MICROLOGIC

ELECTRICAL ISOLATION

NATIONAL

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"Easy on the E·
53-110

Electrical Isolation

Boron Diffusion

Resistant $R/\square = 2.0\ \Omega$

$x_j = 50\mu$

C_N	3	1	0.5
C_B	1.7×10^{15}	5.6×10^{15}	1.2×10^{16}
$\sqrt{D_B}$	1.8	1.9	2.0
C_S	6×10^{18}	5.8×10^{18}	5.0×10^{18}
$\frac{C_B}{C_S\sqrt{\pi}}$	1.6×10^{-4}	5.6×10^{-4}	1.36×10^{-3}
$\frac{x_j}{\sqrt{Dt}}$	5.7	5.2	5.0
$\sqrt{Dt}$	8.8	9.6	10
$\sqrt{t}$	4.9	5.05	5
t	25	25	25

$$\frac{I}{\sqrt{x_j}} = \frac{1}{2.0\times50\times10^{-4}} = 100$$

$$\frac{C_B}{C_S\sqrt{\pi}} = \frac{C_B}{C_S\ 1.77} =$$

$$\sqrt{Dt} = \frac{x_j}{5.7} = \text{etc}$$

$$\sqrt{t} = \frac{\sqrt{Dt}}{\sqrt{D_B}} = 4.9,\ 5.05,\ 5.0$$

Assuming Diff V_T = .65 Ω

Ω	3	1	.5	
C_B	1.7×10^{15}	5.6×10^{15}	1.2×10^{16}	
$\sqrt{D}$	1.8	1.9	2.0	
C_3	2.6×10^{19}	2.5×10^{19}	2.2×10^{19}	
$\frac{C_B}{C_3\sqrt{\pi}}$	$.386 \times 10^{-4}$	—	3×10^{-3}	
$\frac{x_j}{\sqrt{Dt}}$	6.1	5.8	5.5	
$\sqrt{Dt}$	8.2	8.62	9.1	
$\sqrt{t}$	4.55	4.5	4.5	
t	20.5	20.5	20.5	hrs

Run FF1 — 2/27/60
[illegible]

$C_B = 1.2 \times 10^{15}$

$\rho_N = 0.5\ \Omega\text{-cm}$

PRE DEP BORON (Nitryl Boron [illegible])

$T = 1180°C$

$t = 7\ MIN$

$V/I = 1.2$

$x_j = 7\ fr = 1.9\mu$

$Q = 1.13\ C_S \sqrt{Dt}$

@ 1180°C, $\sqrt{D} = 0.8\ \mu\text{-hr}^{1/2}$

from ERF curve C_S vs $\frac{1}{\sqrt{x_j}}$

$C_S = 7 \times 10^{20}$

$\sqrt{t} = \sqrt{7} = 0.117\ hr$

$\therefore Q = (1.13)(7 \times 10^{20})(0.8)(0.342)$

$Q = 2.16 \times 10^{20}$

DIFF. CALCS

$C_S = \frac{Q}{\sqrt{\pi D t}}$

$= \frac{2.16 \times 10^{20}}{(1.77)(2)(4.25)}$

$C_S = 1.435 \times 10^{19}$

$\sqrt{D}$ @1280°C = 2

assuming diff time of 20 hrs

$t = 18\ hrs$

$\sqrt{t} = 4.25$

FFL - 138

Bulk Matl - ρ = 3 - 4 Ω-cm
10 wafers - N type, 8 mil thick
oxidized 2 hrs

Isolation pattern placed on one side only

Boron Predep

V/I ≈ 1.1 Ω
x_j ≈ 8 fr

BORON DIFF @ 1280°C
t = 18 hrs
T = 1280°C
V/I = 1.5 Ω 0.273 Ω/fr
x_j = 180 fr

Diffused thru from both sides

Base pattern placed within isolated collector pattern followed by std. Boron base diffusion & subsequent steps for Flip Flop device

Results

Since base & emitter diffusion was shortened for speed a very thin oxide resulted on surface therefore metalizing could not be performed however active regions were bonded with Al wire & unit tested good.

FFI 141

Bulk matl - $\rho = .4 - .6$
10 wafers - N type
oxidized - 2 hrs
Isolation pattern on one side only

Boron P.D

V/I =
X_j =

BORON DIFF

t = 32 hrs
T = 1280°C
V/I = 1-2 Ω
X_j =

Faulty T.C. in furnace caused shallow diff therefore additional time will be given run.

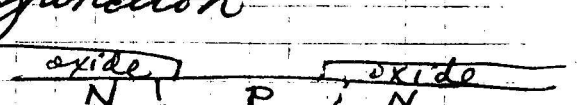
CALCULATIONS INVOLVED IN ELECTRICAL ISOLATION

9/26/60

WANT $V/I = 2.0\ \Omega$ Diff $T = 1280°C$ Boron Diff.

$x_j = 50\ \mu$

for isolated junction



$\sqrt{D}$	1.8	1.9	2.0
ρ_N	3 Ω	1 Ω	0.5 Ω
C_B	1.7×10^{15}	5.6×10^{15}	1.2×10^{16}
C_S	6×10^{18}	5.8×10^{18}	5.0×10^{18}
$\frac{C_B}{C_S\sqrt{\pi}}$	1.6×10^{-4}	5.6×10^{-4}	1.36×10^{-3}
$\frac{x_j}{\sqrt{Dt}}$	5.7	5.2	5.0
$\sqrt{Dt}$	8.8	9.6	10
$\sqrt{t}$	4.9	5.05	5
t	25 hrs	25 hrs	25 hrs

← from curves

$\frac{I}{V x_j} = \frac{1}{2.0\Omega \times 50\mu \times 10^{-4}\ cm} = 100$ for use to determine C_S

$\frac{C_B}{C_S\sqrt{\pi}} = \frac{1.7\times10^{15}}{6\times10^{18}\times1.77} =$ use curve & get $\frac{x_j}{\sqrt{Dt}}$

$\sqrt{Dt} = \frac{x_j}{5.7}$ etc

$\sqrt{t} = \frac{\sqrt{Dt}}{\sqrt{D}} =$ 4.9, 5.05, 5

9/26/60

Boron

assuming Diff $x_j = 50\mu$ $V/I = 0.65\ \Omega$ @ 1280°C

ρ	3	1	0.5	
C_B	1.7×10^{15}	5.6×10^{15}	1.2×10^{16}	
$\sqrt{D}$	1.8	1.9	2.0	
C_S	2.6×10^{19}	2.5×10^{19}	2.2×10^{19}	
$\frac{C_B}{C_S\sqrt{\pi}}$	0.38×10^{-4}	—	3×10^{-3}	
$\frac{x_j}{\sqrt{Dt}}$	6.1	5.8	5.5	
$\sqrt{Dt}$	8.2	8.62	9.1	
$\sqrt{t}$	4.55	4.5	4.5	
$t =$	20.5	20.5	20.5	hrs

9/27/60

Boron electrical Isolation

$C_B = 1.2 \times 10^{16}$

$\rho_N = 0.5\ \Omega\text{-cm}$

$x_j = 45\ \mu$ (desired)

PRE DEP BORON (METHYL BORATE PROCESS)

$T = 1180°C$

$t = 7$ min

$V/I = 1.2\ \Omega$

$x_j = 7$ fr or $1.9\ \mu$

$Q = 1.13\, C_S \sqrt{D.t}$ $\left(1.13 = \frac{2}{\sqrt{\pi}}\right)$

@ 1180°C, $\sqrt{D} = 0.8\ \mu/\text{hr}^{1/2}$

from ERF curve $C_S \cdot V_S \frac{1}{\sqrt{x_j}}$

$C_S = 7 \times 10^{20}$

$\sqrt{t} = \sqrt{7} = 0.117$ hr

$\therefore\ Q = (1.13)(7 \times 10^{20})(0.8)(0.342)$

$Q = 2.16 \times 10^{20}$

next page

BORON DIFF CALCS

$\sqrt{D}$ @ 1280°C = 2

assuming diff time to be 20 hrs on first approx. yielded actual of 18.2 hrs therefore on 2nd approximation 18 hrs was used

$t = 18$ hrs.

$\sqrt{t} = 4.25 \text{ hrs}^{1/2}$

$$C_s = \frac{Q}{\sqrt{\pi D t}}$$

$$= \frac{2.16 \times 10^{20}}{(1.77)(2)(4.25)}$$

$\therefore C_s = 1.435 \times 10^{19}$ for Gaussian

$$\frac{C_s}{C_B} = e^{\frac{x_j^2}{4Dt}}$$

$$\frac{C_s}{C_B} = \frac{1.44 \times 10^{19}}{1.2 \times 10^{16}} = 1.2 \times 10^3$$

$$\ln 1200 = \frac{(x_j)^2}{4Dt} = 7.1$$

where desired $x_j = 45\mu$

$$Dt = \frac{(45)^2}{(4)(7.1)} = 71.5\,\mu^2$$

$$\sqrt{D} = 2$$

$$\therefore D = 4$$

$$t = Dt/D = 71.5/4$$

$t = 17.87$ hrs for diff.

actual run yielded x_j of 43μ in 18 hrs at 1280°C

H.C. Graves

9/27/60