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D E C I S I O N
of 8 March 2001

Case Number: T 0982/95 - 3.4.3

Application Number: 88307183.9

Publication Number: 0303396

IPC: H01L 23/52

Language of the proceedings: EN

Title of invention:
Improved laser-blown links

Applicant:
AT&T Corp.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - denied"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0982/95 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 8 March 2001

Appellant: AT&T Corp.
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Representative: Johnston, Kenneth Graham
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 1 August 1995 refusing European patent application No. 88 307 183.9 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: R. K. Shukla
Members: E. Wolff
A. C. G. Lindqvist

Summary of Facts and Submissions

I. The appeal lies from the decision of the examining division, dated 1 August 1995, to refuse European patent application No. 88 307 183.9 for lack of an inventive step over the following prior art documents:

D1: Patent Abstracts of Japan, vol. 8, No. 81 (E-238)[1518], 13 April 1984;

D2: Patent Abstracts of Japan, vol. 7, No. 103 (E-173)[1248], 6 May 1983;

D3: IBM Technical Disclosure Bulletin, vol. 22, No. 5, October 1979, pages 1971-1972;

D4: EP-A-0 089 814.

II. A notice of appeal was filed on 9 September 1995 against the decision of the examining division dated 1 August 1995. The appeal fee was paid on the same day. The statement setting out the grounds of appeal was filed on 24 November 1995.

Together with the notice of appeal, the appellant filed a fresh set of 18 claims, consisting of independent device claim 1 and its dependent claims 2 to 9, and independent method claim 10 and its dependent claims 11 to 18.

Oral proceedings were not requested.

III. The appellant requested the grant of the patent on the basis of the following documents:

Claims: claims 1 to 18 as filed with the statement of the grounds of appeal on 24 November 1995

Description: pages 1,2 and 6 as originally filed
pages 3 to 5 as filed on 6 August 1992

Drawings: Sheet 1/1 as originally filed

IV. Independent claim 1 of the request reads as follows:

"1. A solid state circuit comprising:

a lower interconnect level having a conductive link (12) adapted to being rendered non-conductive by the application of laser energy thereto; a deposited dielectric layer comprising silicon dioxide (13) overlying said lower interconnect level; and upper interconnect level (14) overlying said dielectric layer and crossing over said lower interconnect level at crossover locations (25);

wherein said dielectric layer (13) has a thickness that is chosen so as to minimize to a desired degree the capacitance between the upper and lower interconnect levels, or alternatively obtain a desired degree of planarization, or both;

CHARACTERISED IN THAT an etch-resistant masking layer (15,24) is formed over at least said crossover locations, and the thickness of said dielectric layer

over said link in the lower interconnect level is chosen to be substantially less than the thickness of said dielectric layer under said etch-resistant masking layer so that the magnitude of the laser energy required to reliably blow the link is reduced."

Independent claim 10 of the request reads as follows:

"10. A method of making an integrated circuit by steps comprising:

forming a first dielectric layer (11) overlying a semiconductor substrate (10), forming on said first dielectric layer a lower interconnect level of conductive material (12) that includes link portions (22) adapted to being rendered non-conductive by laser energy directed thereto depositing a second dielectric layer comprising silicon dioxide (13) overlying said lower interconnect level; and forming an upper interconnect level of conductive material (14) on said second dielelectric layer, with said upper interconnect level crossing over said lower interconnect level at crossover locations (25);

wherein said second dielectric layer (13) has a thickness that is chosen so as to minimize to a desired degree the capacitance between upper and lower interconnect levels, or alternatively obtain a desired degree of planarization, or both;

CHARACTERIZED BY forming an etch-resistant masking layer (15, 24) over at least said crossover locations, and etching portions of said second dielectric layer over said link portions be substantially less than the thickness of said second dielectric layer under said

etch-resistant masking layer so that the magnitude of the laser energy required to reliably blow the link is reduced."

V. The arguments presented by the appellant can be summarised as follows:

(a) Objections by the examiner to the wording of the claim have been addressed by amendments to the claims.

(i) The term "deposited dielectric layer comprising silicon dioxide" replaces "deposited dielelectric layer" to exclude the possibility that the layer consists of silicon nitride only. The new definition includes, but is not limited to glass (Statement of grounds, page 1, last paragraph).

(ii) The phrase "substantially reduced due at least in part to a reduction in the absorption of the laser energy by the dielectric layer" has been changed to "reduced". The effect of the reduction is a significant increase in the reliability of fuse blowing (Statement of grounds, page 2, first paragraph).

(b) The finding by the examining division that the claimed invention lacks an inventive step is based on hindsight. The objective problem as defined by the examiner includes the reduction in laser energy required to blow the link. The objective problem as defined by the examining division is inappropriate. It does not represent the true objective of the invention. The true objective is to maximise the range of laser energies over which links can be reliably blown

(Statement of grounds, page 2, point 2.4), and this is not taught or suggested by the prior art.

Reasons for the Decision

1. The application has been refused by the examining division on the ground that the invention as claimed, inter alia, in claim 1 lacks an inventive step. The decision of the examining division is based on an independent claim 1 which differs from claim 1 in the appellant's request in that in the latter:

   (i) the deposited dielectric layer is specified as "comprising silicon dioxide", and

   (ii) the reduction in the laser energy is no longer specified as being "due at least in part to a reduction in the absorption of the laser energy by the dielectric layer".

1.1 As the appellant has submitted in the statement of the grounds of appeal, these amendments serve to overcome objections raised in the decision under appeal against the subject-matter of claim 1 pursuant to Article 123(2) EPC.

1.2 Also, the appellant has not contended that these amendments have the effect of providing any further relevant distinctions between the prior art and the invention as claimed. The amendment according to sub-paragraph 1(i) consists of a feature already known from document D3, where the intermediate layer 4 and the top layer 5 consist of quartz. This feature is accordingly in the pre-characterizing part of the

claim. The Board also considers that the amendment according to sub-paragraph 1(ii) merely has the effect of making the claim consistent with the description and does not provide any distinction of substance between the subject matter as claimed in claim 1 according to the request now before the Board, and the claim rejected by the examining division in its decision of 1 August 1995.

1.3 In the following, therefore, the question of inventive step has been considered on the basis of the ground for the refusal of the application as set out in the decision under appeal, upon which the appellant has had the opportunity to present his comments.

2. *Inventive step*

2.1 The closest prior art

Document D3, or alternatively document D1, was identified by the examining division to be the nearest prior art. Document D3 relates to a solid state circuit. Using the language of claim 1 of the application, the circuit disclosed in document D3 has the following features in common with the invention as claimed:

(i) a lower interconnect level has a conductive link adapted to being rendered non-conductive by application of laser energy thereto;

(ii) a deposited dielectric layer comprising silicon dioxide overlying said lower interconnect level; and

(iii) an upper interconnect level overlying said dielelectric layer.

Again using the language of claim 1 of the application, the differences between the integrated circuit disclosed in document D3 and the invention as claimed in claim 1 are that claim 1 requires the presence of the following additional features:

(iv) the upper interconnect level crosses over the lower interconnect level at crossover locations;

(v) the dielectric layer has a thickness that is chosen so as to minimize to a desired degree the capacitance between the upper and lower interconnect levels, or alternatively obtain a desired degree of planarization, or both; and

(vi) an etch-resistant masking layer is formed over at least said crossover locations, and

(vii) the thickness of said dielectric layer over said link in the lower interconnect level is chosen to be substantially less than the thickness of said dielectric layer under said etch-resistant masking layer so that the magnitude of the laser energy required to reliably blow the link is reduced.

2.2 In semiconductor devices with multiple levels of wiring separated by insulating layers, it is not uncommon for conductors of different levels to extend in different directions and hence to cross over at certain locations. Indeed, more than one level of conductors is frequently required for the very reason that conductors

need cross-overs in which the conductors remain electrically insulated from one another. The attendant problems of capacitance effects and planarisation in forming a structure with multiple layers of wiring and insulating layers are generally known in the art so that layer thicknesses would be chosen with a view towards minimising these problems.

For the foregoing reasons, the Board does not consider the features referred to in paragraphs 2.1(iv) and (v) to provide a genuine distinction between the claimed invention and the nearest prior art. The conclusion reached by the Board in this respect is thus the same as that previously reached by the examining division (see paragraph 2 of page 5 of the decision of the examining division).

2.3 The objective problem solved by the invention

2.3.1 The examining division had found that the objective problem underlying the subject matter of claim 1 was to improve the ease and reliability of blowing links with an emphasis on the desire to reduce the laser energy required to blow the link.

2.3.2 Against the assessment of the objective problem by the examining division, the appellant has argued that this assessment was based on hindsight. According to the appellant, the true objective is to widen the process window by maximising the difference between minimum and maximum laser energies that reliably blow the link.

2.3.3 Concerning the derivation of the objective problem, the Board finds itself unable to accept the appellant's argument. It is the well-established case-law of the

Boards of Appeal that the objective problem solved by an invention is to be derived from a comparison between the invention as claimed and the nearest prior art.

2.3.4 The claim itself requires that "the magnitude of the laser energy required to reliably blow the link is reduced", rather than that the window is widened between minimum and maximum energy.

2.3.5 The appellant also relies on the text in column 4, lines 51 ff of the published application as supporting his assertion that the true objective is to widen the process window. However, the text referred to relates to a completely different feature of the device which is not claimed. The whole paragraph concerned relates to the beneficial effects of forming the links on pedestals. It refers to the use of the pedestals which "aid the blowing of the links placed thereon." (column 4, lines 37 to 38) and, in the specific passage cited by the appellant, to "using the inventive pedestals" (column 4, lines 51 to 52)

2.3.6 According to column 5, lines 25 to 55 of the application, the etching step used to form the pedestal aids in blowing the links on account of the glass layer being thinner than before etching (600 nm instead of 800 nm). The improvement is postulated to be due to the fact that the reduced thickness allows the silicide conductors to rupture the dielectric layer more easily and at a lower energy level (column 5, lines 38 to 39). Moreover, a thinner layer is considered to reduce the absorption of the laser light, allowing a larger percentage to reach the link.

2.3.7 In the circumstances, the Board is not convinced by the

argument presented by the appellant in the statement of the grounds of appeal, which is that the purpose of thinning the dielectric layer is to widen the window of usable laser powers, rather than to reduce the power at which links can be reliably blown. Instead, in the Board's judgement, the assessment by the examining division of the objective problem solved by the invention is correct.

2.4 The examining division took the view (point 2.5 of the decision) that document D3 is concerned with improving the reliability of laser-cutting links buried beneath a dielectric layer. The solution proposed in document D3 consists of selectively thinning the dielectric layer above the link. According to document D3, the thinning is conveniently carried out simultaneously with the forming of via holes for I/O pads. The examining division was of the opinion that such holes are normally formed by etching with the aid of etch-resistant masks, and that it would be immediately obvious to the skilled person to provide an etch-resistant masking layer over locations where the upper interconnect level crosses over the lower interconnect level in order to reduce the thickness of the dielectric layer exclusively above the link.

2.5 Although the Board agrees with the appellant that in the specific example shown in Figures 1 to 3 of document D3, the layer to be thinned is the upper of two adjoining layers of quartz, the general teaching of document D3 is that a reduction in the thickness of a dielectric material above the link improves the reliability of blowing the link. Moreover, a skilled person encountering cases in which removal of the upper layer alone leads to unsatisfactory results would

consider it obvious to extend the thinning into the lower layer (cf. point 2.5 of the decision of the examining division, in the paragraph bridging pages 7 and 8).

2.6 The appellant has contended that there is no teaching in document D3 that the laser energy required to blow a link is reduced owing to the reduction in the thickness of the dielectric layer. In document D3, the reduction in thickness is for the purpose of reducing splattering of molten material. In the Board's view, what is described in column 5 of the application and on page 1972 of document D3 is in essence the same. According to the application (column 5, lines 25 to 55), the etching step used to form the pedestals aids in blowing the links on account of the glass layer being thinner than before etching (600 nm instead of 800 nm). The improvement is postulated to be due to the fact that the reduced thickness allows the silicide conductors to rupture the dielectric layer more easily and at a lower energy level (column 5, lines 38 to 39). The same is said, albeit in different words, in document D3, where it is stated (page 1972, paragraph 2) that by "selectively weakening the mechanical structure of the quartz layers ... a controlled blowout of the quartz material ... will occur".

2.7 For the foregoing reasons, in the Board's judgement the invention as claimed in claim 1 lacks an inventive step within the meaning of Article 56 EPC.

Order

For these reasons it is decided that:

The appeal is dismissed

The Registrar: The Chairman:

L. Martinuzzi R. K. Shukla