma etching of silicon oxides. According to document D2, using fluorocarbon gases such as CHF_3 produces unsaturated compounds in the plasma which leads to the formation of polymeric material on both the wafer surface and the reactor chamber (page 72, left hand column, third paragraph). According to document D2, polymer formation on the wafer can reduce etch rates and may result in incomplete removal of oxide from contact windows (page 72, left hand column, paragraph 4). On the basis of the effect, described as known, that addition of oxygen to CHF_3 reduces polymer formation, document D2 sets out the results of studies concerning several oxygen containing gases such as O_2, N_2O and CO_2, in various concentrations. According to document D2, O_2 significantly decreased the polymer deposition rate but also significantly reduced the etch selectivity with respect to silicon; CO_2 was found to be less effective than O_2 in reducing polymer formation but to reduce much less than O_2 the etch selectivity as between silicon and

photoresist (page 72, left hand column, paragraphs 6 to 9).

CO_2 forms part of the gas mixture described in document D1 (page 110, right hand column, Table 1) during the vertical etching stage. The disclosure in document D2 demonstrates that at the priority date of the invention the problem of polymer formation was known, as well as that it was known that adding CO_2 to the gas mixture reduces polymer formation during the vertical etching stage, that reduced polymer formation is achieved at the cost of a reduced etch selectivity and that, conversely, increased etch selectivity is accompanied by increased polymer formation.

Faced with the need for greater etch selectivity in order to achieve the object of better controllability of the etched slope, the skilled person is therefore encouraged to contemplate how a high etch selectivity can be maintained free from the interference caused by the presence of polymer. Given that the removal of unwanted material by etching is a standard technique in the field of semiconductor manufacture, that removal of unwanted material by etching is the purpose of the reactive ion etching process and that the removal of polymer requires nothing more than replacing the gases used for etching the substrate with a gas known to etch polymer, the skilled person would as a result of these routine considerations arrive at the solution that the polymer needs to be removed from time to time to prevent its build up.

In the Board's judgement therefore the invention as claimed in claim 1 of the auxiliary request A, which provides for periodic removal of polymer and hence the

invention as claimed in claim 1 of each of the auxiliary requests B to E, does not involve an inventive step.

In addition to the written auxiliary requests A to E, the appellant requested during the oral proceedings that the Board consider the issue of inventive step in respect of claim 2 of all the auxiliary requests if the Board were to conclude that the process claimed in claim 1 was not inventive.

Claim 2 of auxiliary request A is directed to repeating steps (a) and (b) of the main claim a second time before proceeding to step (c).

Claim 2 of auxiliary requests B to E is directed to the feature of repeating steps (a) and (b) of the process claimed in claim 1 until a desired depth is reached before proceeding to step (c).

In each case, therefore, claim 2 provides for the mere repetition of a step or of a sequence of steps, respectively, specified in claim 1.

In the Board's view, such a repetition with a view to obtaining the desired depth would be a routine measure for a person skilled in the art and therefore cannot confer an inventive step on the process concerned. A main claim including the features of claims 1 and 2 as proposed would not have met the requirement of an inventive step.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

D. Spigarelli R. K. Shukla