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D E C I S I O N
of 5 December 1996

Case Number: T 0802/93 - 3.4.1

Application Number: 88305407.4

Publication Number: 0296747

IPC: H01L 21/82

Language of the proceedings: EN

Title of invention:
Integrated circuit with tub tie

Applicant:
AT&T Corp.

Opponent:
-

Headword:
Integrated circuit with tub tie/AT&T Corp.

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - yes"

Decisions cited:
-

Catchword:
-

Case Number: T 0802/93 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 5 December 1996

Appellant: AT&T Corp.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office dated 21 April 1993 refusing European patent application No. 88 305 407.4 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: G. D. Paterson
Members: R. K. Shukla
H. J. Reich

Summary of Facts and Submissions

I. European patent application No. 88 305 407.4 was refused by a decision of the Examining Division on the ground that the subject matter of independent claim 1 as filed on 8 May 1992 did not fulfil the requirement of inventive step (Articles 52(1) and 56 EPC) having regard to the prior art disclosed in document D1 (EP-A-0 183 032). During the examination proceedings, the examining Division had also cited the following prior art documents:

D2: Semiconductor International, May 1985, "Silicide Technology Spotlight" by P. Burggraaf, pages 293 to 298, and

D3: US-A-4 435 896.

II. Independent claim 1, which formed the basis of the above decision reads as follows:

"An integrated circuit having a first transistor formed in a doped first tub region (101) of a first conductivity type formed in a silicon body (100) of a given conductivity type, with the source (103) of said first transistor being electrically connected to said first tub region,

Characterized in that said source is electrically connected to said first tub region by means of a first metal silicide tub tie conductor (106) that contacts said silicon body from said source to an adjacent heavily doped contact region (105) of said first conductivity type formed entirely within said first tub region."

III. In the above decision, the Examining Division reasoned essentially as follows:

The subject matter of claim 1 differs from what is disclosed in document D1 only in that the heavily doped contact region is formed entirely within the first tub region. Although document D1 does not explicitly mention any tub- tie function, it is clear to a skilled person that the source 38 is connected to the tub 17 via the silicide layer 39 and the N+ region 35. The minor modification of the teaching of document D1, i.e. formation of the N+ region entirely within the first tub region - cannot be regarded as involving an inventive step.

IV. The Applicant lodged an appeal against the decision and requested the grant of a patent on the basis of an amended set of claims. In the grounds of appeal, the Appellant argued essentially as follows.

Document D1 is concerned with reducing the number of masking steps in the manufacture of a CMOS circuit (see page 1, lines 29 to 32). To this end the N^+ source/drain implant is performed by using polygates 32 and field oxide 30 as a mask (see figure 9 and page 6), and thereafter a selective P^+ source/drain implant is carried out by implanting P-type impurities at a higher dose than the previous N^+ implant, thereby overcompensating the N^+ implant to form the P^+ regions. Subsequently a silicide layer 39 overlying the N^+ is formed. The N+ region extending between the N- and P-tub regions (17,18) and the silicide region 39 are thus mere artifacts resulting from the placement of the isolation region 30, and do not suggest an effective tub-tie as in the present invention. For these reasons, the skilled person would not have any incentive to modify the device described in document D1 such that the N^+ region is entirely within the tub 17.

V. In response to a communication from the Board, the Appellant submitted on 22 July 1996 an amended set of claims 1 to 5 and amended pages 2 to 4 of the description, and now requests the grant of a patent on the basis of these amended claims and description, and the drawings as originally filed.

Independent claim 1 of this set of claims has the following wording.

"An integrated circuit having a first transistor formed in a doped first tub region (101) of a first conductivity type formed in a silicon body (100) of a given conductivity type,

and further comprising a doped second tub region (102) of a second conductivity type opposite to said first conductivity type, with said second tub region abutting said first tub region at a boundary, and still further comprising a field oxide isolation region (120) formed on said boundary at the surface of said silicon body;

wherein a second transistor is formed in said second tub region;

CHARACTERIZED IN THAT the source (103) of said first transistor is electrically connected to said first tub region by means of a first metal silicide tub tie conductor (106) that contacts said silicon body from said source to an adjacent heavily doped contact region (105) of said first conductivity type formed entirely within said first tub region;

and the source (111) of said second transistor is electrically connected by means of a second tub tie (112) to said second tub region, wherein said second

tub tie is a metal silicide that contacts said silicon body from the source of said second transistor to an adjacent heavily doped contact region (113) of said second conductivity type formed entirely within said second tub region."

Reasons for the Decision

1. *Amendments*

The subject-matter of Claim 1 is based on claim 1, the description on page 3, line 4 to page 4, line 29 of the embodiment of Figure 1 and Figure 1, all as originally filed.

The subject-matter of claim 2 is disclosed in the originally filed claim 6 taken in combination with the application documents cited above.

The subject-matter of Claim 3 is disclosed in the description on page 4, line 34 and page 5, lines 3 to 5 and Figure 1, as filed.

The subject-matters of claims 4 and 5 are derivable from Figures 1 and 2 as originally filed.

The description has been amended so as to be consistent with the amended claim 1.

The Board is therefore satisfied that the amendments comply with the requirement of Article 123(2) EPC.

The amended claims also comply with the requirements of Article 84 EPC and Rule 29(1) EPC.

2. *Inventive step*

2.1 In the decision under appeal, document D1 is regarded as the closest prior art. For the reasons which follow in section 2.3 below, however, the Board does not consider this document to be relevant to the present invention. Moreover, claim 1 under consideration requires that a field oxide isolation region is formed on the boundary at which first and second tub regions abut each other. Document D1 however describes a CMOS process wherein the field oxide is offset from such a boundary.

2.2 Document D3 cited in the present application discloses a field oxide isolation region formed on a boundary between two adjoining tub regions, and can be regarded as the prior art coming closest the invention. An integrated circuit as defined in the precharacterising part of claim 1 under consideration is described in this document (see e.g. Figure 8).

The integrated circuit according to the claimed invention is thus distinguished over the closest prior art in the provision of electrical connections between the respective source and the tub region as set out in the characterising part of the claim.

2.3 Document D3 itself is not concerned with the above problem and does not give any hint to the claimed solution.

Document D1 describes a twin-well CMOS process employing a minimum number of photomasks (see page 1, lines 29 to 32). As described on page 6, lines 9 to 15 with reference to Figure 9, phosphorus ions are implanted at a dosage of 4×10^{14} per cm^2 using polygates 32 and field oxide 30 as ion-implantation masks to produce N-type source/drain regions 35 in a P-well 18

and N-type regions 35 extending into an N-well 17. A subsequent selective boron implantation at a dosage of about $5X10^{15}$ per cm^2 converts parts of the N-type regions into P+ source/drain regions 38, so that the impurity concentration of N-type regions 35, and in particular, of the N-type region 35 extending between the P+ source/drain region 38 and the field oxide 30 is about ten times lower than the boron concentration of P+ source/drain region 38. It also follows from the disclosure on page 9, lines 12 to 17 and page 10, line 33 to page 11, line 2 that the N-type regions 35 are lightly doped so as to suppress hot-carrier effects for N-channel devices (which are susceptible to hot-carrier effects). The Board therefore agrees with the Applicant that although the N-type region 35 extending between the P+ source/drain region 38 and the field oxide 30 is designated as **N+** in the document, it is not sufficiently highly doped to provide an effective tub-tie contact, and that a skilled person would not derive this function from the document. Also, the provision of a highly doped N+ tub-tie contact as in the present invention would be contrary to the teaching of document D1 requiring only one photomasking step as shown in Figure 10 for converting lightly doped N-type regions into P-type source/drain regions. In the Board's view, therefore, a skilled person concerned with providing a tub-tie in a CMOS integrated circuit would not consider the disclosure in document D1 to be relevant to this end. The Board also notes that lightly doped phosphorous source/drain regions (35) are clad with titanium silicide (39) so as to reduce sheet resistance which is usually associated with a lightly doped region (see page 9, lines 18 to 21). Titanium silicide (39) is thus not used as a tub-tie contact in document D1.

In the Board's view, therefore, it would not be obvious to combine the teaching of document D1 with that of document D3.

2.4 Document D2 discloses the use of metal silicide for reducing contact resistance. There is however no mention of the problem concerning the formation of tub ties and there is no teaching in this document which would lead the skilled person to the claimed solution.

For the above reasons, in the Board's judgment, none of the cited prior art documents would lead the person skilled in the art to the claimed invention. The subject matter of claim 1 therefore involves an inventive step within the meaning of Article 56 EPC.

2.5 The remaining claims, being dependent on claim 1, also fulfil the requirement of inventive step.

Order

for these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent on the documents specified in section V above.

The Registrar: The Chairman:

M. Beer G. D. Paterson