

**CIRRUS LOGIC INC.;
ONMIVISION TECHNOLOGIES, INC.;
AND TEXAS INSTRUMENTS, INC.*,
Petitioner**

v.

**GREENTHREAD, LLC,
Patent Owner**

IPR2024-00001* (U.S. Patent No. 10,734,481)

IPR2024-00016 (U.S. Patent No. 10,510,842)

IPR2024-00019* (U.S. Patent No. 11,316,014)

IPR2024-00020 (U.S. Patent No. 11,121,222)

Petitioner's Demonstratives

January 28, 2025 Oral Hearing

COVINGTON

BEIJING BOSTON BRUSSELS DUBAI FRANKFURT JOHANNESBURG LONDON
LOS ANGELES NEW YORK PALO ALTO SAN FRANCISCO SEOUL SHANGHAI WASHINGTON

Overview of the Pending IPR Petitions

	Patent (IPR Proceeding)	Key Grounds
Jan 28th Hearing ("Active Region" Claims)	842 patent (IPR2024-00016) 481 patent (IPR2024-00001) 014 patent (IPR2024-00019) 222 patent (cl. 1) (IPR2024-00020)	Kawagoe (obviousness) Wieczorek + Wolf
Jan 31st Hearing ("Drift Layer" Claims)	195 patent (IPR2024-00017) 502 patent (IPR2024-00018) 222 patent (cl. 44) (IPR2024-00021)	Payne (obviousness) Payne + Wolf Onoda (anticipation) Onoda + Wolf

- Overview of the IPR Petitions
- Overview of the '842, '481, '014, and '222 Patents
- The Instituted Grounds
- The Prior Art Discloses All Claim Limitations
- The Prior Art Discloses “A Graded Dopant Concentration To Aid Carrier Movement”

- The Prior Art Discloses “a Second Doping Type”
- The “Isolation Region” Dependent Claims are Obvious
- Greenthread’s Settlement Agreements Do Not Show Nonobviousness
- The Petitions are Timely

Overview of the '842, '481, '014, and '222 Patents

'842 Patent

(12) **United States Patent**
Rao

(10) **Patent No.:** **US 10,510,842 B2**
(45) **Date of Patent:** **Dec. 17, 2019**

(54) **SEMICONDUCTOR DEVICES WITH
GRADED DOPANT REGIONS**

(71) Applicant: **GREENTHREAD, LLC**, Dallas, TX
(US)

(72) Inventor: **G.R. Mohan Rao**, Allen, TX (US)

(73) Assignee: **GREENTHREAD, LLC**, Dallas, TX
(US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/590,282**

(22) Filed: **May 9, 2017**

(65) **Prior Publication Data**

US 2017/0243876 A1 Aug. 24, 2017

Related U.S. Application Data

(60) Continuation of application No. 14/931,636, filed on
Nov. 3, 2015, now Pat. No. 9,647,070, which is a
continuation of application No. 14/515,584, filed on
Oct. 16, 2014, now Pat. No. 9,190,502, which is a
continuation of application No. 13/854,319, filed on
(Continued)

1. A semiconductor device, comprising:

a substrate of a first doping type at a first doping level having first and second surfaces;

a first active region disposed adjacent the first surface of the substrate with a second doping type opposite in
conductivity to the first doping type and within which transistors can be formed;

a second active region separate from the first active region disposed adjacent to the first active region and within
which transistors can be formed;

transistors formed in at least one of the first active region or second active region; and

**at least a portion of at least one of the first and second active regions having at least one graded dopant
concentration to aid carrier movement from the first surface to the second surface of the substrate.**

'842 Patent, Ex. 1001 (-00016), Claim 1

'481 Patent

(12) **United States Patent**
Rao

(10) **Patent No.:** **US 10,734,481 B2**
(45) **Date of Patent:** **Aug. 4, 2020**

(54) **SEMICONDUCTOR DEVICES WITH
GRADED DOPANT REGIONS**

(71) Applicant: **GREENTHREAD, LLC**, Dallas, TX
(US)

(72) Inventor: **G. R. Mohan Rao**, Allen, TX (US)

(73) Assignee: **Greenthread, LLC**, Dallas, TX (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/717,950**

(22) Filed: **Dec. 17, 2019**

(65) **Prior Publication Data**

US 2020/0127095 A1 Apr. 23, 2020

Related U.S. Application Data

(60) Continuation of application No. 15/590,282, filed on
May 9, 2017, now Pat. No. 10,510,842, which is a
continuation of application No. 14/931,636, filed on
Nov. 3, 2015, now Pat. No. 9,647,070, which is a
continuation of application No. 14/515,584, filed on
(Continued)

1. A semiconductor device, comprising:

a substrate of a first doping type at a first doping level having first and second surfaces;

a first active region disposed adjacent the first surface of the substrate with a second doping type opposite in
conductivity to the first doping type and within which transistors can be formed;

a second active region separate from the first active region disposed adjacent to the first active region and within
which transistors can be formed;

transistors formed in at least one of the first active region or second active region;

**at least a portion of at least one of the first and second active regions having at least one graded dopant
concentration to aid carrier movement from the first surface to the second surface of the substrate;**

and at least one well region adjacent to the first or second active region containing at least one graded dopant region,
the graded dopant region to aid carrier movement from the first surface to the second surface of the substrate.

'481 Patent, Ex. 1001 (-00001), Claim 1

'014 Patent

(12) **United States Patent**
Rao

(10) **Patent No.:** **US 11,316,014 B2**
(45) **Date of Patent:** ***Apr. 26, 2022**

(54) **SEMICONDUCTOR DEVICES WITH
GRADED DOPANT REGIONS**

(71) Applicant: **GREENTHREAD, LLC**, Dallas, TX
(US)

(72) Inventor: **G. R. Mohan Rao**, Allen, TX (US)

(73) Assignee: **GREENTHREAD, LLC**, Dallas, TX
(US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **17/371,839**

(22) Filed: **Jul. 9, 2021**

(65) **Prior Publication Data**
US 2021/0359086 A1 Nov. 18, 2021

Related U.S. Application Data
(60) Continuation of application No. 16/947,294, filed on
Jul. 27, 2020, now Pat. No. 11,121,222, which is a
(Continued)

1. An electronic system, the system comprising:

at least one semiconductor device, the at least one semiconductor device including:

a substrate of a first doping type at a first doping level having a surface;

a first active region disposed adjacent the surface with a second doping type opposite in conductivity to the first
doping type and within which transistors can be formed;

a second active region separate from the first active region disposed adjacent to the first active region and within
which transistors can be formed;

transistors formed in at least one of the first active region or second active region;

**at least a portion of at least one of the first and second active regions having at least one graded dopant
concentration to aid carrier movement from the first and second active regions towards an area of the
substrate where there are no active regions;**

and at least one well region adjacent to the first or second active region containing at least one graded dopant region,
the graded dopant region to aid carrier movement from the surface towards the area of the substrate where there are
no active regions, wherein at least some of the transistors form digital logic of the semiconductor device.

'222 Patent (Claim 1)

(12) **United States Patent**
Rao

(10) **Patent No.:** US 11,121,222 B2
(45) **Date of Patent:** Sep. 14, 2021

(54) **SEMICONDUCTOR DEVICES WITH
GRADED DOPANT REGIONS**

(71) Applicant: **GREENTHREAD, LLC**, Dallas, TX
(US)

(72) Inventor: **G.R. Mohan Rao**, Allen, TX (US)

(73) Assignee: **GREENTHREAD, LLC**, Dallas, TX
(US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/947,294**

(22) Filed: **Jul. 27, 2020**

(65) **Prior Publication Data**

US 2021/0005716 A1 Jan. 7, 2021

Related U.S. Application Data

(60) Continuation of application No. 16/717,950, filed on
Dec. 17, 2019, now Pat. No. 10,734,481, which is a
(Continued)

1. A VLSI semiconductor device, comprising:

a substrate of a first doping type at a first doping level having a surface;

a first active region disposed adjacent the surface with a second doping type opposite in conductivity to the first
doping type and within which transistors can be formed;

a second active region separate from the first active region disposed adjacent to the first active region and within
which transistors can be formed;

transistors formed in at least one of the first active region or second active region;

**at least a portion of at least one of the first and second active regions having at least one graded dopant
concentration to aid carrier movement from the first and second active regions towards an area of the
substrate where there are no active regions;**

and at least one well region adjacent to the first or second active region containing at least one graded dopant region,
the graded dopant region to aid carrier movement from the surface towards the area of the substrate where there are
no active regions, wherein at least some of the transistors form digital logic of the VLSI semiconductor device.

'222 Patent, Ex. 1001 (-00020), Claim 1

The Instituted IPR Grounds

IPR2024-00016 (U.S. Patent No. 10,510,842)			
Ground	Claims	35 U.S.C §	Prior Art
I	1-18	103(a)	Kawagoe
II	1-3, 5-11, 13-18	103(a)	Wieczorek, Wolf
III	1-18	103(a)	Kawagoe, Gupta
IV	1-3, 5-11, 13-18	103(a)	Wieczorek, Wolf, Gupta

IPR2024-00001 (U.S. Patent No. 10,734,481)			
Ground	Claims	35 U.S.C §	Prior Art
I	1–9, 12–14, 16–27, 30–36	103(a)	Kawagoe
II	1, 2, 4–9, 12–22, 24–27, 30–36	103(a)	Wieczorek, Wolf
III	1–9, 12–14, 16–27, 30–36	103(a)	Kawagoe, Gupta
IV	1, 2, 4–9, 12–22, 24–27, 30–36	103(a)	Wieczorek, Wolf, Gupta
V	19, 36	103(a)	Kawagoe, Silverbrook
VI	19, 36	103(a)	Wieczorek, Wolf, Silverbrook

IPR2024-00019 (U.S. Patent No. 11,316,014)			
Ground	Claims	35 U.S.C §	Prior Art
I	1-9, 12-14, 16-21, and 23-28	103(a)	Kawagoe
II	1-2, 4-9, 12-23, and 25-28	103(a)	Wieczorek, Wolf
III	1-9, 12-14, 16-21, and 23-28	103(a)	Kawagoe, Gupta
IV	1-2, 4-9, 12-23, and 25-28	103(a)	Wieczorek, Wolf, Gupta
V	19	103(a)	Kawagoe, Silverbrook
VI	19	103(a)	Wieczorek, Wolf, Silverbrook

IPR2024-00020 (U.S. Patent No. 11,121,222)			
Ground	Claims	35 U.S.C §	Prior Art
I	1-9, 12-14, 16-21, 23-28, and 31-42	103(a)	Kawagoe
II	1-2, 4-9, 12-23, 25-28, and 31-42	103(a)	Wieczorek, Wolf
III	1-9, 12-14, 16-21, 23-28, and 31-42	103(a)	Kawagoe, Gupta
IV	1-2, 4-9, 12-23, 25-28, and 31-42	103(a)	Wieczorek, Wolf, Gupta
V	19 and 37	103(a)	Kawagoe, Silverbrook
VI	19 and 37	103(a)	Wieczorek, Wolf, Silverbrook

The Prior Art Discloses
All Claim Limitations

Kawagoe (Ex. 1007)

United States Patent [19]

Kawagoe et al.

[11] Patent Number: 6,043,114

[45] Date of Patent: Mar. 28, 2000

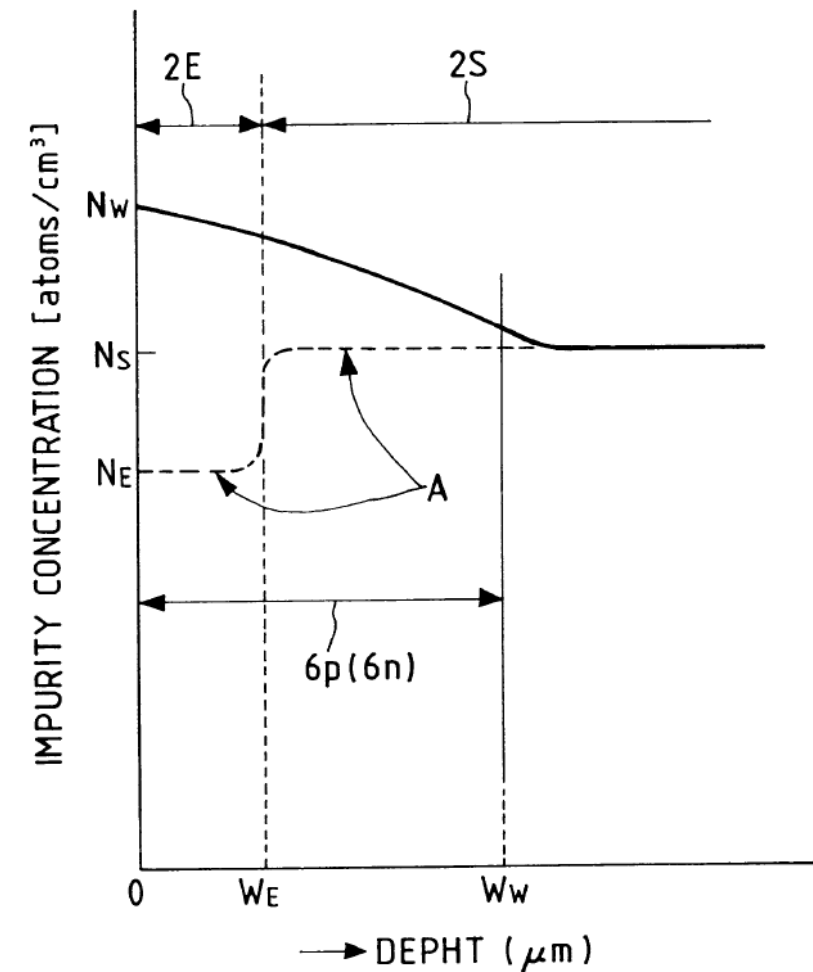
[54] PROCESS FOR MANUFACTURING A SEMICONDUCTOR WAFER, A SEMICONDUCTOR WAFER, PROCESS FOR MANUFACTURING A SEMICONDUCTOR INTEGRATED CIRCUIT DEVICE, AND SEMICONDUCTOR INTEGRATED CIRCUIT DEVICE

[75] Inventors: Hiroto Kawagoe, Hinode-machi; Tatsumi Shirasu, Kawasaki; Shogo Kiyota, Tateno-machi; Norio Suzuki, Higashimurayama; Eiichi Yamada, Kumage-gun; Yuji Sugino, Nakakoma-gun; Manabu Kitano, Yanai; Yoshihiko Sakurai, Takashi Naganuma, both of Nakakoma-gun; Hisashi Arakawa, Kohfu, all of Japan

[73] Assignee: Hitachi, Ltd., Tokyo, Japan

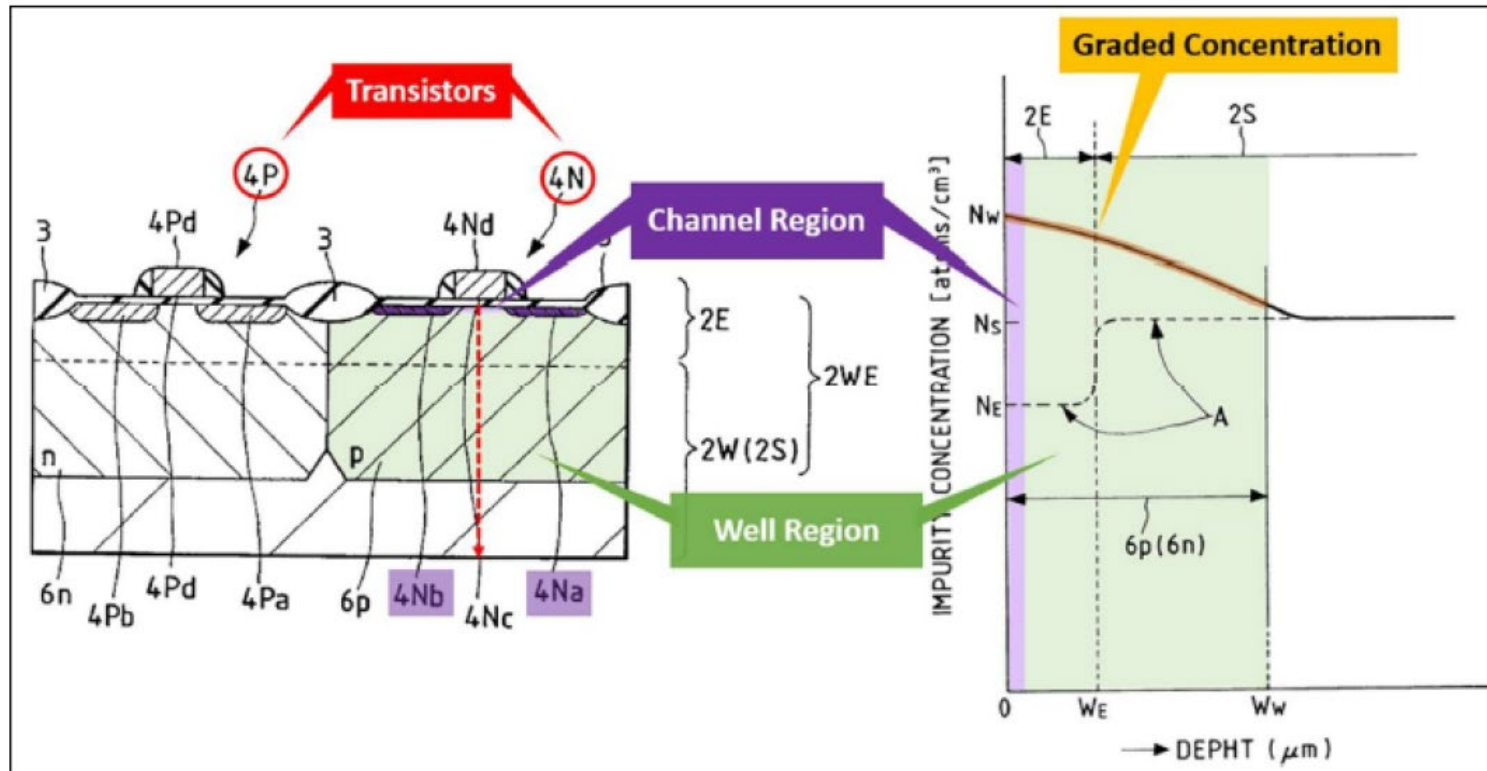
[21] Appl. No.: 08/934,774

[22] Filed: Sep. 22, 1997



Kawagoe, Ex. 1007 (-00016) (-00001) (-00019) (-00020), Fig. 17

Kawagoe discloses the elements of Claim 1 ('842 Patent)



1. A semiconductor device, comprising:

a **substrate** of a first doping type at a first doping level having first and second surfaces;

a **first active region** disposed adjacent the first surface of the substrate with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed;

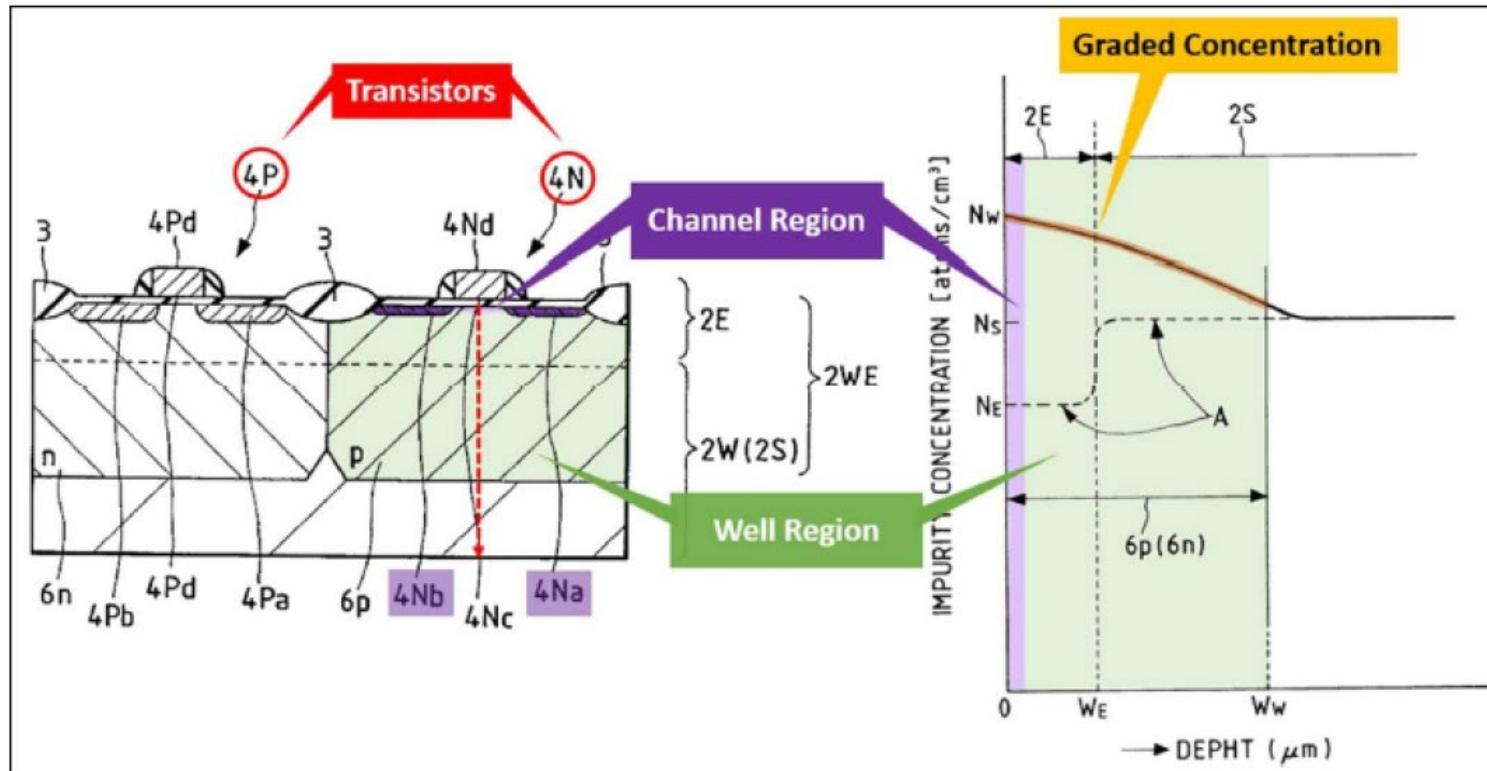
a **second active region** separate from the first active region disposed adjacent to the first active region and within which transistors can be formed;

transistors formed in at least one of the first active region or second active region; and

at least a portion of at least one of the first and second active regions having at least one **graded dopant concentration to aid carrier movement from the first surface to the second surface of the substrate.**

'842 Patent (Ex. 1001) (-00016), Claim 1

Kawagoe discloses the elements of Claim 1 ('481 Patent)



1. A semiconductor device, comprising:

a **substrate** of a first doping type at a first doping level having first and second surfaces;

a **first active region** disposed adjacent the first surface of the substrate with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed;

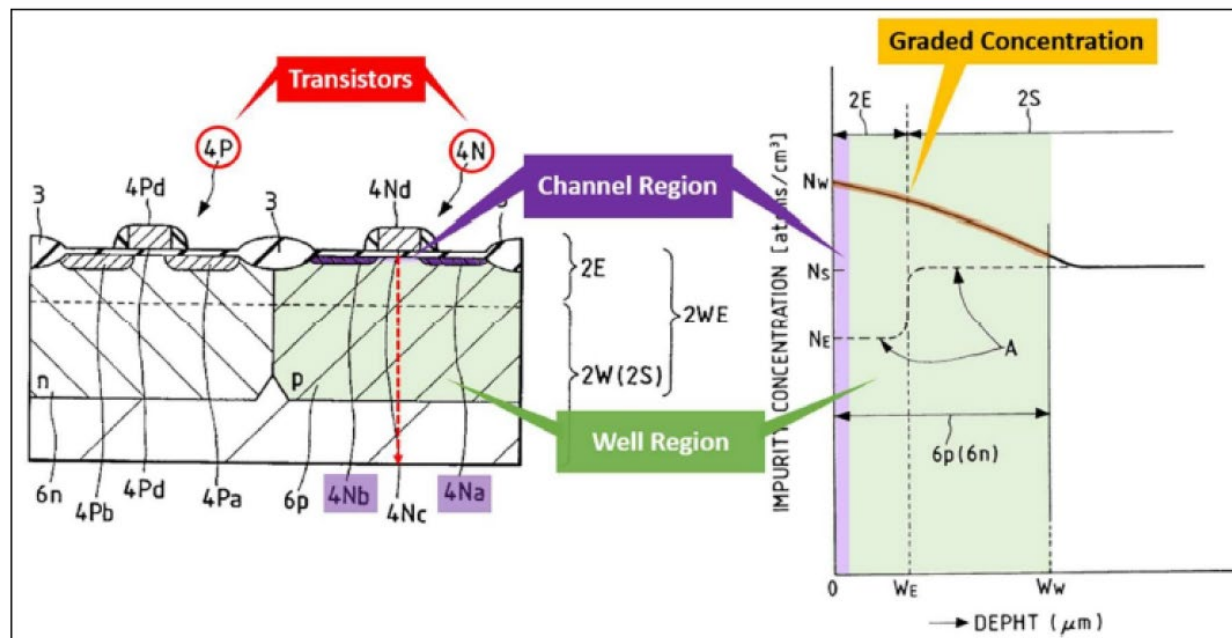
a **second active region** separate from the first active region disposed adjacent to the first active region and within which transistors can be formed; which

transistors formed in at least one of the first active region or second active region;

at least a portion of at least one of the first and second active regions having at least one **graded dopant concentration to aid carrier movement from the first surface to the second surface of the substrate**;

and at least one **well region** adjacent to the first or second active region containing at least one graded dopant region, the graded dopant region to aid carrier movement from the first surface to the second surface of the substrate.

Kawagoe discloses the elements of Claim 1 ('014 Patent)



1. An electronic system, the system comprising:

at least one semiconductor device, the at least one semiconductor device including:

a **substrate** of a first doping type at a first doping level having a surface;

a **first active region** disposed adjacent the surface with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed;

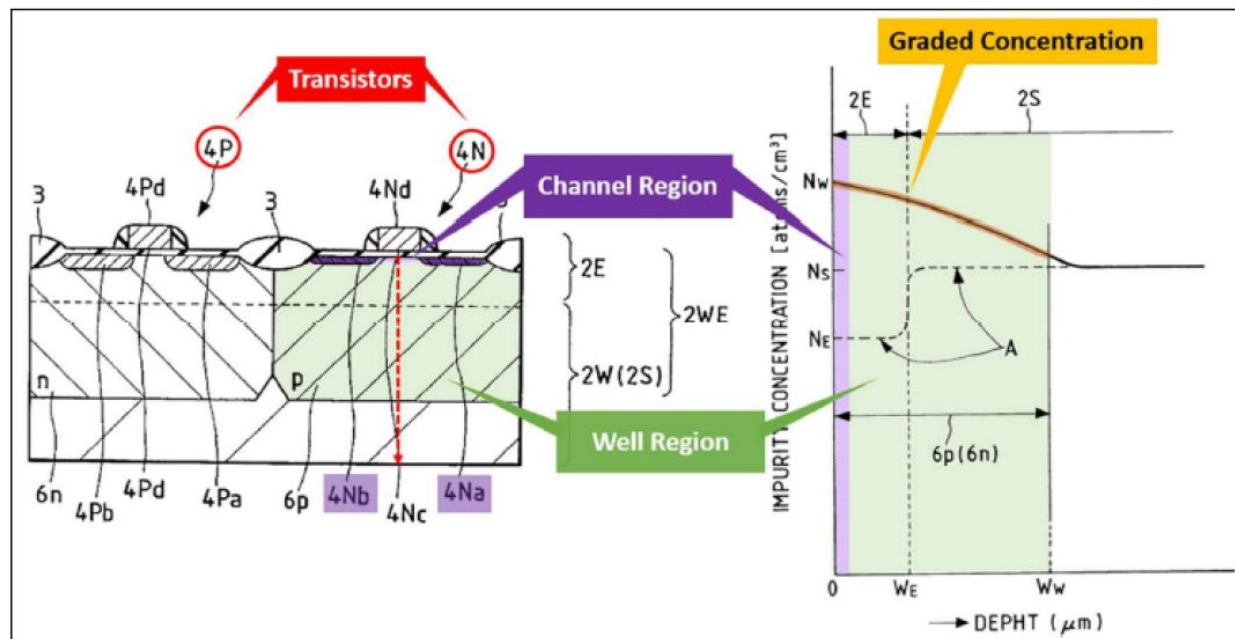
a **second active region** separate from the first active region disposed adjacent to the first active region and within which transistors can be formed;

transistors formed in at least one of the first active region or second active region;

at least a portion of at least one of the first and second active regions having at least one **graded dopant concentration to aid carrier movement from the first and second active regions towards an area of the substrate where there are no active regions**;

and at least one **well region** adjacent to the first or second active region containing at least one graded dopant region, the graded dopant region to aid carrier movement from the surface towards the area of the substrate where there are no active regions, wherein at least some of the transistors form digital logic of the semiconductor device.

Kawagoe discloses the elements of Claim 1 ('222 Patent)



1. A VLSI semiconductor device, comprising:

a **substrate** of a first doping type at a first doping level having a surface;

a **first active region** disposed adjacent the surface with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed;

a **second active region** separate from the first active region disposed adjacent to the first active region and within which transistors can be formed;

transistors formed in at least one of the first active region or second active region;

at least a portion of at least one of the first and second active regions having at least one **graded dopant concentration to aid carrier movement from the first and second active regions towards an area of the substrate where there are no active regions**;

and at least one **well region** adjacent to the first or second active region containing at least one graded dopant region, the graded dopant region to aid carrier movement from the surface towards the area of the substrate where there are no active regions, wherein at least some of the transistors form digital logic of the VLSI semiconductor device.

Wieczorek (Ex. 1006)

(19) **United States**

(12) **Patent Application Publication** (10) Pub. No.: **US 2003/0183856 A1**
Wieczorek et al. (43) Pub. Date: **Oct. 2, 2003**

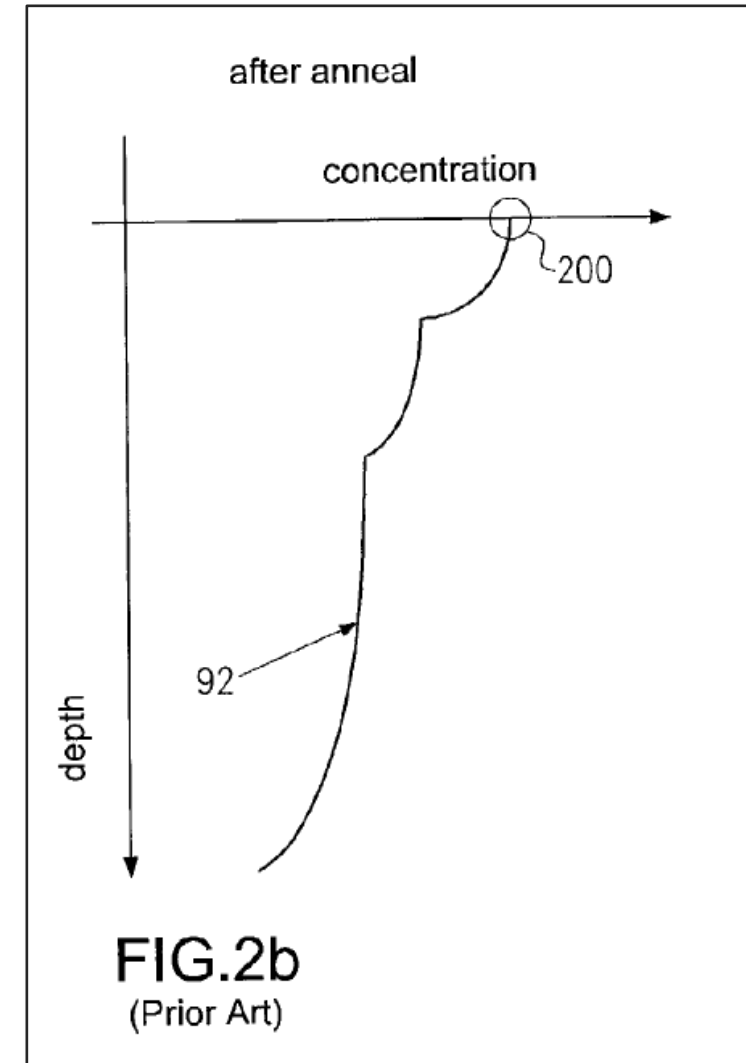
(54) **SEMICONDUCTOR DEVICE HAVING A RETROGRADE DOPANT PROFILE IN A CHANNEL REGION AND METHOD FOR FABRICATING THE SAME**

(76) Inventors: **Karsten Wieczorek**, Dresden (DE);
Manfred Horstmann, Dresden (DE);
Rolf Stephan, Dresden (DE)

Correspondence Address:
J. Mike Amerson
Williams, Morgan & Amerson, P.C.
Suite 250
7676 Hillmont
Houston, TX 77040 (US)

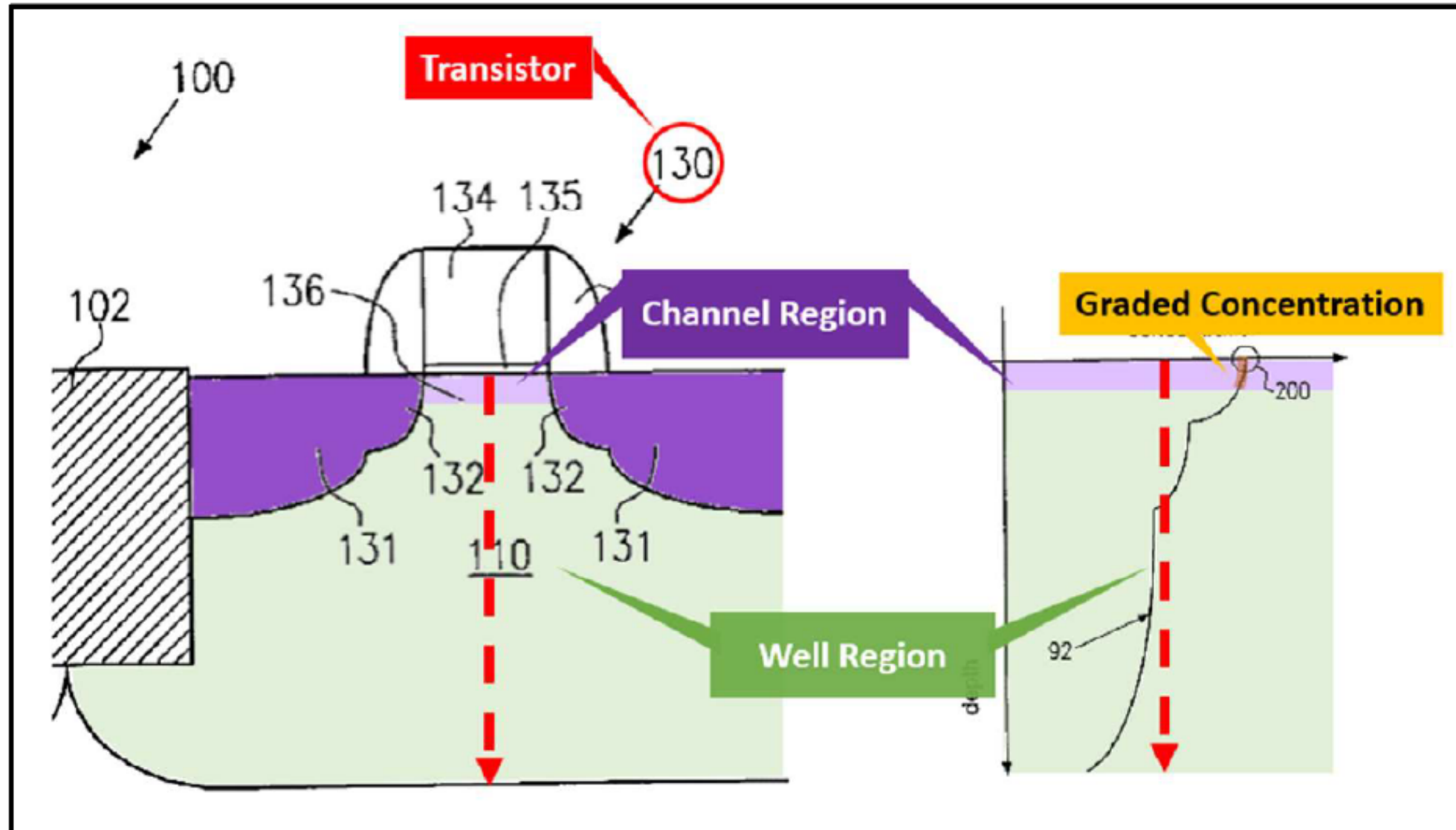
(21) Appl. No.: **10/282,980**

(22) Filed: **Oct. 29, 2002**

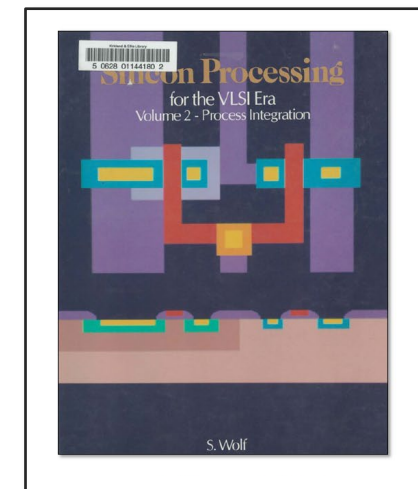
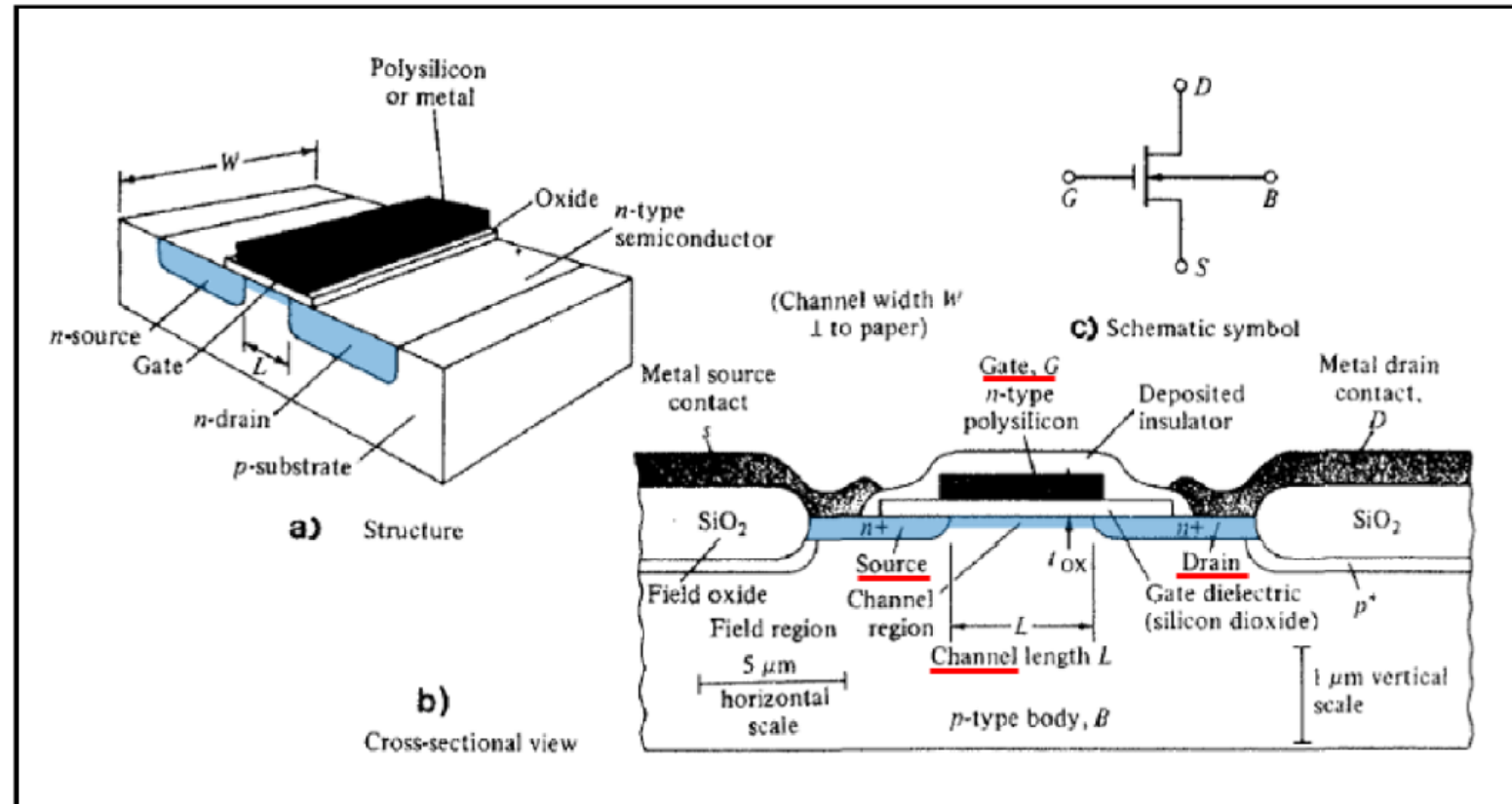


Wieczorek (Ex. 1006) Fig. 2b

Wieczorek has a graded dopant concentration to aid carrier movement



Wolf: Active Regions Include Source, Drain, and Channel of Transistor

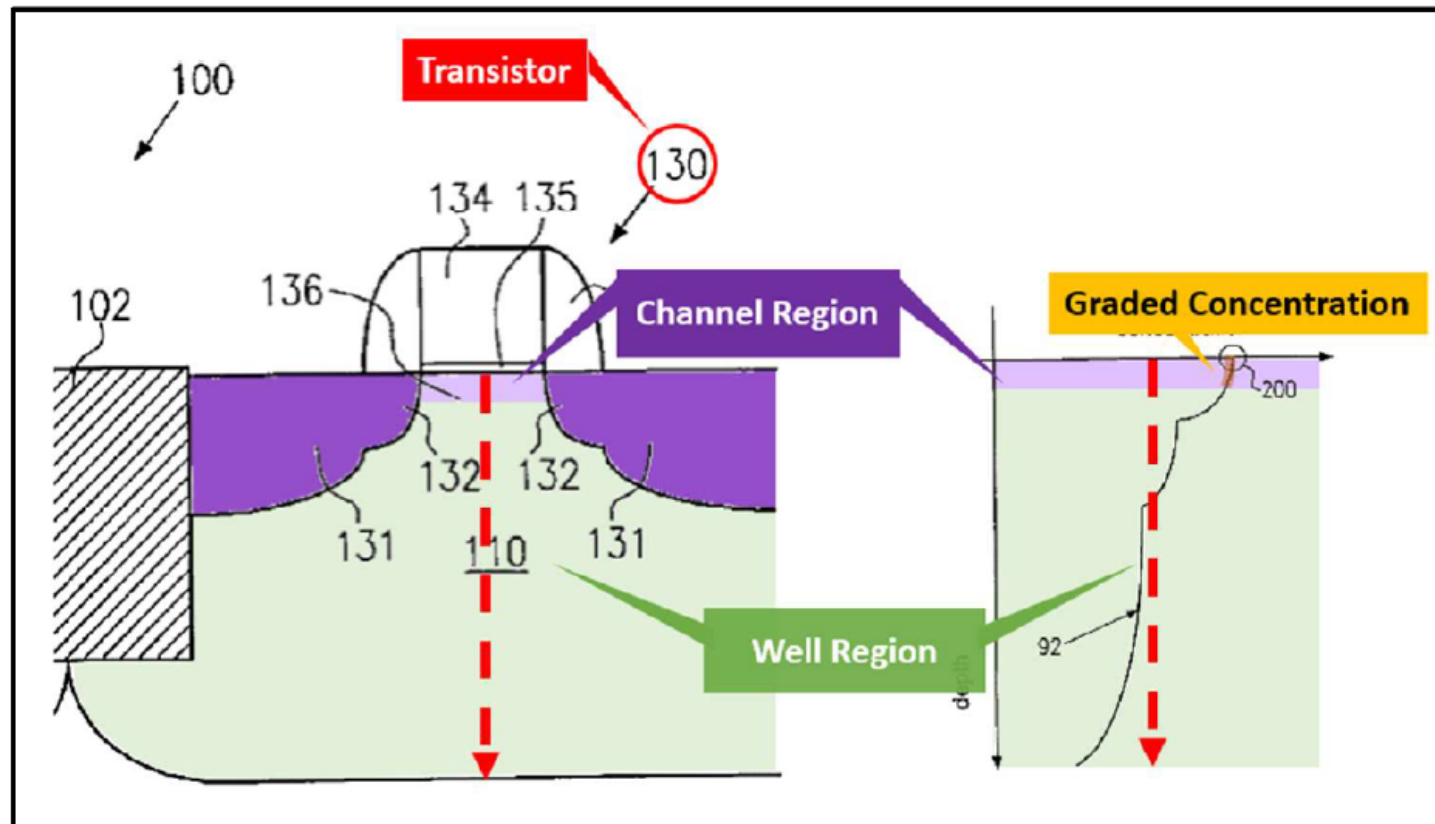


Wolf (*Silicon Processing for the VLSI Era* (2000)) (Ex. 1008B)

The top surface of the body consists of *active* or *transistor* regions as well as *passive* or (*field*) regions. The active regions are those in which transistor action occurs; i.e., the channel and the heavily doped source and drain regions.

Wolf, Ex.1008B, p.299

Wieczorek-Wolf discloses the elements of Claim 1 ('842 Patent)



1. A semiconductor device, comprising:

a **substrate** of a first doping type at a first doping level having first and second surfaces;

a **first active region** disposed adjacent the first surface of the substrate with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed;

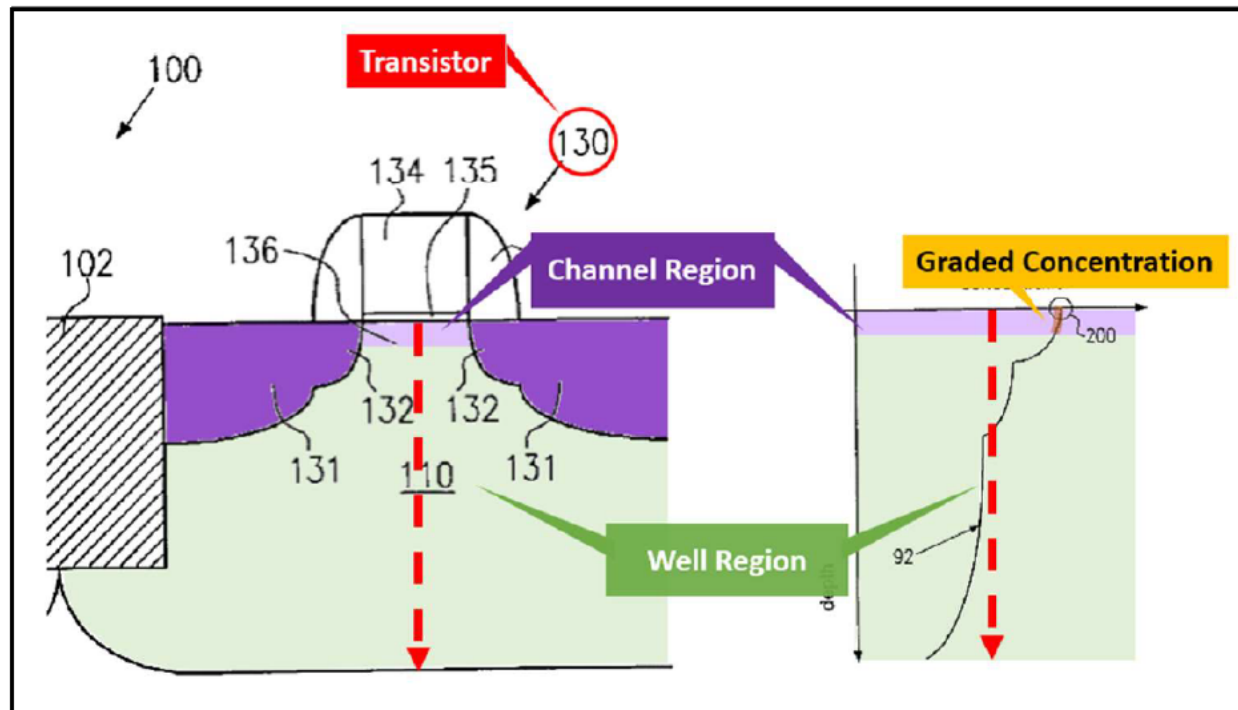
a **second active region** separate from the first active region disposed adjacent to the first active region and within which transistors can be formed;

transistors formed in at least one of the first active region or second active region; and

at least a portion of at least one of the first and second active regions having at least one **graded dopant concentration to aid carrier movement from the first surface to the second surface of the substrate.**

'842 Patent, Ex. 1001 (-00016), Claim 1

Wieczorek-Wolf discloses the elements of Claim 1 ('481 Patent)



1. A semiconductor device, comprising:

a **substrate** of a first doping type at a first doping level having first and second surfaces;

a **first active region** disposed adjacent the first surface of the substrate with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed;

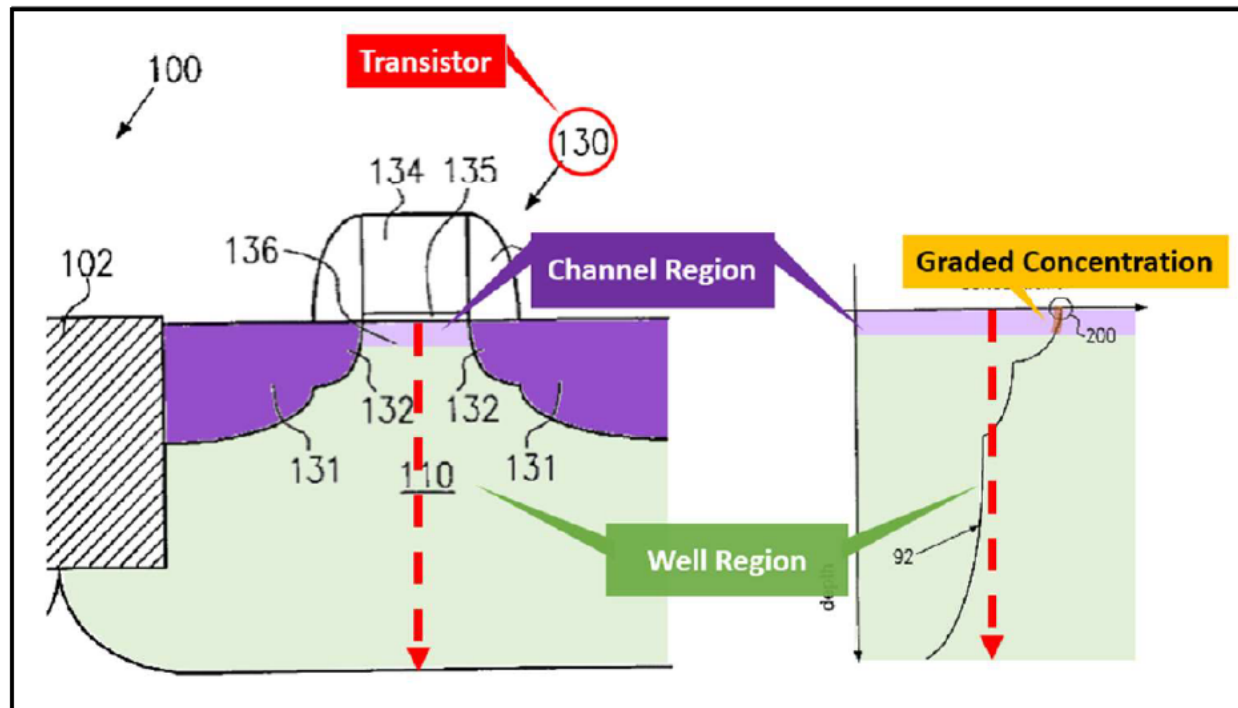
a **second active region** separate from the first active region disposed adjacent to the first active region and within which transistors can be formed; which

transistors formed in at least one of the first active region or second active region;

at least a portion of at least one of the first and second active regions having at least one **graded dopant concentration to aid carrier movement from the first surface to the second surface of the substrate**;

and at least one **well region** adjacent to the first or second active region containing at least one graded dopant region, the graded dopant region to aid carrier movement from the first surface to the second surface of the substrate.

Wieczorek-Wolf discloses the elements of Claim 1 ('014 Patent)



1. An electronic system, the system comprising:

at least one semiconductor device, the at least one semiconductor device including:

a **substrate** of a first doping type at a first doping level having a surface;

a **first active region** disposed adjacent the surface with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed;

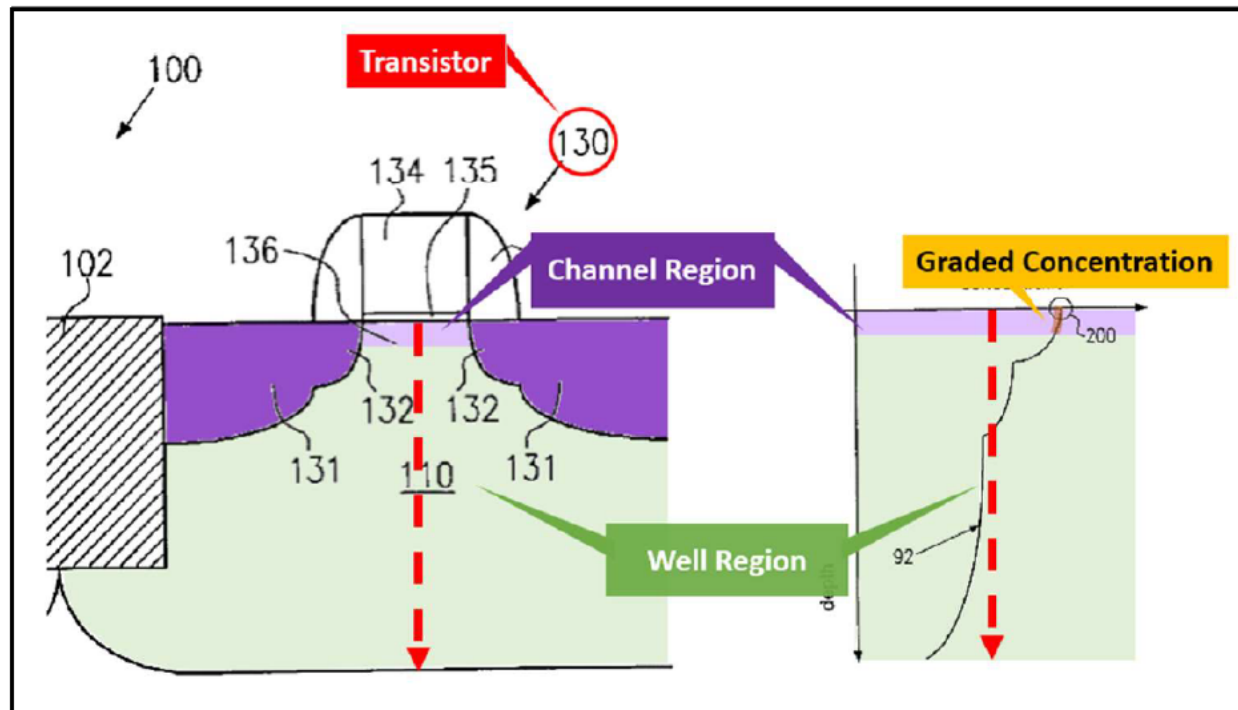
a **second active region** separate from the first active region disposed adjacent to the first active region and within which transistors can be formed;

transistors formed in at least one of the first active region or second active region;

at least a portion of at least one of the first and second active regions having at least one **graded dopant concentration to aid carrier movement from the first and second active regions towards an area of the substrate where there are no active regions**;

and at least one **well region** adjacent to the first or second active region containing at least one graded dopant region, the graded dopant region to aid carrier movement from the surface towards the area of the substrate where there are no active regions, wherein at least some of the transistors form digital logic of the semiconductor device.

Wieczorek-Wolf discloses the elements of Claim 1 ('222 Patent)



1. A VLSI semiconductor device, comprising:

a substrate of a first doping type at a first doping level having a surface;

a first active region disposed adjacent the surface with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed;

a second active region separate from the first active region disposed adjacent to the first active region and within which transistors can be formed;

transistors formed in at least one of the first active region or second active region;

at least a portion of at least one of the first and second active regions having at least one graded dopant concentration to aid carrier movement from the first and second active regions towards an area of the substrate where there are no active regions;

and at least one well region adjacent to the first or second active region containing at least one graded dopant region, the graded dopant region to aid carrier movement from the surface towards the area of the substrate where there are no active regions, wherein at least some of the transistors form digital logic of the VLSI semiconductor device.

Gupta (Ex. 1014)

United States Patent [19] Gupta

[11] Patent Number: 6,163,877
[45] Date of Patent: *Dec. 19, 2000

[54] METHOD AND APPARATUS FOR
OPTIMIZING TRANSISTOR CELL LAYOUT
WITH INTEGRATED TRANSISTOR
FOLDING

[75] Inventor: Avaneendra Gupta, Ann Arbor, Mich.

[73] Assignee: Intel Corporation, Santa Clara, Calif.

[*] Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

[21] Appl. No.: 08/744,199

[22] Filed: Nov. 5, 1996

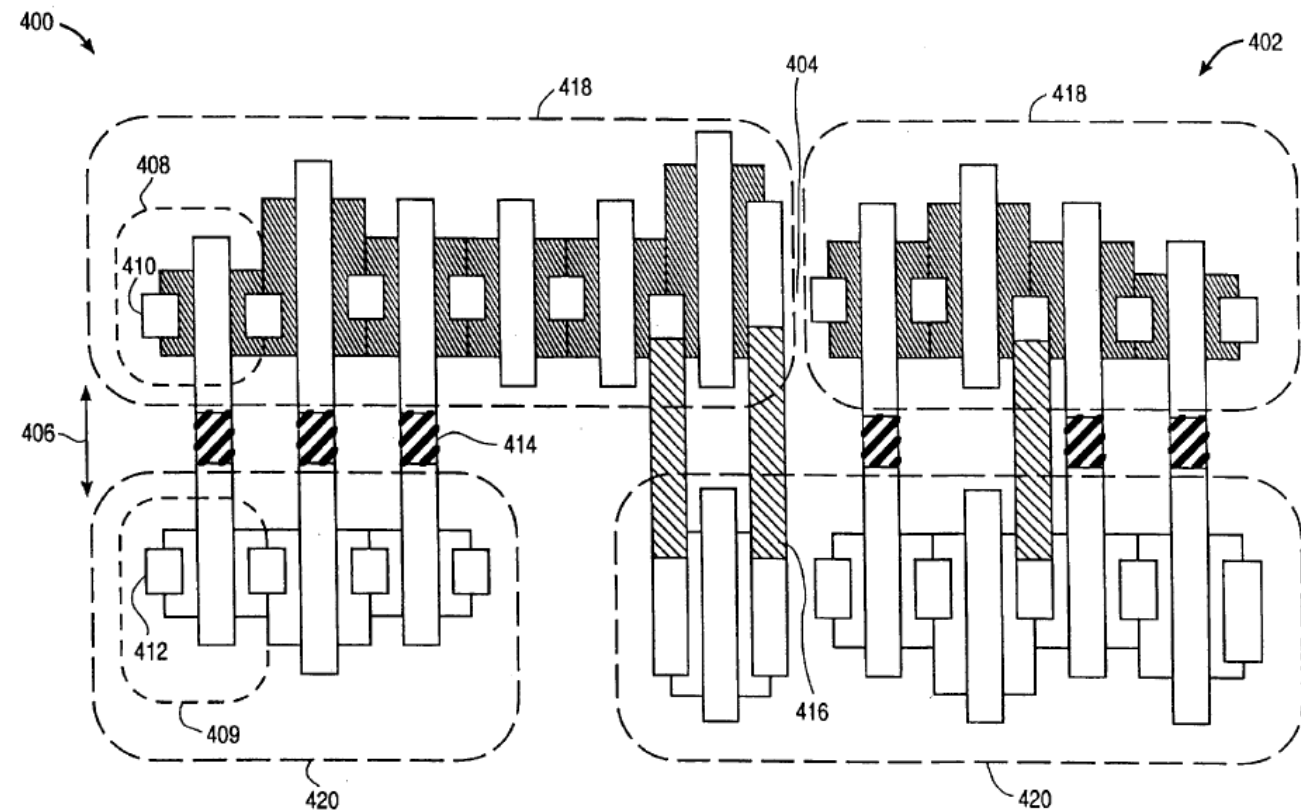


FIG. 4

Gupta (Ex. 1014), Fig. 4

Gupta: a plurality of “transistors” or “devices” was well known

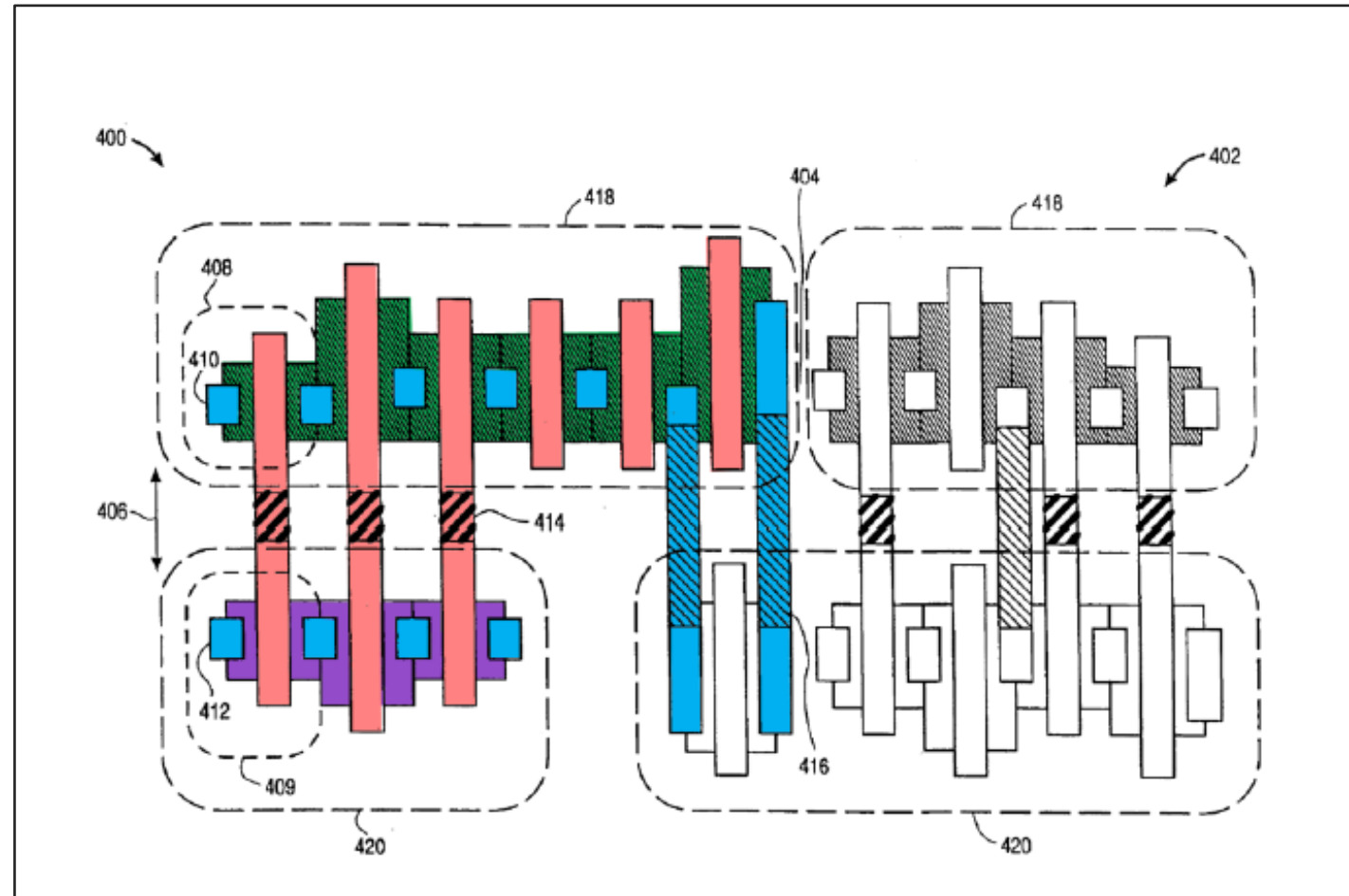


FIG. 4 is an illustration of a layout style known as one dimensional layout style. ... Referring to FIG. 4, one dimensional layout 402 includes two horizontal diffusion rows for the placement of P and N transistors. PMOS transistors are placed in top row 418 and NMOS transistor are placed in bottom row 420. If two adjacent transistors have electrically equivalent terminals, they are abutted so as to share a diffusion area, forming a chain.

Silverbrook (Ex. 1042)

(12) **United States Patent**
Silverbrook

(10) Patent No.: **US 6,614,560 B1**
(45) Date of Patent: **Sep. 2, 2003**

(54) **INTEGRATED CAMERA CIRCUIT
INCLUDING IMAGE SENSOR, IMAGE
PROCESSING, AND PRINTER DRIVE
CIRCUITS**

(75) Inventor: **Kia Silverbrook, Sydney (AU)**

(73) Assignee: **Silverbrook Research Pty Ltd,
Balmain (AU)**

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/113,104**

(22) Filed: **Jul. 10, 1998**

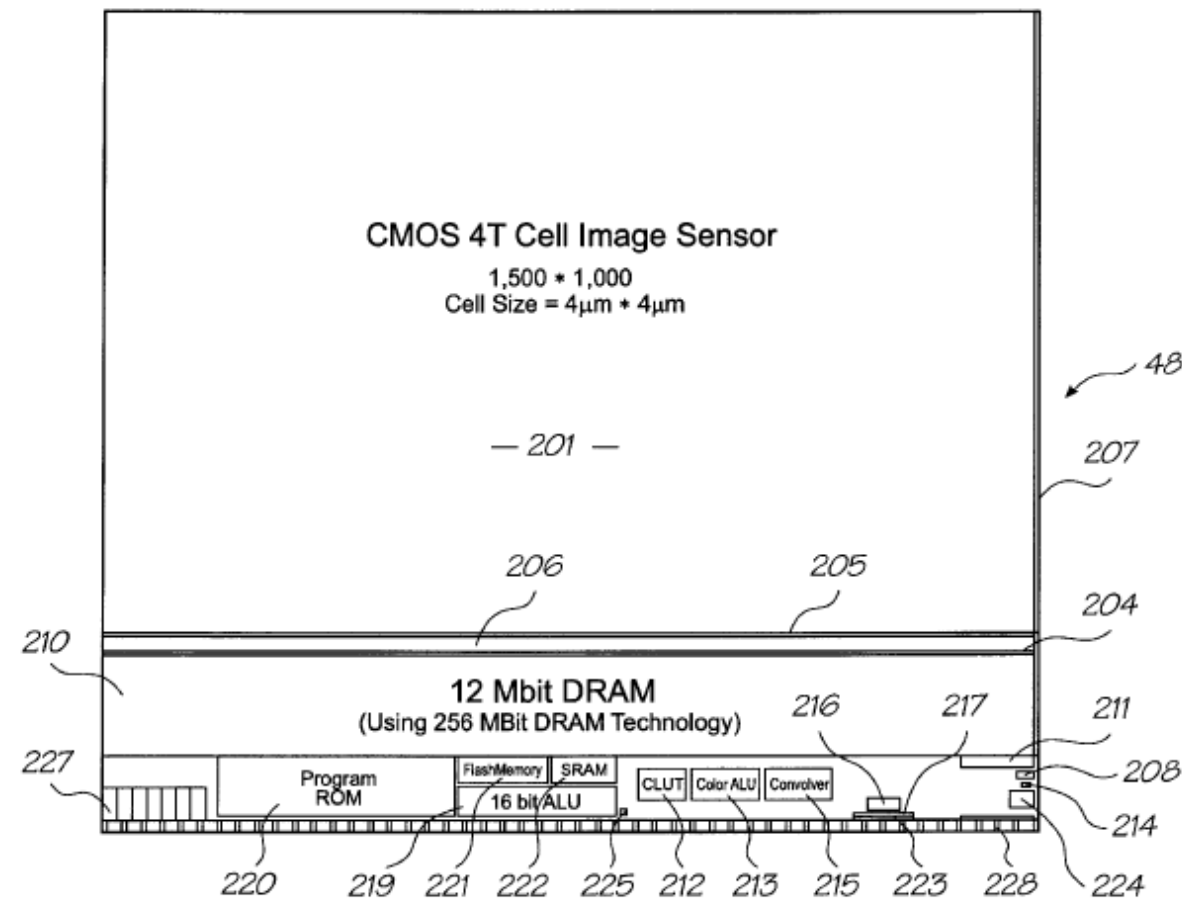


FIG. 15

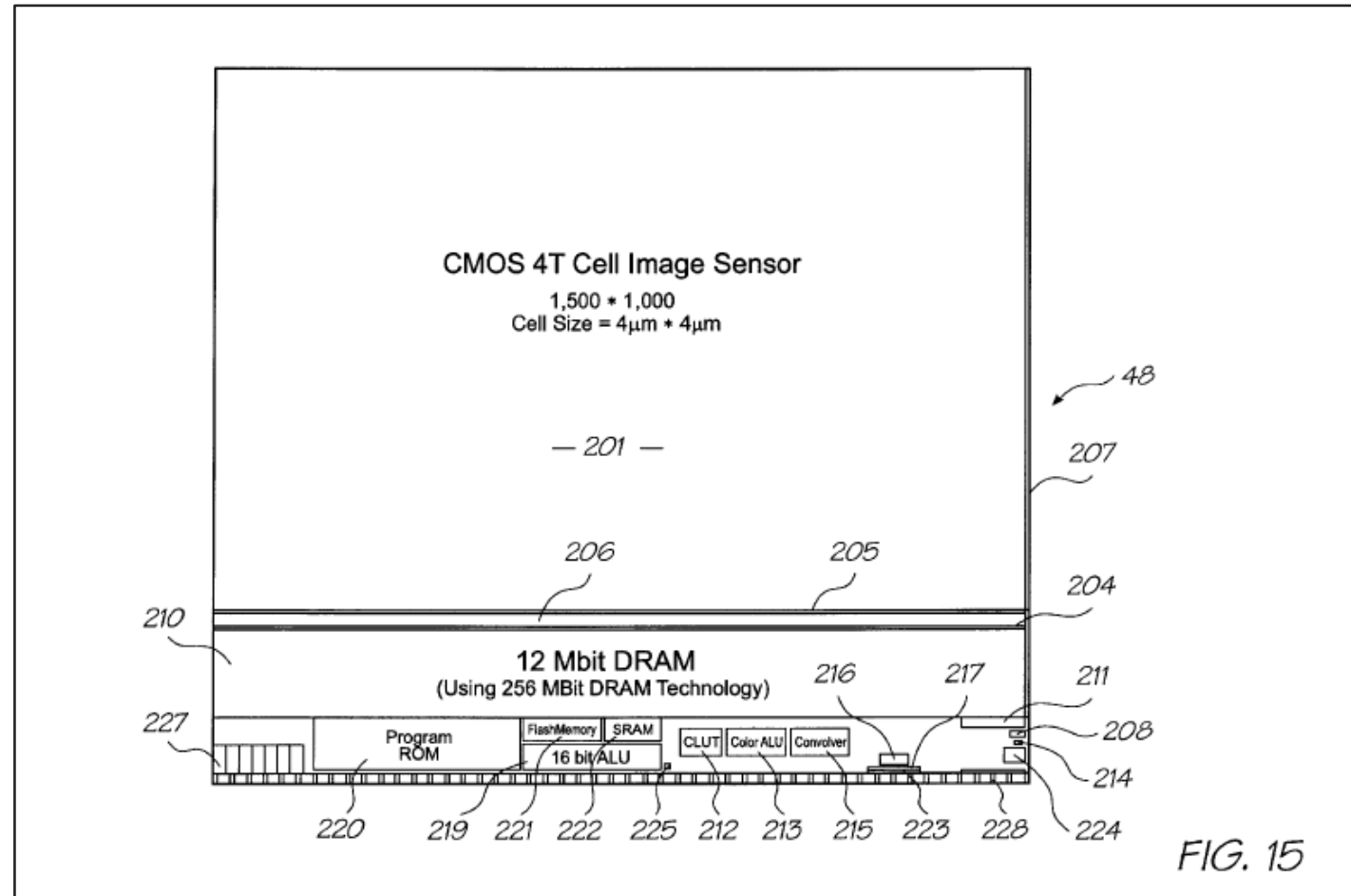
Silverbrook: “CMOS image sensors” were well known

Dependent Claims:

'481: claims 19, 36

'014: claim 19

'222: claims 19, 37



Turning now to FIG. 15, there is shown an example layout of the Image Capture and Processing Chip (ICP) 48. The Image Capture and Processing Chip 48 provides most of the electronic functionality of the camera with the exception of the print head chip. The chip 48 is a highly integrated system. It combines CMOS image sensing, analog to digital conversion, digital image processing, DRAM storage, ROM, and miscellaneous control functions in a single chip.

Prior Art Discloses “a Graded Dopant
Concentration To Aid Carrier Movement”

The Challenged Claims are Directed to a Device

Apparatus claims “**cover what a device *is*, not what a device *does*.**”

ParkerVision, Inc. v. Qualcomm Inc., 903 F.3d 1354, 1361 (Fed. Cir. 2018).

1. A **semiconductor device**, comprising:

a **substrate** of a first doping type at a first doping level having first and second surfaces;

a **first active region** disposed adjacent the first surface of the substrate with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed;

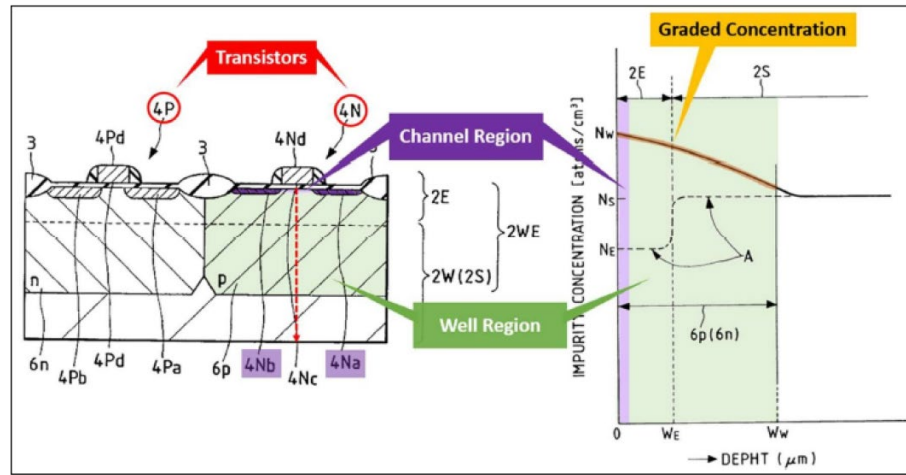
a **second active region** separate from the first active region disposed adjacent to the first active region and within which transistors can be formed;

transistors formed in at least one of the first active region or second active region; and

at least a portion of at least one of the first and second active regions having at least one **graded dopant concentration** to aid carrier movement from the first surface to the second surface of the substrate.

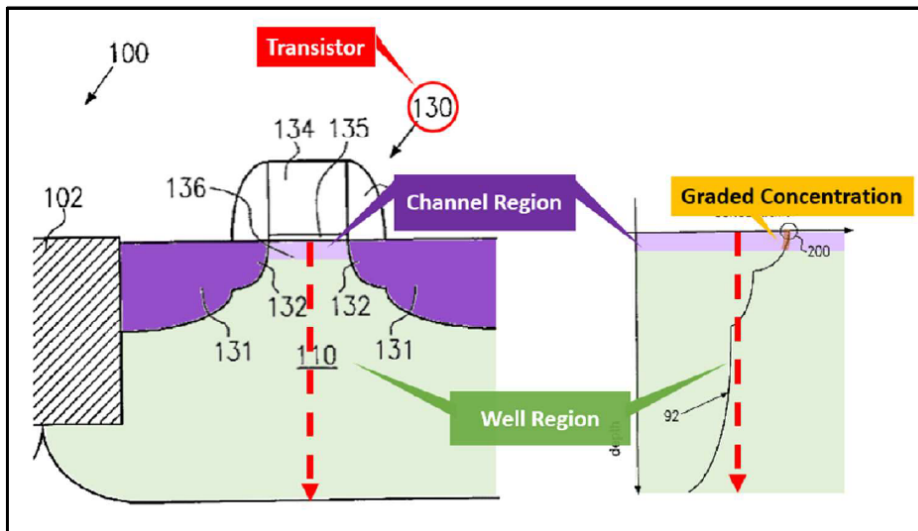
'842 Patent (Ex. 1001) (-00016), Claim 1

Prior art discloses a graded concentration to aid carrier movement in the claimed direction



Claim 1 (842): at least one **graded dopant concentration to aid carrier movement** from the first surface to the second surface of the substrate

Claim 1 (481): at least one **graded dopant concentration to aid carrier movement** from the first surface to the second surface of the substrate

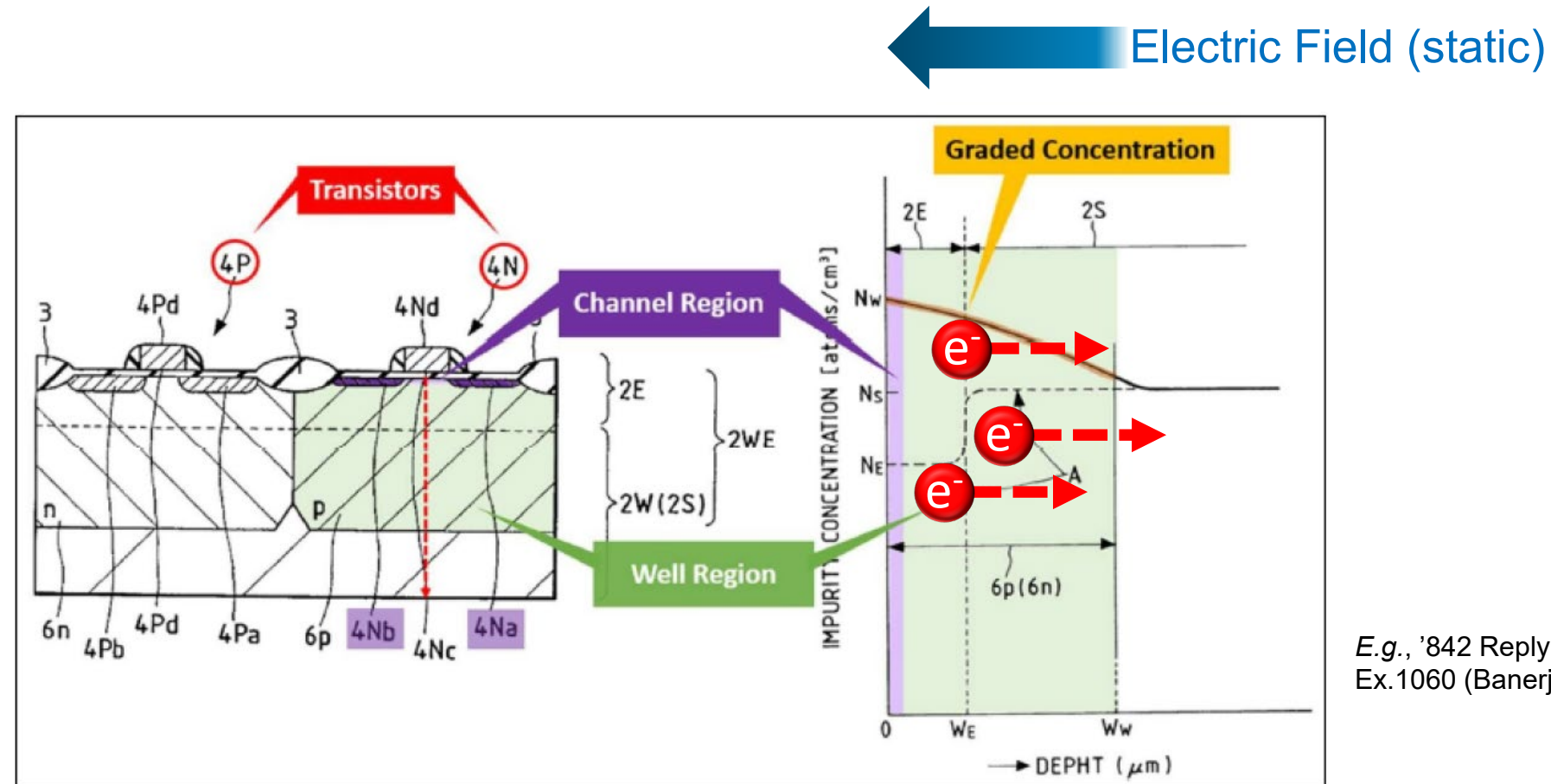


Claim 1 (014): at least one **graded dopant concentration to aid carrier movement** from the first and second active regions towards an area of the substrate where there are no active regions

Claim 1 (222): at least one **graded dopant concentration to aid carrier movement** from the first surface and second active regions towards an area of the substrate where there are no active regions

'842 Pet. at 28-36, 56-60; '842 Reply at 1
'481 Pet. at 28-34, 63-67; '481 Reply at 1
'014 Pet. at 23-28, 57-61; '014 Reply at 1-2
'222-I Pet. at 22-27, 59-63; '222-I Reply at 1

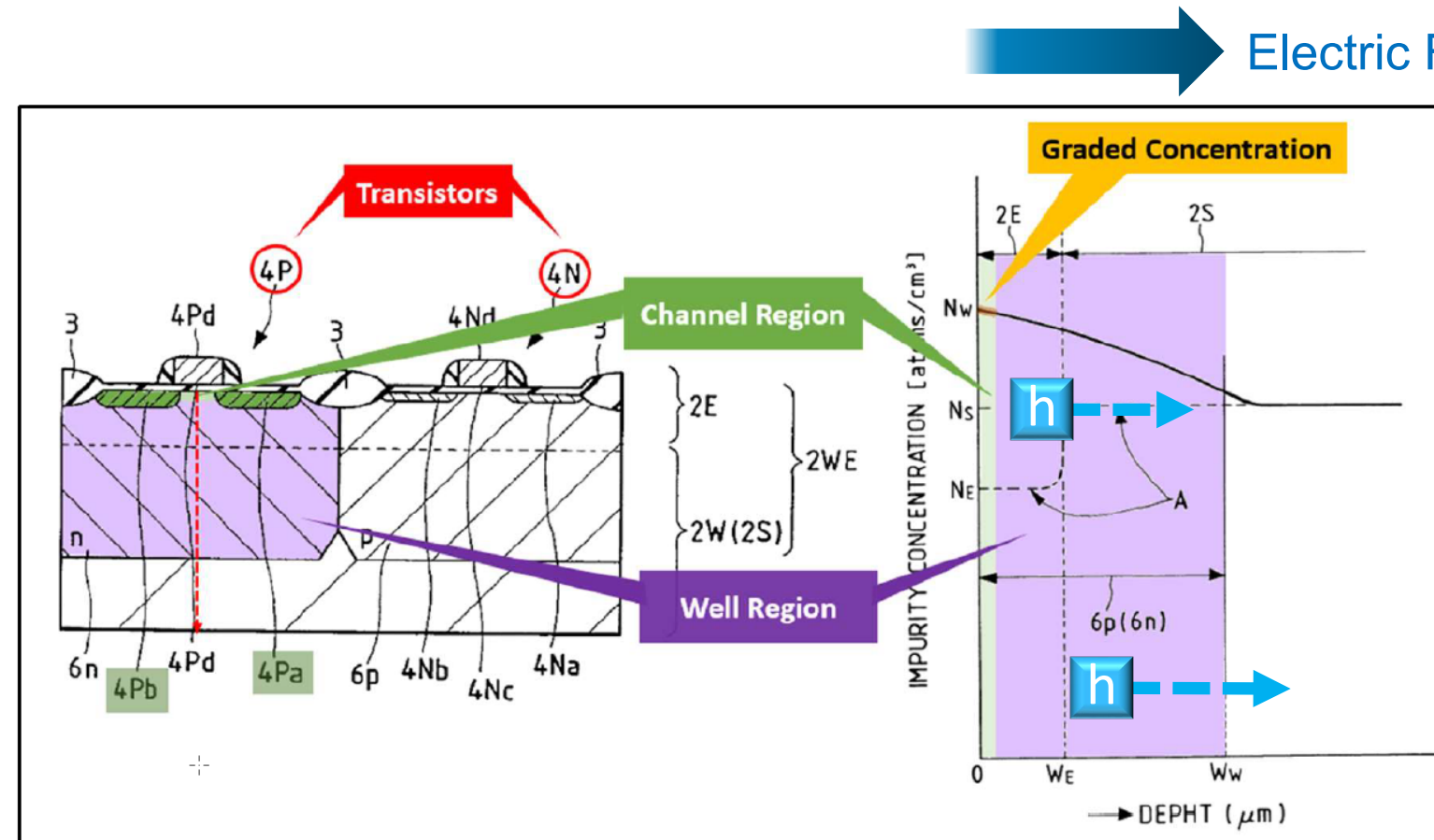
Kawagoe Makes Clear That Its Graded Dopant Concentration Aid Carrier Movement



E.g., '842 Reply at 7-8, 17-19
Ex.1060 (Banerjee Supp. Decl.), ¶¶7, 21-25

Thus, the **impurity concentration of the p-well 6p is given such a gradient that it is gradually lowered in the depthwise direction** from the surface of the epitaxial layer 2E, so that the influence to be caused by the carriers (or electrons) due to the a-ray is lowered. **Specifically, the electrons produced by the a-ray are attracted to the substrate body 2S by that concentration gradient** and prevented from entering the p-well 6p so that the soft errors can be reduced in case the MIS memory of the DRAM or the like is formed in the p-well 6p.

Kawagoe Makes Clear That Its Graded Dopant Concentration Aid Carrier Movement



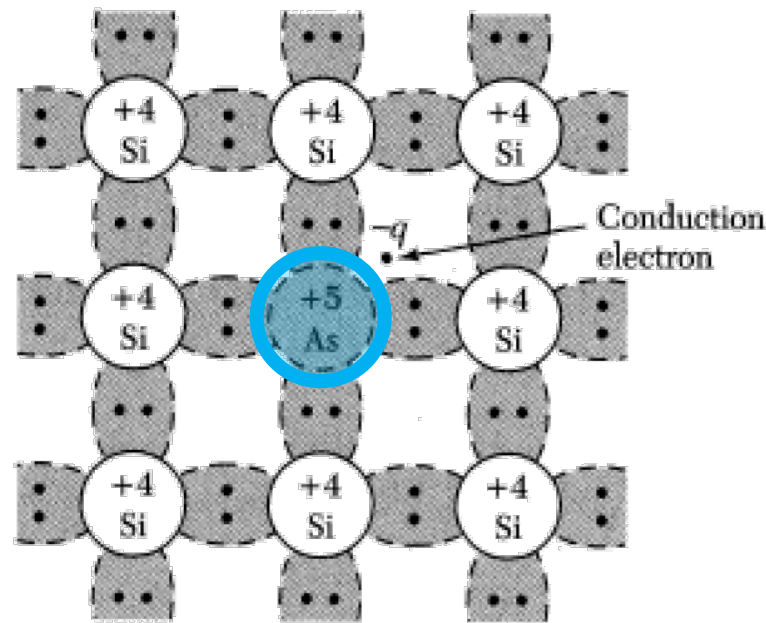
E.g., '842 Reply at 7-8, 17-19
Ex.1060 (Banerjee Supp. Decl.), ¶¶7, 21-25

[A]s shown in FIGS. 16 and 17, [] the p-well 6p and n-well 6n have their impurity concentrations gradually lowered in the depthwise direction from the principal surface (having an impurity concentration N_w) of the epitaxial layer 2E.

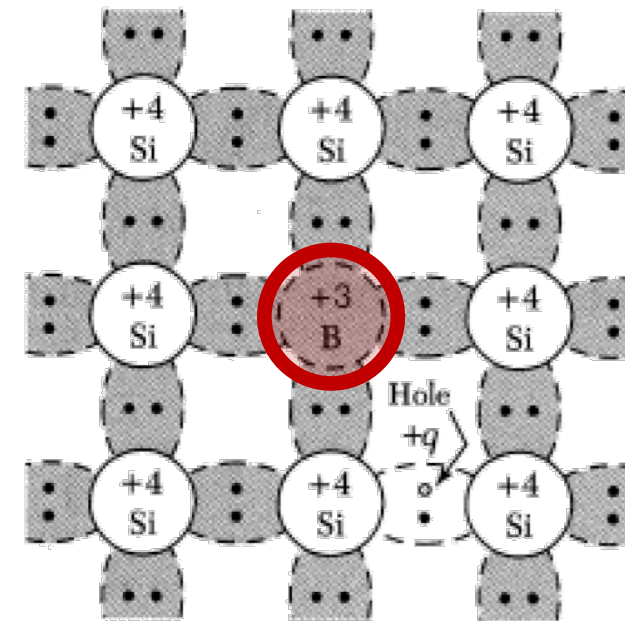
Silicon Semiconductor May be Implanted with N-Type Dopants or P-Type Dopants

N-type dopant (e.g., As)
Donor (positive ions)

P-type dopant (e.g., B)
Acceptor (negative ions)



(a)



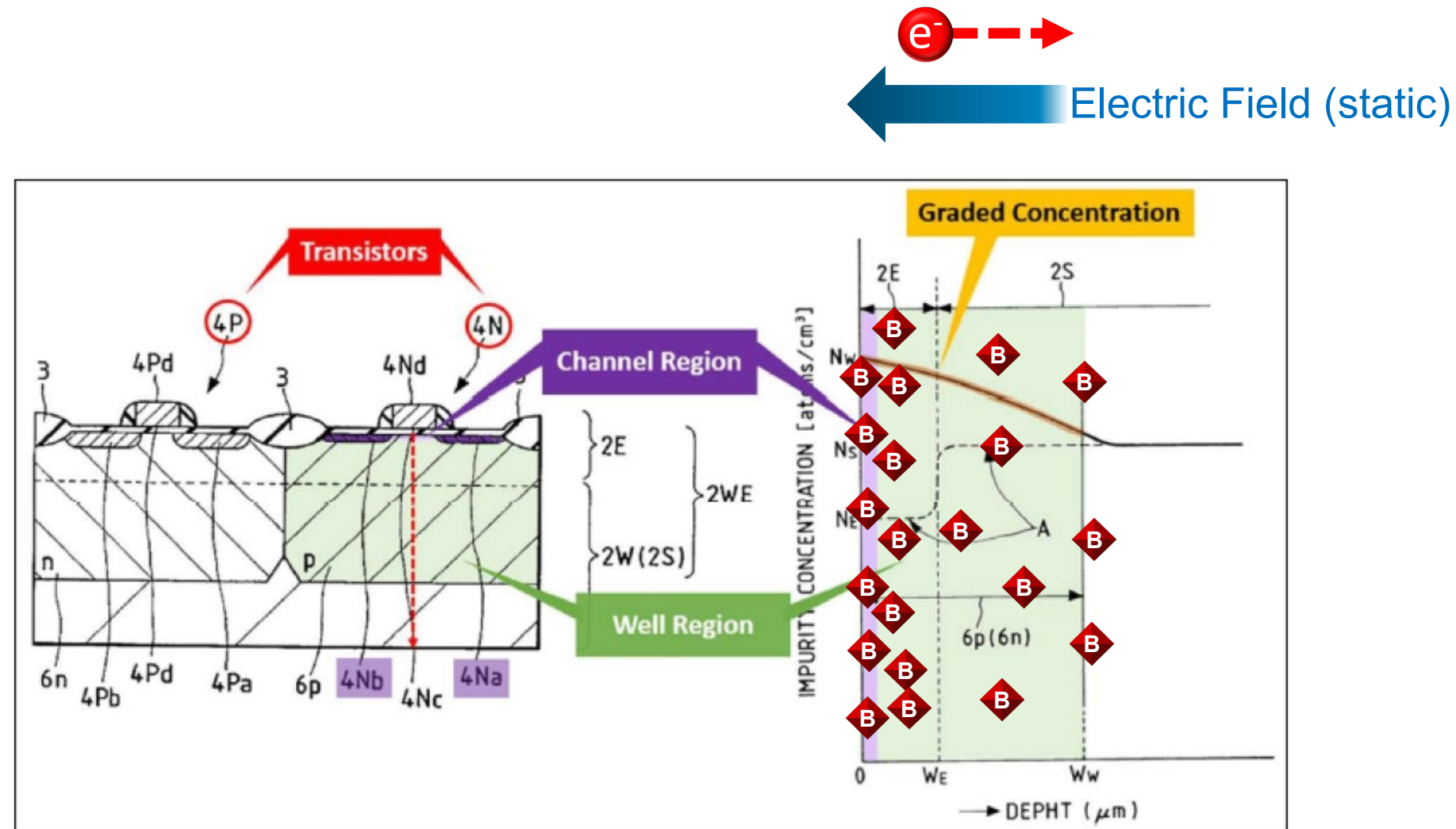
(b)

Fig. 23 Schematic bond pictures for (a) *n*-type Si with donor (arsenic) and (b) *p*-type Si with acceptor (boron).

Size (Ex. 1061) at 28

Ex. 1060 (Banerjee Supp. Declaration) at ¶12

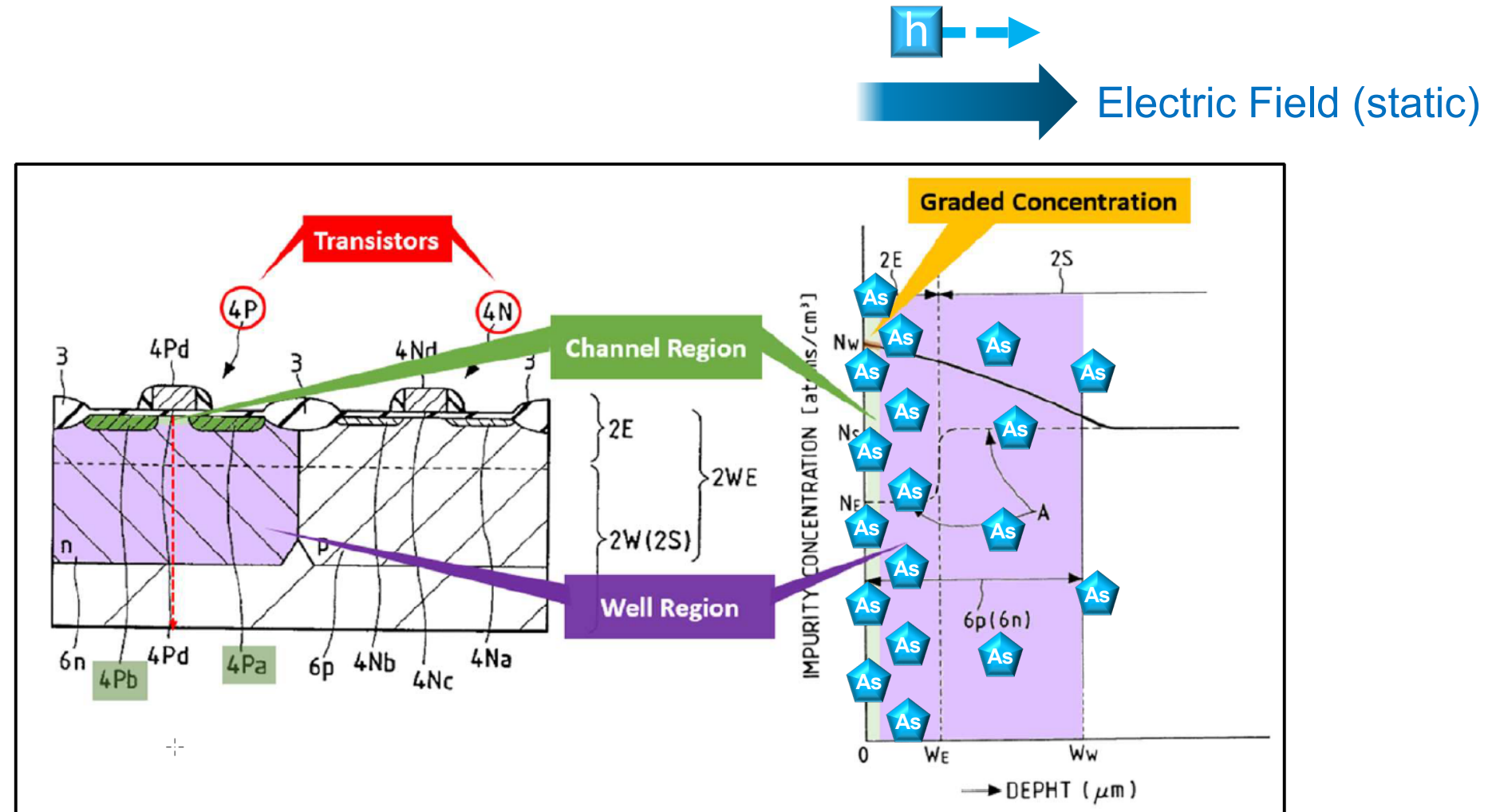
P-type Dopants (e.g., Boron (B)) create Negative Ions in Kawagoe's NMOS Transistor



E.g., '842 Reply at 7-8, 17-19
Ex.1060 (Banerjee Supp. Decl.), ¶¶7, 21-25

'842 Pet. at 13, 28-36;
'481 Pet. at 13, 28-34;
'014 Pet. at 23-28;
'222 Pet. at 22-27

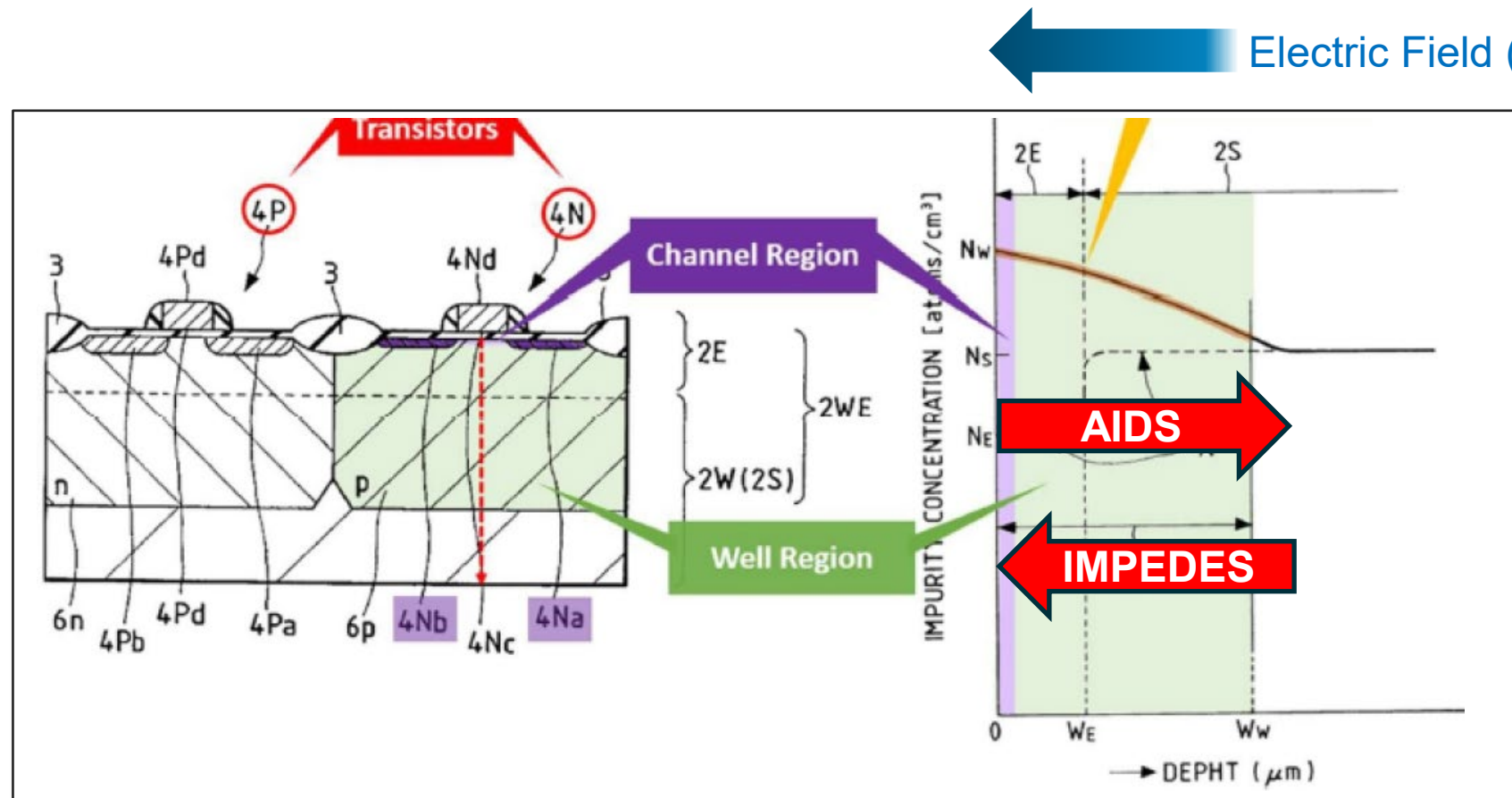
N-type Dopants (e.g., Arsenic (As)) create Positive Ions in Kawagoe's PMOS Transistor



E.g., '842 Reply at 7-8, 17-19
Ex.1060 (Banerjee Supp. Decl.), ¶¶7, 21-25

'842 Pet. at 13, 28-36;
'481 Pet. at 13, 28-34;
'014 Pet. at 23-28;
'222 Pet. at 22-27

Electric Field Aids Electron Movement in One Direction and Impedes Movement in the Opposite Direction



E-field Affects Minority Carrier Drift:

- Aids Movement Downward
- Impedes Movement Upward

See '842 POR at 16-17;
'481 POR at 16-17;
'014 POR at 15-16;
'222-I POR at 15

Thus, the impurity concentration of the p-well 6p is given such a gradient that it is gradually lowered in the depthwise direction from the surface of the epitaxial layer 2E, so that the influence to be caused by the carriers (or electrons) due to the α -ray is lowered. **Specifically, the electrons produced by the α -ray are attracted to the substrate body 2S by that concentration gradient** and prevented from entering the p-well 6p so that the soft errors can be reduced in case the MIS memory of the DRAM or the like is formed in the p-well 6p.

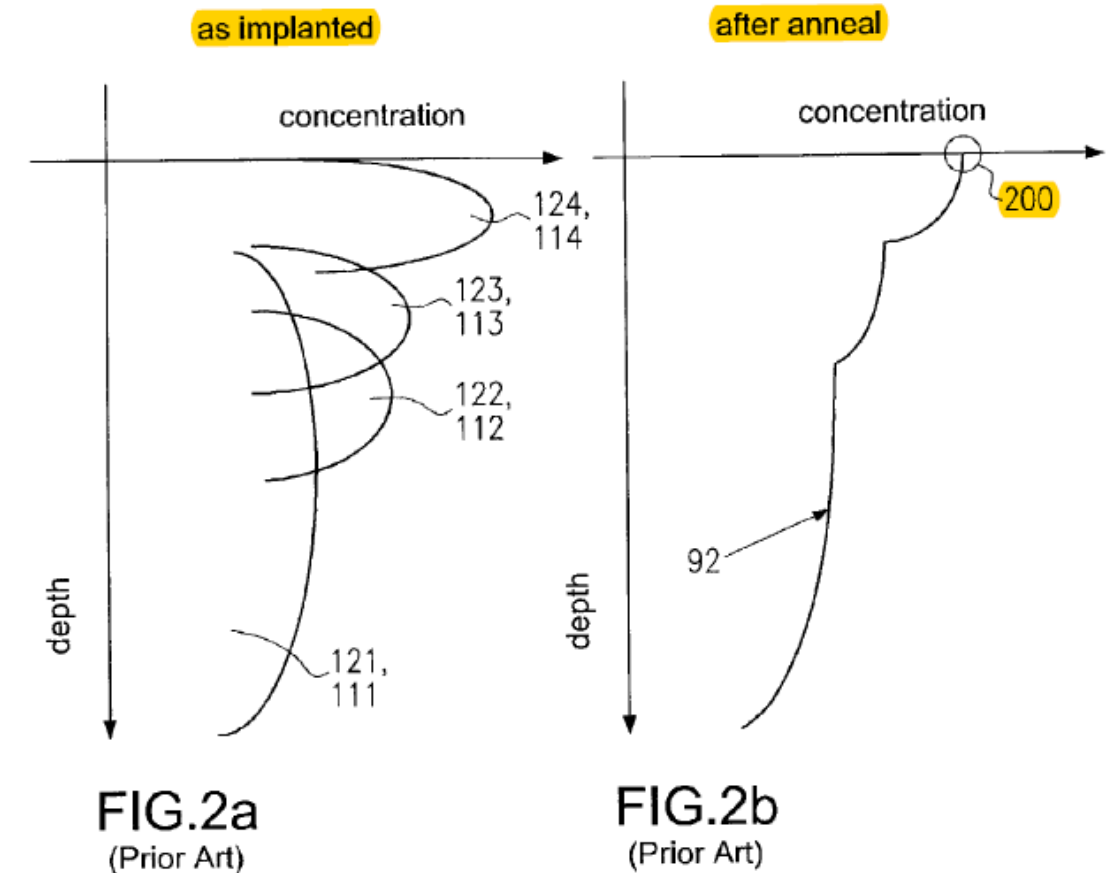
Kawagoe (Ex. 1007), Figs. 17, 23, 16:2-11

Wieczorek Discloses a Gradient that Aids Movement of Carriers

Wieczorek:

[0011] FIG. 2b shows a corresponding graph with a typical dopant profile with respect to the depth of the respective well structure. Due to the up-diffusion of the dopant atoms during the heat treatment, the initially retrograde profile in the vicinity of the surface of the semiconductor device 100, as indicated by reference number 200, may have become substantially uniformly distributed.

Wieczorek (Ex. 1006), Figs. 2a-b, [0011]



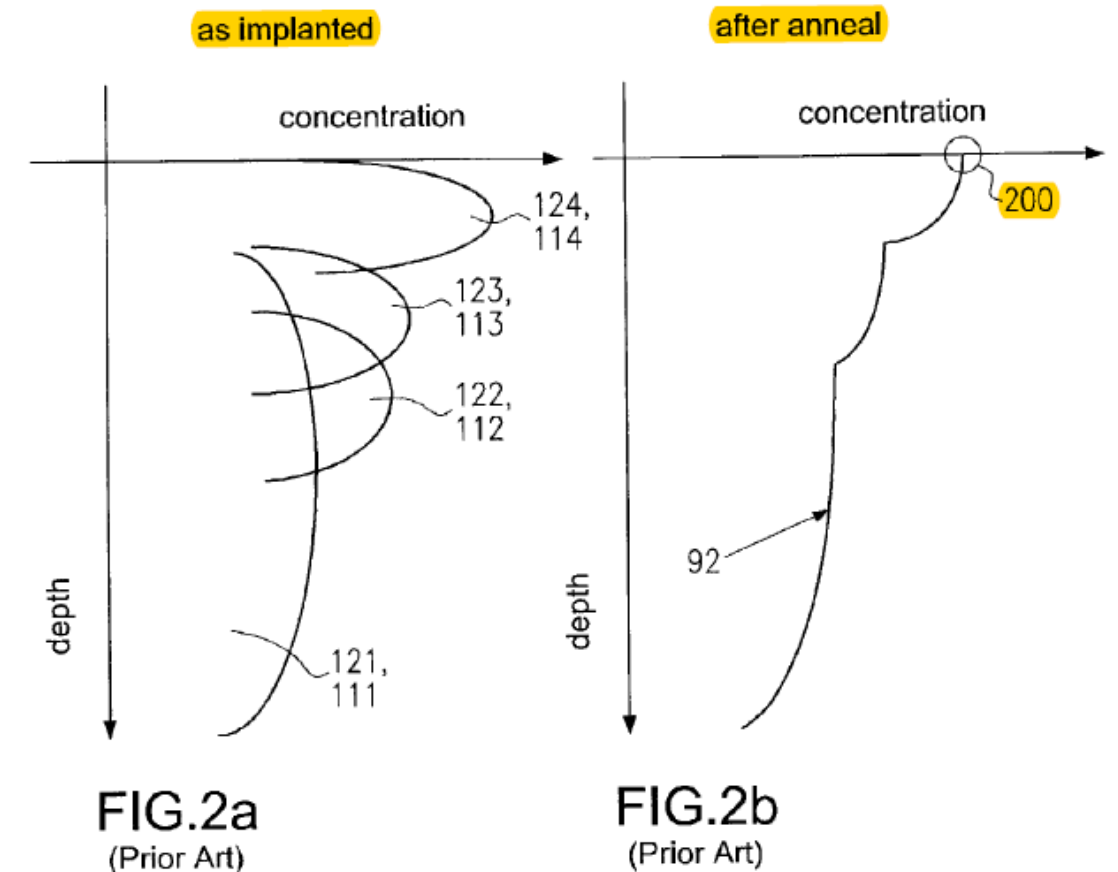
Dr. Banerjee Confirmed that Wieczorek Has a Graded Dopant Concentration, Not a “Flat Region”

Dr. Banerjee’s Declaration (Unrebutted):

Referring to Figs. 1b and 2b below, Wieczorek teaches that, following heat treatments, the dopant profile (200) becomes substantially uniformly distributed in the vicinity of the surface of the semiconductor device 100, compared to the initially retrograde profile. Ex. 1006, [0011]. Nonetheless, **Wieczorek explains that graded dopant concentrations in such prior art CMOS devices peak at the surface of the substrate and decrease with depth** . . .

* * * *

I note that Wieczorek, in discussing Figure 2b, mentions that following heat treatment, the profile “in the vicinity of the surface of the semiconductor device 100, as indicated by reference number 200, may have become **substantially uniformly distributed**,” *id.* at [0011], but **this description is made relative to the “initially retrograde profile” shown in Figure 2a**; this is not inconsistent with my understanding that **Wieczorek still teaches and depicts a graded dopant concentration** that is downward-sloping **from the top surface of the substrate**.



Wieczorek (Ex. 1006),
Figs. 2a-b

'842 Pet. at 58-59; Ex. 1003 (Banerjee Decl.) (-00016), ¶141;
'481 Pet. at 64-65; Ex. 1003 (Banerjee Decl.) (-00001), ¶160;
'014 Pet. at 58-59; Ex. 1003 (Banerjee Decl.) (-00019), ¶148;
'222 Pet. at 60-61; Ex. 1003 (Banerjee Decl.) (-00020), ¶156

Prosecution History: Applicant Conceded that a Graded Dopant Concentration Necessarily Aids Carrier Movement

The Office Action maintains a rejection pursuant to 35 U.S.C. §112, first paragraph, and in particular states that, because “movement of minority carriers is affected by multiple forces and fields” ... it does not appear that simply the presence of ‘a unidirectional drift field’ in itself can achieve ‘drawing all minority carriers from said surface layer to said substrate.’” Office Action at ¶3.

195 Patent File History (Ex. 1016) at 289-290 (Apr. 17, 2012 Response)

Prosecution History: Applicant Conceded that a Graded Dopant Concentration Necessarily Aids Carrier Movement

Applicant respectfully disagrees with this position because (as previously argued by Applicant) a unidirectional drift (electric) field necessarily affects all the present minority carriers in the same way – moving all minority carriers in the same direction because of the unidirectional drift due to the existence of the electric field. See “Physics and Technology of Semiconductor Devices,” A.S. Grove, pp. 224-225, John Wiley and Sons, Inc., New York, 1st Edition 1967 (“This same electric field will then be of such direction as to aid the motion of injected holes. Thus the injected minority carriers will now move not only by diffusion but also by drift due to the existence of this electric field.”). Depending on the particular slope of the graded concentration of dopant, all minority carriers are either swept “down” (from the surface layer to the substrate) or “up” (from the substrate to the surface layer). See Applicant’s Figs. 5(b) and 5(c).

195 Patent File History (Ex. 1016) at 289-290 (Apr. 17, 2012 Response)

'842 Pet. at 33-35; '842 Reply at 3-4;
'481 Pet. at 33-36; '481 Reply at 3-4;
'014 Pet. at 28-31; '014 Reply at 3-4;
'222-I Pet. at 27-29; '222-I Reply at 3-4

Prosecution History: Applicant Conceded that a Graded Dopant Concentration Necessarily Aids Carrier Movement

The Office Action also states that “such a unidirectional drift field may attempt to apply a force on all minority carriers in a specific direction, it does not appear to ensure (without knowing other parameters of the device) that it will draw ‘all’ minority carriers...” Yet, this argument appears to not consider that the graded dopant concentration itself creates a “built-in” electrical field that forces the movement of carriers into a particular direction, whereby the “direction” of the electrical field and the resulting direction of the carrier movement depends solely on the slope of the graded concentration of dopant. With regard to the existence of a “built-in” electric field created by a graded dopant density, *see*, e.g., Jastrzebski (US 4,481,522) col. 5, lines 11-13 (cited in Office Action). Applicant respectfully submits that this inherent “built-in” unidirectional electric field is the additional parameter for ensuring that all minority carriers are being moved in one direction and which parameter the Office Action deemed to be missing from the disclosure.

195 Patent File History (Ex. 1016) at 289-290 (Apr. 17, 2012 Response)

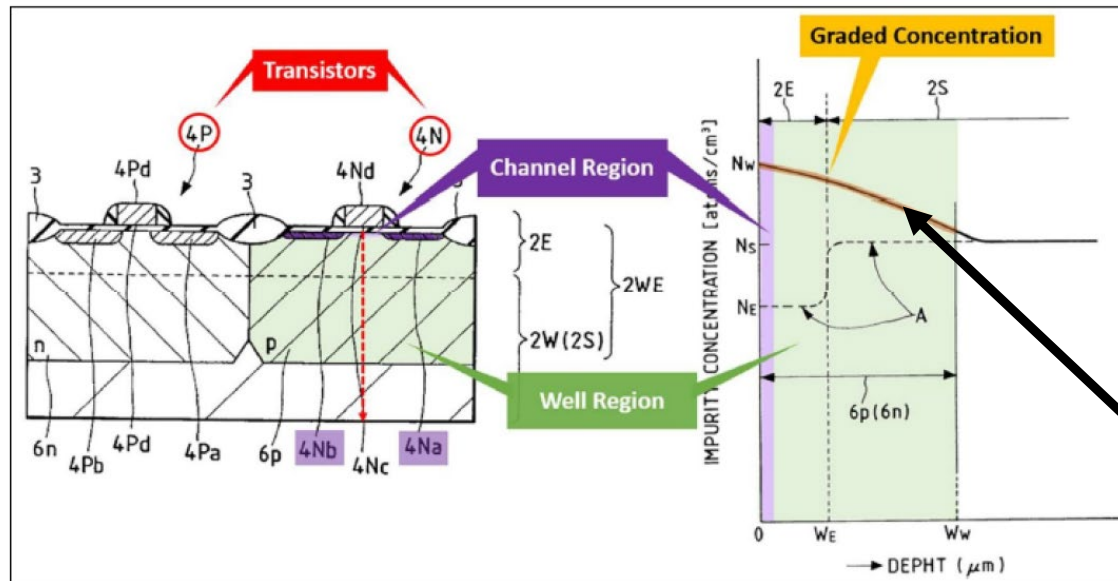
Examiner’s Office Action:

Whereas it is true that such a unidirectional drift field may attempt to apply a force on all minority carriers in a specific direction, it does not appear to ensure (without knowing other parameters of the device) that it will draw “all” minority carriers from said surface layer to said surface.

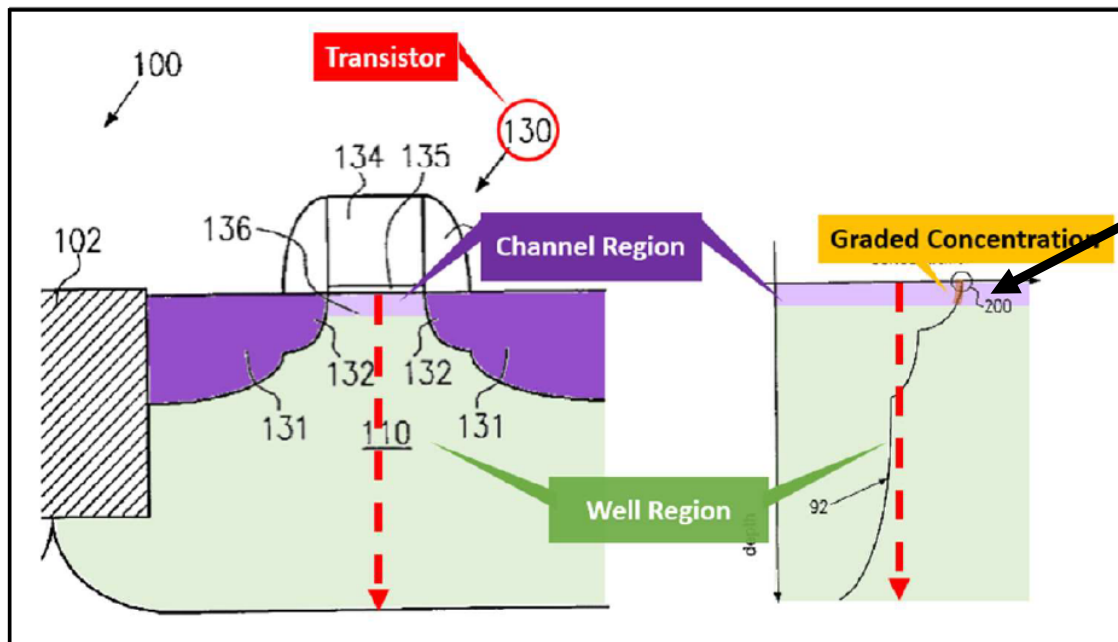
195 Patent File History (Ex. 1016) at 270
(Dec. 20, 2011 Office Action)

’842 Pet. at 33-35; ’842 Reply at 3-4;
’481 Pet. at 33-36; ’481 Reply at 3-4;
’014 Pet. at 28-31; ’014 Reply at 3-4;
’222-I Pet. at 27-29; ’222-I Reply at 3-4

Prior art discloses a Graded Concentration to Aid Carrier Movement in the Claimed Direction



'842 Pet. at 33-35; '842 Reply at 2-4;
'481 Pet. at 33-36; '481 Reply at 2-4;
'014 Pet. at 28-31; '014 Reply at 3-4;
'222-I Pet. at 27-29; '222-I Reply at 2-4



Dr. Glew has admitted:

- There are graded dopant concentrations in Kawagoe and Wieczorek
- Graded dopant concentrations generate electric fields
- Electric fields cause minority carriers to drift in a particular direction

Greenthread and Its Expert Acknowledged that “Carriers Will Move” When There’s Graded Dopant Concentration

Greenthread (During Litigation); Dr. Glew Declaration

When the dopant concentration is graded in a particular direction, other charge **carriers will move** in the gradient direction (or opposite direction) depending on the charge carrier’s polarity. This phenomenon is called “**carrier drift.**”

Ex. 2057 (Glew Declaration) at ¶33.

Ex. 1020 (Greenthread Claim Construction Brief) at 1.

Dr. Glew Deposition (IPR2023-01242/43/44):

Q. So when you talk about in paragraph 49 a concentration gradient aiding carrier movement or impeding carrier movement, that cannot be agnostic to the direction of the carrier movement, right?
A. Well, **a field will provide a force** in a direction aiding -- direction – **aiding movement in the direction of the force. That's just basic physics.**

Ex. 1069 (Jul. 16, 2024 Glew Tr.) at 108:15-23.

Greenthread’s “Aid Carrier Movement” Arguments Fail

Greenthread’s Argument	Why This Argument Fails
“Aid carrier movement” requires that a carrier move	Claims are directed to a <u>device</u> with structural features, not a method
“Carrier movement” refers to the net movement of carriers when the device is turned ON	Greenthread rewrites the claims. Drift-induced movement (even when device is OFF) is sufficient
Petitioners now argue that “carrier movement” refers to Brownian motion	Red herring; Petitioners merely provided technical context, that that carriers are constantly moving.
The direction of the slope is insufficient to show “aided”	Nothing in the intrinsic record suggests measuring or comparing slope magnitude
Warrick, WDTX, and EDTX confirm that the claims require measuring the magnitude of the slope	Greenthread mischaracterizes each of these documents
Kawagoe does not address carriers in the active region	Greenthread admits, and prior art confirms, that carriers would be present in Kawagoe’s active region
Dr. Banerjee: “3 categories of forces” affect carrier movement	Dr. Banerjee confirmed that these 3 categories of forces don’t alter the carrier movement
Dr. Banerjee: an additional, gate oxide-induced E-field imparts an additional force on the carriers	Claims directed to “ <i>a graded dopant concentration</i> to aid carrier movement”; other E-fields don’t negate this

See generally '842 Reply; '481 Reply; '014 Reply;'222-I Reply;
Ex. 2078 (Dec. 6, 2024 Banerjee Tr.)

The Claims Do Not Require Measuring the Slope
Magnitude and Comparing it with *Other Forces*

Greenthread: Claims Require Slope “Magnitude” and “Other Forces”

Dr. Glew’s Declaration:

Based on Dr. Banerjee’s declaration, it is apparent that for his analysis of the “aid the movement carriers ...” limitation he only considered the downward sloping nature of Kawagoe’s concentration gradient, and not any other aspect of the gradient (e.g., the magnitude of the force it produces on carriers) or whether there are any **external forces (e.g., opposing forces, e.g., due to the intrinsic resistance of silicon)** such that the net force might not be aiding carrier movement in the claimed manner. . . . Therefore, a POSITA would need to know **other parameters of the relevant device (e.g., magnitude of concentration gradient, intrinsic resistance of silicon, presence of any other external forces)** to know whether a drift field associated with a concentration gradient would aid carrier movement.

Ex. 2057 (Glew Decl.) (-00016), ¶50; Ex. 2057 (Glew Decl.) (-00016), ¶50;
Ex. 2057 (Glew Decl.) (-00019), ¶50 Ex. 2057 (Glew Decl.) (-00020), ¶50

’842 POR at 7-8; ’481 POR at 7-8; ’014 POR at 7-8; ’222-I POR at 7-8

The Claims Do Not Require Any Specific Magnitude for the Slope Gradient

Dr. Glew's Declaration:

Therefore, a POSITA would need to know **other parameters of the relevant device (e.g., magnitude of concentration gradient, intrinsic resistance of silicon, presence of any other external forces)** to know whether a drift field associated with a concentration gradient would aid carrier movement.

Claim 1 (842): at least **one graded dopant concentration** to aid carrier movement from the first surface to the second surface of the substrate

Ex. 2057 (Glew Decl.) (-00016), ¶50; Ex. 2057 (Glew Decl.) (-00016), ¶50;
Ex. 2057 (Glew Decl.) (-00019), ¶50 Ex. 2057 (Glew Decl.) (-00020), ¶50

'842 Reply at 1;
'481 Reply at 1;
'014 Reply at 1;
'222-I Reply at 1

Specification: Aiding Carrier Movement Does not Hinge on A Specific Magnitude of the Gradient

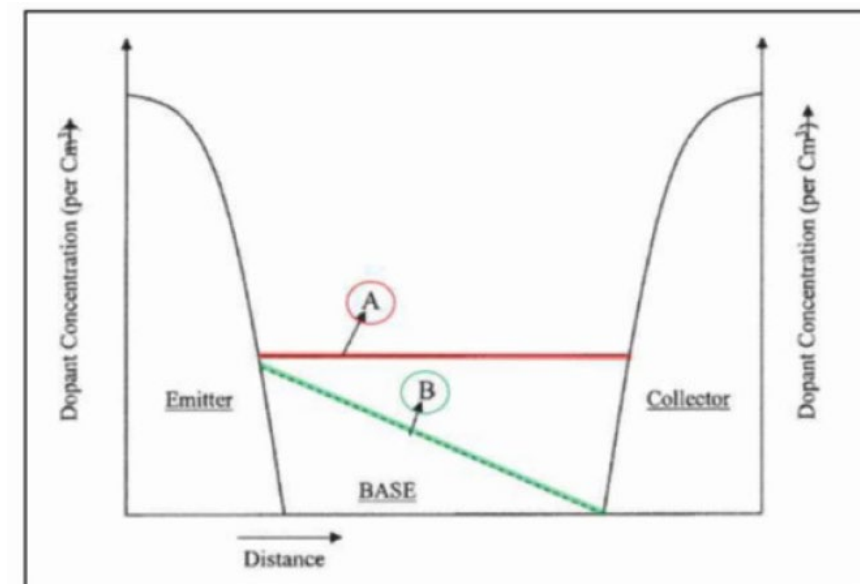
Dr. Glew's Declaration:

Therefore, a POSITA would need to know **other parameters of the relevant device (e.g., magnitude of concentration gradient, intrinsic resistance of silicon, presence of any other external forces)** to know whether a drift field associated with a concentration gradient would aid carrier movement.

Specification:

The relative doping concentrations of emitter and collector regions varies from 10^{18} to $10^{20}/\text{cm}^3$, whereas the base region is 10^{14} to $10^{16}/\text{cm}^3$ depending on the desired characteristics of the BJT. In graded base p-n-p transistors, the donor dopant concentration may be 10 to 100x at the emitter-base junction, relative to the base-collector junction (x1). . . . "The **relative slope** of the donor concentration throughout the base creates a suitable aiding drift electric field, to help the holes (p-n-p transistor) transverse from emitter to collector."

'842 Patent (Ex. 1001) (-00016),
2:62-3:5 Fig. 1



Ex. 2057 (Glew Decl.) (-00016), ¶50; Ex. 2057 (Glew Decl.) (-00016), ¶50;
Ex. 2057 (Glew Decl.) (-00019), ¶50 Ex. 2057 (Glew Decl.) (-00020), ¶50

'842 Reply at 5-6;
'481 Reply at 5-6;
'014 Reply at 5-6;
'222-I Reply at 5-6

Greenthread Conceded That “Relative Slope” Does Not Imply a Magnitude

Greenthread’s Continuing Prosecution (Aug. 2024):

Dr. Glew’s Declaration:

Therefore, a POSITA would need to know **other parameters of the relevant device (e.g., magnitude of concentration gradient, intrinsic resistance of silicon, presence of any other external forces)** to know whether a drift field associated with a concentration gradient would aid carrier movement.

In order to describe how the term “gradient” is utilized and described and supported in the Specification, Applicant will try to step through how such as introduced and utilized in the Specification. In addition, the declaration under 37 CFR 1.132 of Douglas Holberg as an expert is filed herewith as support for this discussion. Applicant additionally notes that although the below

* * *

The structure of this transistor is described as having a base region that has a donor dopant concentration gradient that is high at the emitter-base junction and low at the base-collector injunction. This corresponds to the label “B” in Figure 1. This is defined as a “relative slope” which means nothing more than the fact that one-side is relatively lower than the other side. This

Ex. 2057 (Glew Decl.) (-00016), ¶50;
Ex. 2057 (Glew Decl.) (-00016), ¶50;
Ex. 2057 (Glew Decl.) (-00019), ¶50;
Ex. 2057 (Glew Decl.) (-00020), ¶50

Aug. 2024 Remarks in 17/728,588 (Ex.1070) at 9;
Aug. 2024 Holberg Declaration in 17/728,588 (Ex.1064) at 5

'842 Reply at 5-6;
'481 Reply at 5-6;
'014 Reply at 5-6;
'222-I Reply at 5-6

Greenthread Did Not Mention “Magnitude” of the Gradient During Prosecution

Dr. Glew’s Declaration:

Therefore, a POSITA would need to know **other parameters of the relevant device (e.g., magnitude of concentration gradient, intrinsic resistance of silicon, presence of any other external forces)** to know whether a drift field associated with a concentration gradient would aid carrier movement.

Applicant respectfully disagrees with this position because (as previously argued by Applicant) **a unidirectional drift (electric) field necessarily affects all the present minority carriers in the same way – moving all minority carriers in the same direction because of the unidirectional drift due to the existence of the electric field. See “Physics and Technology of Semiconductor Devices,” A.S. Grove, pp. 224-225, John Wiley and Sons, Inc., New York, 1st Edition 1967 (“This same electric field will then be of such direction as to aid the motion of injected holes. Thus the injected minority carriers will now move not only by diffusion but also by drift due to the existence of this electric field.”). Depending on the particular slope of the graded concentration of dopant, all minority carriers are either swept “down” (from the surface layer to the substrate) or “up” (from the substrate to the surface layer). See Applicant’s Figs. 5(b) and 5(c).**

195 Patent File History (Ex. 1016) at 289-290 (Apr. 17, 2012 Response)

Ex. 2057 (Glew Decl.) (-00016), ¶50; Ex. 2057 (Glew Decl.) (-00016), ¶50;
Ex. 2057 (Glew Decl.) (-00019), ¶50 Ex. 2057 (Glew Decl.) (-00020), ¶50

COVINGTON

’842 Pet. at 33-35; ’842 Reply at 3-4;
’481 Pet. at 33-36; ’481 Reply at 3-4;
’014 Pet. at 28-31; ’014 Reply at 3-4;
’222-I Pet. at 27-29; ’222-I Reply at 3-4

Greenthread Did Not Mention “Magnitude” of the Gradient During Prosecution

Dr. Glew’s Declaration:

Therefore, a POSITA would need to know **other parameters of the relevant device (e.g., magnitude of concentration gradient, intrinsic resistance of silicon, presence of any other external forces)** to know whether a drift field associated with a concentration gradient would aid carrier movement.

Ex. 2057 (Glew Decl.) (-00016), ¶50; Ex. 2057 (Glew Decl.) (-00016), ¶50;
Ex. 2057 (Glew Decl.) (-00019), ¶50 Ex. 2057 (Glew Decl.) (-00020), ¶50

The Office Action also states that “such a unidirectional drift field may attempt to apply a force on all minority carriers in a specific direction, it does not appear to ensure (without knowing other parameters of the device) that it will draw ‘all’ minority carriers...” Yet, this argument appears to not consider that **the graded dopant concentration itself creates a “built-in” electrical field that forces the movement of carriers into a particular direction, whereby the “direction” of the electrical field and the resulting direction of the carrier movement depends solely on the slope of the graded concentration of dopant.** With regard to the existence of a “built-in” electric field created by a graded dopant density, *see*, e.g., Jastrzebski (US 4,481,522) col. 5, lines 11-13 (cited in Office Action). Applicant respectfully submits that **this inherent “built-in” unidirectional electric field is the additional parameter for ensuring that all minority carriers are being moved in one direction** and which parameter the Office Action deemed to be missing from the disclosure.

195 Patent File History (Ex. 1016) at
289-290 (Apr. 17, 2012 Response)

’842 Pet. at 33-35; ’842 Reply at 3-4;
’481 Pet. at 33-36; ’481 Reply at 3-4;
’014 Pet. at 28-31; ’014 Reply at 3-4;
’222-I Pet. at 27-29; ’222-I Reply at 3-4

Dr. Glew Admittedly Did Not Consider Greenthread's Prosecution Statements

Dr. Glew's Deposition:

Q But maybe let me ask you, sitting here right now, when you reviewed the file history for the '195 patent, you must -- did you review all the office actions by the examiner and responses by GreenThread?

A I would say **I glanced at the file history**. There was nothing outstanding that I saw at the time. I didn't -- I included -- I don't think I included any comments in my report on the file history. **It didn't seem relevant** to what the -- any of the issues I was rebutting at the time.

Ex. 1063 (Oct. 16, 2024 Glew Tr.) at 179:17-180:6

Dr. Banerjee Supp. Declaration:

98. During the deposition, Dr. Glew admitted that he had only “glanced” at the prosecution history, because—according to him—“**[i]t didn't seem relevant** to ... any of the issues I was rebutting at the time.” Ex.1063-Glew-Tr. 179:18-180:6. In my opinion, **this is a glaring omission from his analysis, because the above statements of the file history are technical representations that speak to what level of disclosure in the prior art is sufficient to demonstrate the “aid carrier movement” term.**

Ex. 1060 (Banerjee Supp. Declaration) at ¶98

Prosecution History: Regarding Analogous Claims, Applicant Conceded That “Any Magnitude” is Sufficient

Patent Examiner:

Note that **applicant has not claimed a specific magnitude** of the drift electric field and hence **any magnitude of drift electric field, however small, reads on the claim**. The ordinary artisan would have been motivated to modify Currie for at least the purpose of aiding carrier movement in a specific, desired direction.

195 Patent File History (Ex. 1016) at 139-40 (Dec. 30, 2009 Office Action)

3. (currently amended) A VLSI digital semiconductor device with graded dopant concentration in the well regions and the active channel regions, to aid carrier movement away from the active surface regions, towards the substrate:

A VLSI Digital Semiconductor device comprising:

a surface region;

a substrate;

an active channel region capable of providing a localized drift electric field without the application of an external potential;

an isolation well region capable of providing a localized drift electric field without the application of an external potential; and

a graded dopant concentration in either the channel region or the well region to aid carrier movement away from the surface region towards the substrate.

195 Patent File History (Ex. 1016) at 123
(Aug. 26, 2009 Amendment & Response)

Greenthread's Presents Arguments on “Aid Carrier Movement” are Inconsistent with its Litigation Positions

During Prior Litigation:

“To aid the movement” is a simple term that is readily understood by POSITAs and lay persons alike. Ex. 1, ¶85. Any one that has put a little WD40 on a rusty hinge, or stretched before exercising, knows what it means “to aid the movement” of something. **Likewise, nobody would dispute that a wheelchair ramp “aids the movement” of someone in a wheelchair.**

* * * *

By the time the claim gets to the phrase “to aid movement,” it is merely clarifying what the electric field does. Any question about what is meant by “to aid the movement” is answered by the preceding claim language. **Electric drift fields are a well-known phenomenon that cause carriers to move, and a POSITA would have readily recognized that when a “static unidirectional electric drift field” is present that it aids the movement of the minority carriers.**

Ex. 1020 (Greenthread Claim Construction Brief) at 25-27.

Now, to Avoid Invalidity:

In “a **complex electronic device**, movement of minority carriers is affected by **multiple forces and fields**” (citing Patent Examiner).

Since **Petitioners do not measure** or account for these forces, and **do not compare** them to the **magnitude of the force exerted by the gradients** in the alleged prior art, they fail to establish that the disclosed gradients would “aid carrier movement.”

'842 POR at 8-9;
'481 POR at 7-9;
'014 POR at 7-9;
'222-I POR at 7-9

'842 Reply at 6-7;
'481 Reply at 6-7;
'014 Reply at 6-7;
'222-I Reply at 6-7

Speed or Acceleration of Movement is Admittedly Irrelevant

During Prior Litigation:

The claim specifies the graded dopants create an electric field that aids movement of the carriers away from the surface layer. Defendants assert that the specification does not provide guidance on how to assess or measure carrier movement. This is not true. The claims and the specification make clear that the electric field must move the carriers in a particular direction (from the surface layer to the substrate). **Whether the carrier movement has a particular speed or acceleration is beyond the scope of the claim**, as long as it meets the other limitations of the claim.

Ex. 1020 (Greenthread Claim Construction Brief) at 29.

Greenthread Asserts That the Claims Hinge on Slope “Magnitude” and “Other Forces”

Greenthread’s Response:

Petitioners’ assumption that the gradients in their prior art references would aid carrier movement fails, because they assume that any gradient would suffice to overcome the **other forces that are present**, such as the inherent resistance of silicon. Since **Petitioners do not measure or account for these forces, and do not compare them to the magnitude of the force exerted by the gradients** in the alleged prior art, they fail to establish that the disclosed gradients would “aid carrier movement.” Ex. 2057, ¶¶46-50.

’842 POR at 7-8; ’481 POR at 7-8; ’014 POR at ’7-8; ’222-I POR at 7-8

Carriers in a Doped Semiconductor are Free to Move

Dr. Glew Misunderstands Basic Semiconductor Physics

Dr. Glew's Declaration:

Therefore, a POSITA would need to know **other parameters of the relevant device (e.g., magnitude of concentration gradient, intrinsic resistance of silicon, presence of any other external forces)** to know whether a drift field associated with a concentration gradient would aid carrier movement.

Ex. 2057 (Glew Decl.) (-00016), ¶50;
Ex. 2057 (Glew Decl.) (-00016), ¶50;
Ex. 2057 (Glew Decl.) (-00019), ¶50;
Ex. 2057 (Glew Decl.) (-00020), ¶50

'842 Reply at 9-11;
'481 Reply at 9-11;
'014 Reply at 9-11;
'222-I Reply at 9-11

Dr. Glew's Deposition:

A Yes. It's my opinion, position -- it's a fact, I think -- that the mere presence of electrical field isn't sufficient to cause electrons to become charge carriers. **There's a -- essentially a threshold voltage to cause motion** as well as resistance to the materials.

* * * *

Q You mentioned threshold voltage. Are you referring to a voltage that would be applied between the source and a drain for a transistor to conduct?

A Well, I could use threshold voltage in a couple of contexts. That would be one, and that is one that I had mentioned previously. But **there's also a threshold voltage to liberate an extra electron from a crystal structure.**

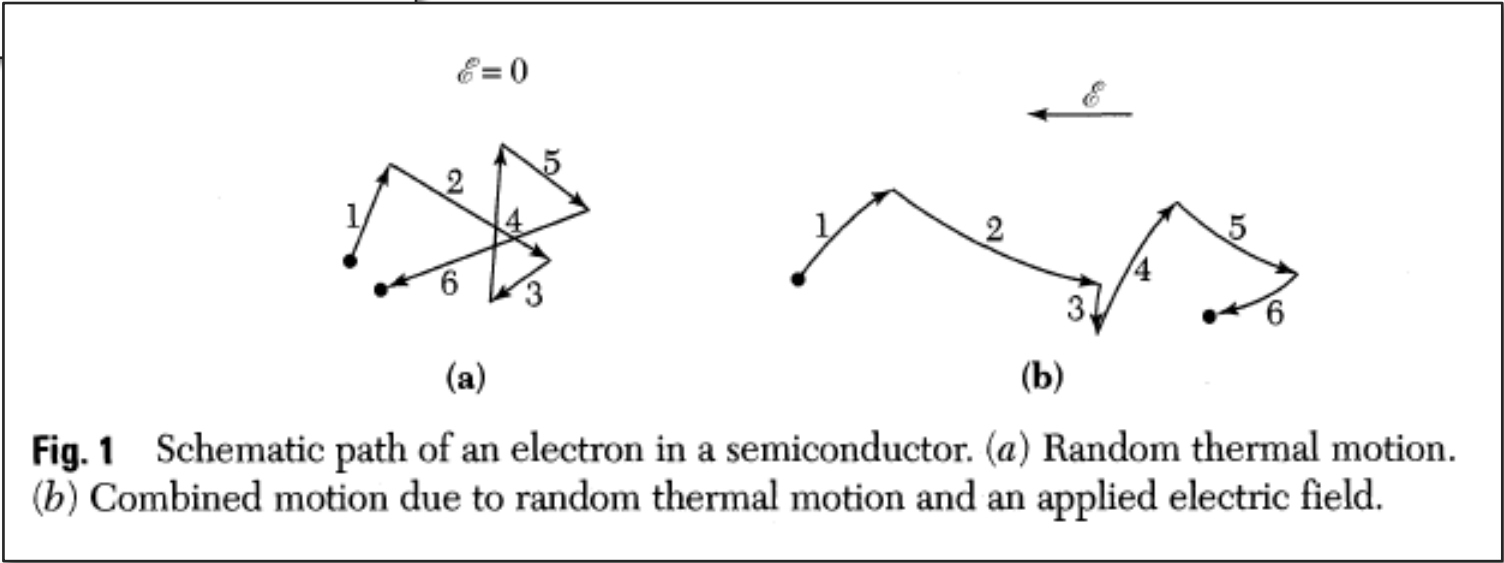
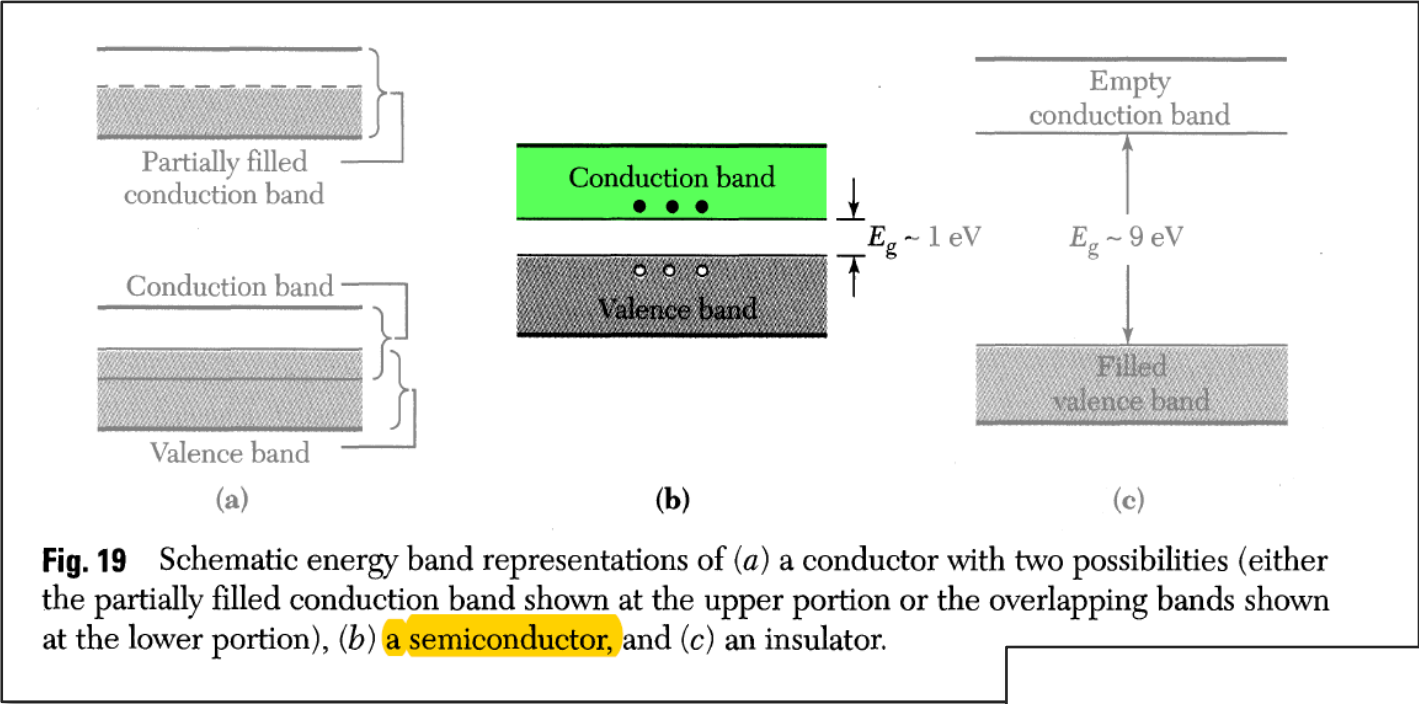
* * * *

Q Do you recall mentioning threshold voltage in your expert declaration? Is that correct?

A I'm not sure if I used the phrase "threshold voltage." I certainly spoke of that concept, that there's certain voltage required to cause motion, you know. **A small enough voltage won't make an electron free or liberate it from the atoms it's bonded to. A larger voltage will.**

Ex. 1063 (Oct. 16, 2024 Glew Tr.) at 104:21–108:11

Carriers in a doped semiconductor are in “Brownian” motion (i.e., free to move)



'842 Reply at 11;
'481 Reply at 11;
'014 Reply at 11;
'222-I Reply at 11

Petitioners Did Not Offer a “Brownian” Claim Construction

Greenthread’s Sur-Reply:

Petitioners now argue that . . . “**aiding carrier movement**” does not refer to the flow of carriers in a semiconductor device, but rather the constant, random, thermal—a.k.a. “**Brownian**”—vibration of individual electrons. That theory and **claim construction** make no sense and should be rejected as an improper new argument.

’842 Sur-Reply at 1; ’481 Sur-Reply at 1;
’014 Sur-Reply at 1; ’222-I Sur-Reply at 1

- Petitioners simply provided context, that carriers in a semiconductor are *already moving* (in Brownian motion), to rebut Dr. Glew’s theory

Dr. Glew’s Deposition:

But **there’s also a threshold voltage to liberate an extra electron from a crystal structure.**

Ex. 1063 (Oct. 16, 2024 Glew Tr.) at 104:21–108:11

’842 Reply at 9-11;
’481 Reply at 9-11;
’014 Reply at 9-11;
’222-I Reply at 9-11

Intrinsic Resistance, Silicon Stress, and Temperature do not Preclude Movement of Carriers

Dr. Glew's Declaration:

[A] POSITA would need to know other parameters of the relevant device (e.g., magnitude of concentration gradient, **intrinsic resistance of silicon**, presence of **any other external forces**) to know whether a drift field associated with a concentration gradient would aid carrier movement.

Ex. 2057 (Glew Decl.) (-00016), ¶50; Ex. 2057 (Glew Decl.) (-00016), ¶50;
Ex. 2057 (Glew Decl.) (-00019), ¶50; Ex. 2057 (Glew Decl.) (-00020), ¶50

Dr. Glew's Deposition:

Q Okay. Did you have any other opposing force in mind when you mentioned "e.g.,...intrinsic resistance of silicon"?
A Let me briefly review the paragraph. I gave an example of external forces such as intrinsic resistance. **Other opposing forces potentially could be stress of the device.**

Ex. 1063 (Oct. 16, 2024 Glew Tr.) at 152:11-17

- Carrier don't need to over come any intrinsic resistance. Presents a friction-like force that affects speed or acceleration of movement, which is beyond the scope of the claims
- Temperature variations do not preclude movement

Greenthread Mischaracterizes Dr. Banerjee's Textbook

Greenthread's Sur-Reply:

Dr. Banerjee claims that any electric field would necessarily aid the movement of electrons in Brownian motion. Ex. 2078, 210:16-17. But, when Dr. Banerjee addressed Brownian motion in his textbook, he took a different position. There, he said that “the force [of an electric field] may be *insufficient* to alter appreciably the random path of an individual electron.” Ex. 1062A, 99 (PDF page 50) (emphasis added).

'842 Sur-Reply at 10; '481 Sur-Reply at 10;
'014 Sur-Reply at 10; '222-I Sur-Reply at 10

Greenthread Mischaracterizes Dr. Banerjee's Textbook

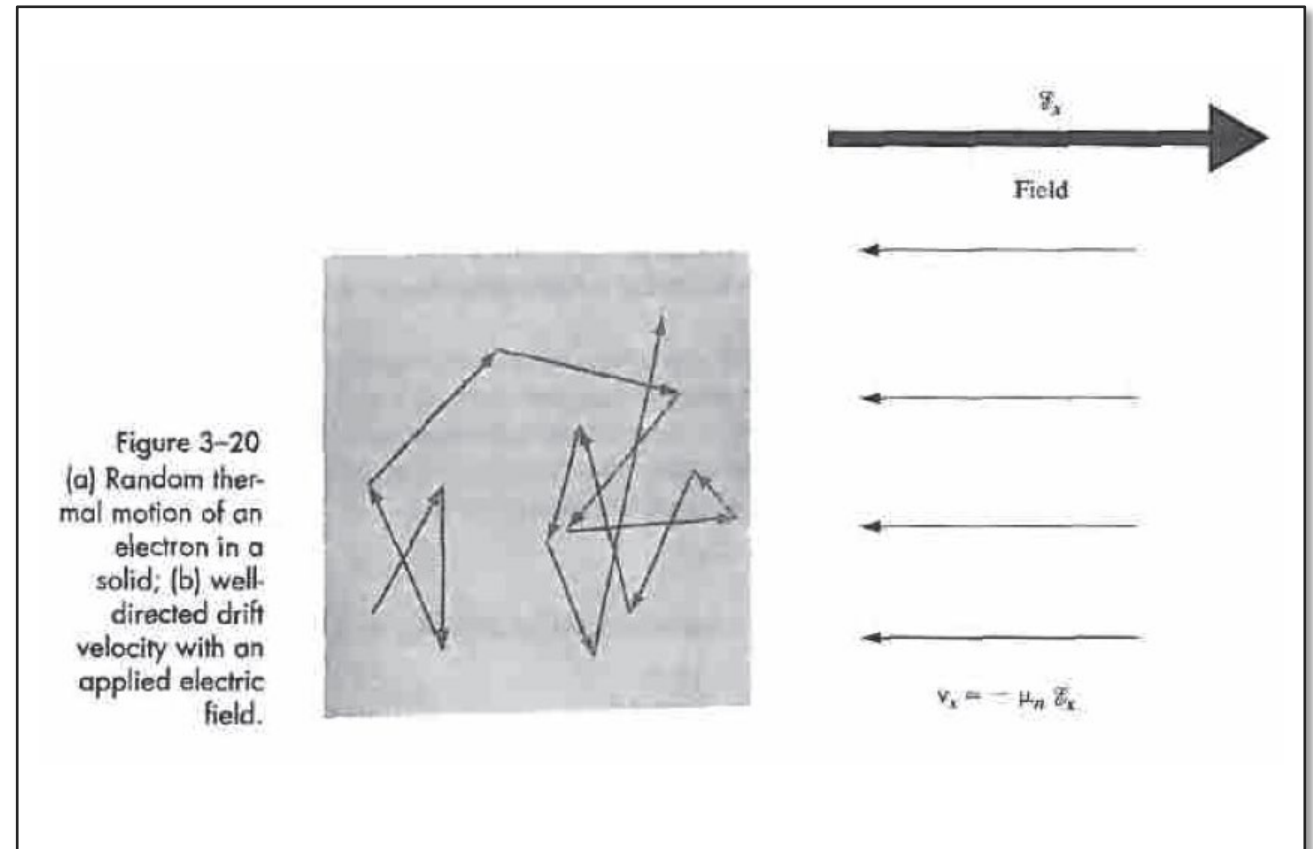
Streetman/Banerjee:

3.4.1 Conductivity and Mobility

The charge carriers in a solid are in constant motion, even at thermal equilibrium. At room temperature, for example, the thermal motion of an individual electron may be visualized as random scattering from lattice vibrations, impurities, other electrons, and defects (Fig. 3-20a). Since the scattering is random, there is no net motion of the group of n electrons/cm³ over any period of time. This is not true of an individual electron, of course. The probability of the electron in Fig. 3-20a returning to its starting point after some time t is negligibly small. However, if a large number of electrons is considered (e.g., 10^{16} cm⁻³ in an n-type semiconductor), there will be no preferred direction of motion for the group of electrons and no net current flow.

If an electric field $\mathcal{E}_x$ is applied in the x -direction, each electron experiences a net force $-q\mathcal{E}_x$ from the field. This force may be insufficient to alter appreciably the random path of an individual electron; the effect when averaged over all the electrons, however, is a net motion of the group in the $-x$ -direction (Fig. 3-20b). If p_x is the x -component of the total momentum of the group, the force of the field on the n electrons/cm³ is

$$-nq\mathcal{E}_x = \left. \frac{dp_x}{dt} \right|_{\text{field}} \quad (3-29)$$



Streetman/Banerjee (Ex.1062A) at 98-99

Greenthread Incorrectly Reads the Disputed Limitations as Referring to “Net Movement”

Dr. Glew Incorrectly Construes “Aid Carrier Movement” as Referring to Net Movement, When the Device is “ON”

- Only considered *net movement* of carriers (requires an applied voltage)
- Did not consider drift-induced “*carrier movement*” in the device OFF state

A **When it is off, there is no motion of carriers.**

* * *

Q **There may not be any net movement of carriers or there may not be any net flow of current, but the carriers are in motion** even though the transistors is not operating; is that correct?

A. To me, the question makes no sense. It's nonsensical. **The movement of carriers is current.** So I just can't fathom what you're asking.

Q Okay. So if the transistor's sitting there and it is not operating but there is a dopant electric field, is your testimony that the electrons would not be in motion?

A It's my testimony that when the current -- excuse me -- when the transistor is off, there should be no **net current flow** in the transistor and that the channel region should not become electron rich and hole poor.

A. . . .I haven't performed an additional analysis of the balance of any stat- --any "off" state activity.

Q . . . I'm just asking you, do you have a position **whether there will be any drift** from the surface to the substrate of the electrons based on the dopant electric field when the transistor is not operating?

A As I've said before, **there should be no net current flow** that would degrade the performance of the device, which is meant not to have current flow **when it's off.**

Ex. 1063 (Oct. 16 2024 Glew Tr.) at 50:10-52:22, 62:10-63:12

Ex. 1060 (Banerjee Supp. Declaration) at ¶¶23-27 (explaining drift and diffusion)

Dr. Banerjee Explained Why Dr. Glew's Interpretation And Analysis is Flawed

95. Based on the portions of the deposition transcript I have cited above, it appears that Dr. Glew is misreading the claims to specifically require a *net movement* of carriers, or a “net current.” However, the claims do not speak to the *net movement* of carriers. Rather, the claims require structural features of the device — here, a “graded dopant concentration” that is capable of aiding the movement of carriers. While I do not dispute Dr. Glew’s assessment that an external voltage must be applied in order to cause *net movement* of carriers, or *net current* to flow, that is beside the point, because even at equilibrium (i.e., where no external voltages are applied to the device) *minority carriers will move via drift by virtue of the static electric field alone*. Further, while all of the challenged claims

Ex. 1060 (Banerjee Supp. Decl.) at ¶¶91-95

Intrinsic Record does not Disclose
Any External Forces

The Intrinsic Record Does Not Disclose “External Forces”

- The claims require a “graded concentration of dopants that aids movement”
- Specification does not disclose such external forces
- File history does not disclose external forces

Dr. Banerjee's Conclusions on the "Aid Carrier Movement" Term Account for the "3 Categories of Forces"

Greenthread's Sur-Reply:

According to Dr. Banerjee, those categories are (1) "periodic crystalline potential" (*id.* at 82:9-12), (2) "externally applied forces or a built-in electric field" (*id.* at 83:19-84:1) and (3) "random forces, ... such as lattice vibrations or static random forces due to structural defects in the crystal." *Id.* at 84:16-21.

'842 Sur-Reply at 3-5; '481 Sur-Reply at 3-5;
'014 Sur-Reply at 3-5; '222 Sur-Reply at 3-5

"Category 1" Considered

Q. Okay. Did you need to make any measurements for any category 1 forces in order to arrive at the conclusions you reached in these proceedings?

A. No, I did not.

Q. And why not?

A. Because the patent talks about these long -- these long range electric fields created by doping gradients and that is not impacted by the different periodic forces.

Ex. 2078 (Dec. 6, 2024 Banerjee Tr.) at 319:10-22.

"Category 2" Considered

Q. Okay. And I believe you mentioned that the second category of force components includes an externally applied fields or doping electric fields; is that accurate?

A. Yes.

Q. Okay. And with respect to doping electric fields, does that include electric fields due to dopant concentration variations?

A. Yes.

Q. And is that force component addressed in your supplemental declaration?

A. Yes.

Ex. 2078 (Dec. 6, 2024 Banerjee Tr.) at 320:1-14.

Dr. Banerjee's Conclusions on the "Aid Carrier Movement" Term Account for the "3 Categories of Forces"

"Category 3" Considered

Q. Okay. And, finally, I believe the third category of force component that you mentioned had to do with random collisions or scattering; is that right?

A. Yes.

Q. And do you recall testifying that that category affects mobility, which, in turn, affects resistivity?

A. Yes.

Q. Okay. And did you address resistivity in your supplemental declaration?

A. Yes.

Q. Okay. And, briefly, does the resistivity affect whether or not carriers will move via drift due to a dopant electric field created by a graded dopant concentration?

A. Resistivity will not impact whether the carriers will move via drift. But I -- as I mentioned during my deposition, it will impact the speed at which they move.

Q. Okay. And do the claims at issue in these proceedings call for any particular speed of carrier movement?

A. They do not.

Ex. 2078 (Dec. 6, 2024 Banerjee Tr.) at 319:10-22.

The Prior Art Devices Disclose “a Graded Dopant Concentration . . . To Aid Carrier Movement,” Even if Other Fields Are Present

Greenthread’s Sur-Reply:

Dr. Banerjee testified that the gate electrode and gate oxide on a transistor can create a countervailing electric field that would be present in the active region (or surface). Ex. 2078, 219:16-220:20, 222:19-22; 223:20-224:1. . . . Dr. Banerjee did not consider the effect of these device components on the electric field created by the prior art dopant gradient. Id. at 224:2-8. . . . By failing to consider how “built-in” “structural” features of the prior art work, Dr. Banerjee’s fails to answer the question whether the prior art device was “reasonably capable of operating so as to meet the claim limitations.”

’842 Sur-Reply at 11-12; ’481 Sur-Reply at 11-12; ’014 Sur-Reply at 11-12; ’222 Sur-Reply at 11-12

Q. Does the conclusions that you reached in this case, are they affected by the presence of electric fields due to gate oxide or gate electrodes?

A. No.

Q. **Why are they not affected by electric fields due to gate oxide or gate electrodes?**

A. **All the claims are talking about electric fields created by doping gradient.** Gate oxide and gate electrodes are a different matter altogether.

Q. Does **the drift of carriers due to the built-in field created by a graded dopant concentration, is that altered by the presence of other fields**, potential fields stemming from gate oxide or gate electrodes?

A. **No, they are not.**

Ex. 2078 (Dec. 6, 2024 Banerjee Tr.) at 325:2-329:1.

The Prior Art Devices Disclose “a Graded Dopant Concentration . . . To Aid Carrier Movement,” Even if Other Fields Are Present

Q. Do you recall being asked a series of questions about other hypothetical scenarios in which multiple other electric fields may be present?

A. Yes.

Q. As part of the analysis you performed in arriving at your conclusions, did you need to add up different electric field vectors in order to reach your conclusions regarding the challenged claims?

A. No, I did not.

Q. Did you need to, for purposes of arriving at your conclusions for the challenged claims, need to subtract one electric field vector from another electric field vector?

A. No, I did not because nothing in the patents --

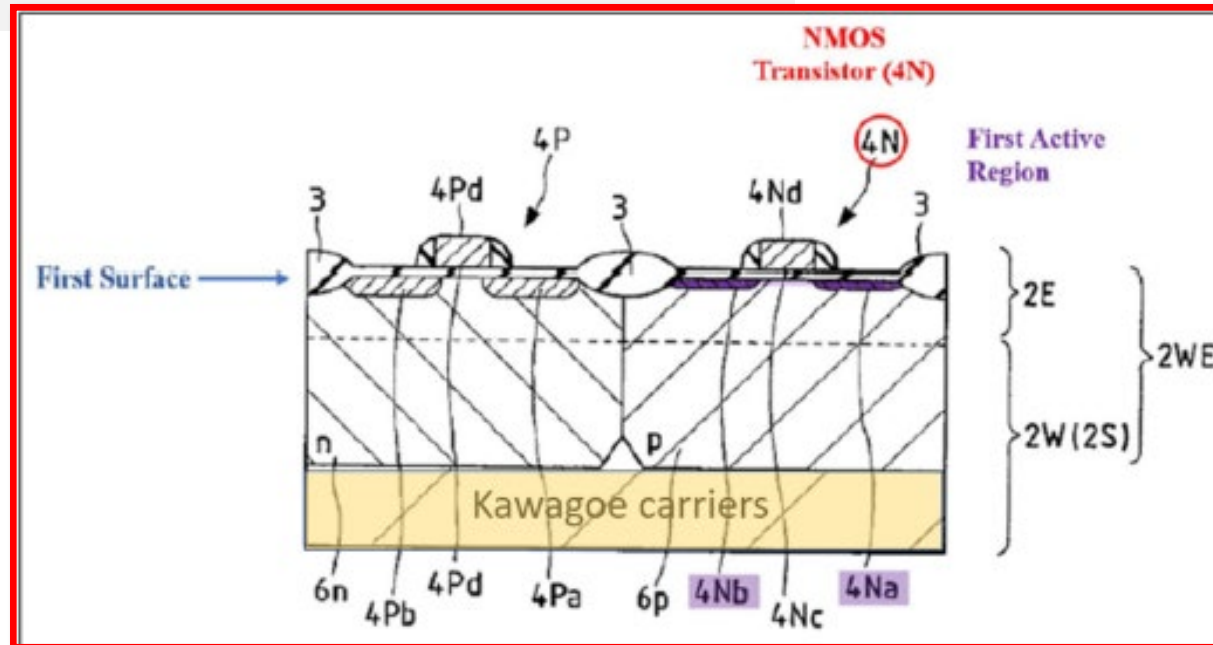
A. **The patents are not dealing with net motion. They are dealing with the drift field specifically of minority carriers due to the built-in field due to the doping gradient.**

Ex. 2078 (Dec. 6, 2024 Banerjee Tr.) at 329:2-330:10.

Carriers are present in Kawagoe's active region

Kawagoe's Device has Carriers in the Active Region

Dr. Glew's Annotation:



Contrary to Dr. Glew's annotation, Greenthread admits that Kawagoe's active region includes carriers

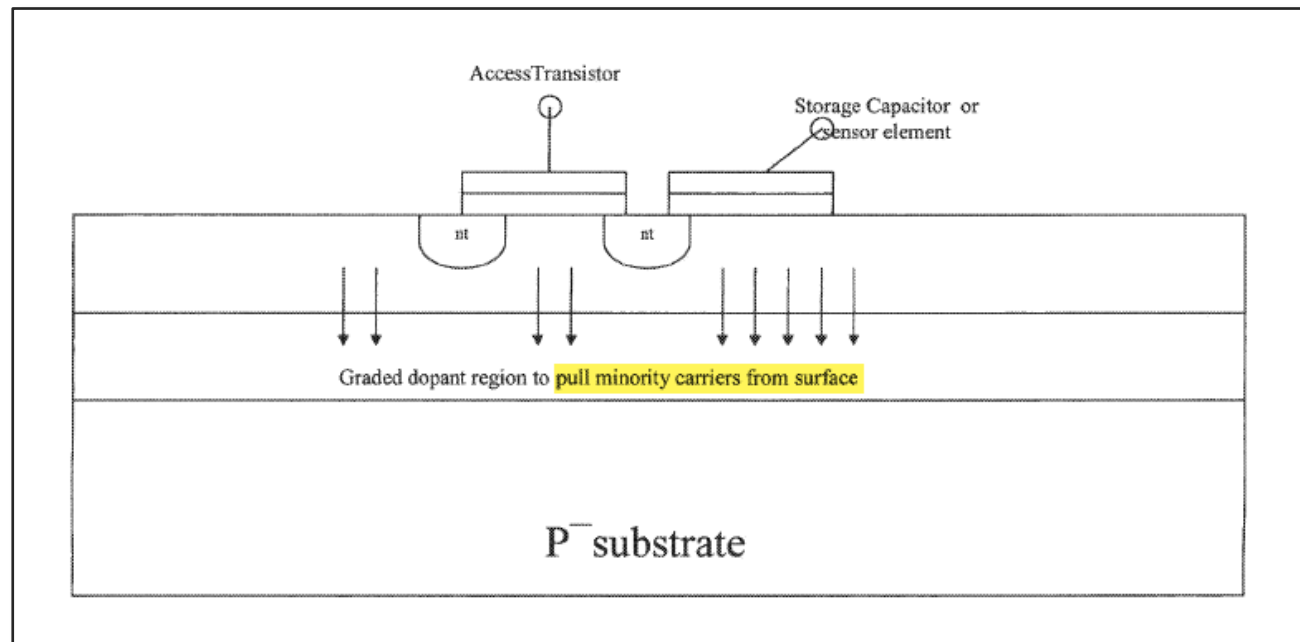
Ex. 2057 (Glew Decl.) (-00016), ¶52;
Ex. 2057 (Glew Decl.) (-00016), ¶52;
Ex. 2057 (Glew Decl.) (-00019), ¶52;
Ex. 2057 (Glew Decl.) (-00020), ¶52

But see Greenthread's Response:

"The fact that **Kawagoe's transistors presumably have carriers in the active region** is beside the point. Kawagoe says nothing about those carriers and Petitioners do not point to any teaching about those carriers."

'842 POR at 2; '481 POR at 2;
'014 POR at 2; '222-I POR at 2

Kawagoe's Device has Carriers in the Active Region



The Greenthread Patents acknowledge that minority carriers would be present in the active region of a CMOS device

Most of these techniques either divert the **minority carriers** away from the **active regions** of critical charge storage nodes at the surface, or, increase minority carrier density locally as the particular application requires.

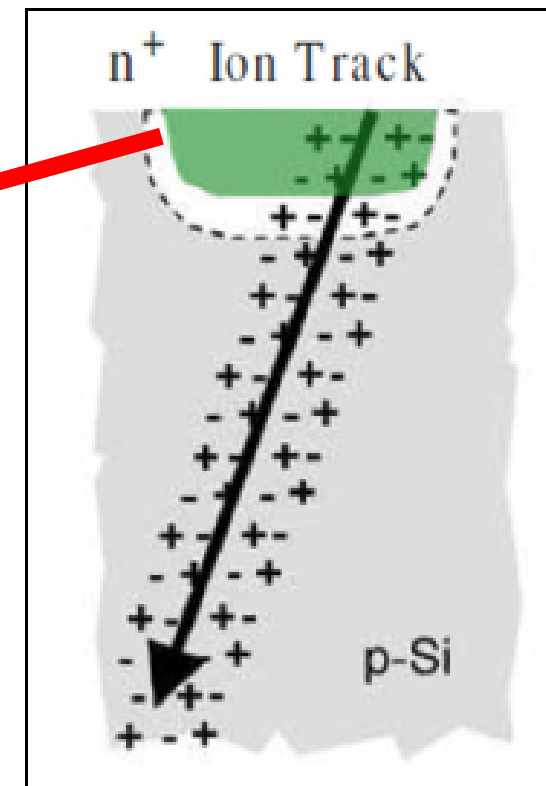
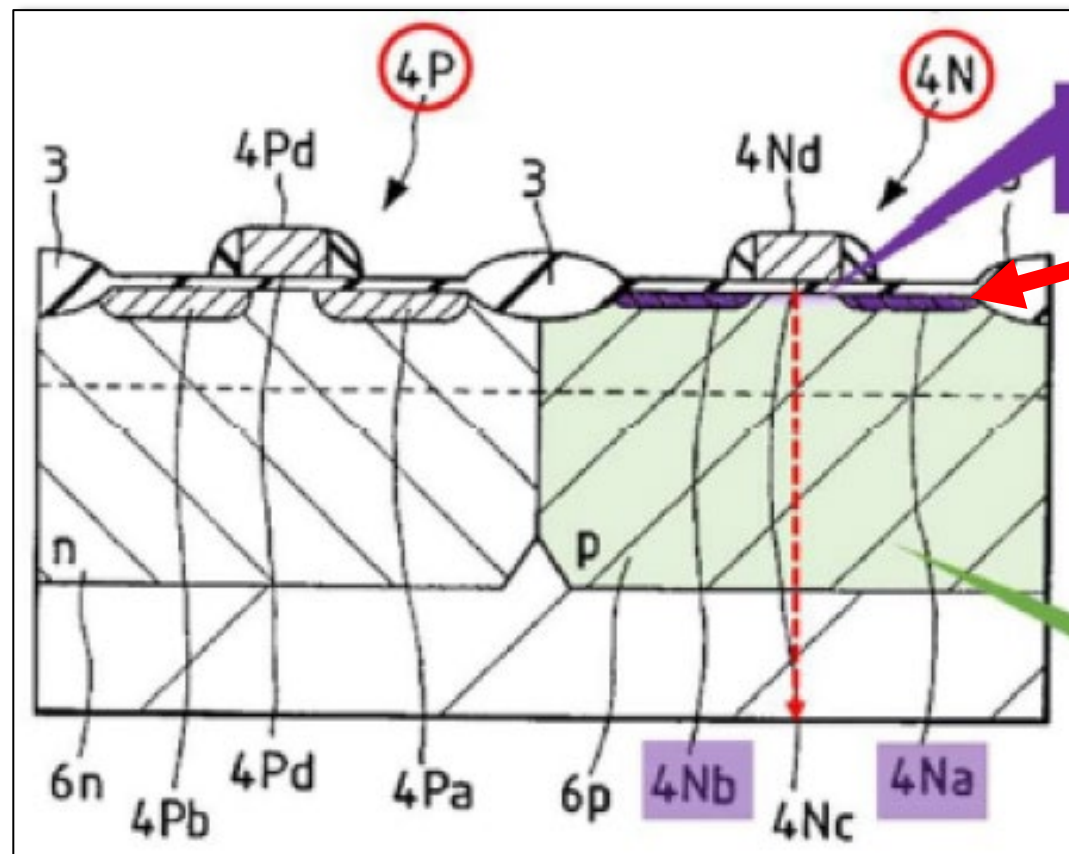
* * * *

Hence, a novel technique is described herein which creates a drift field to sweep these unwanted **minority carriers from the active circuitry** at the surface into the substrate in a monolithic die as quickly as possible.

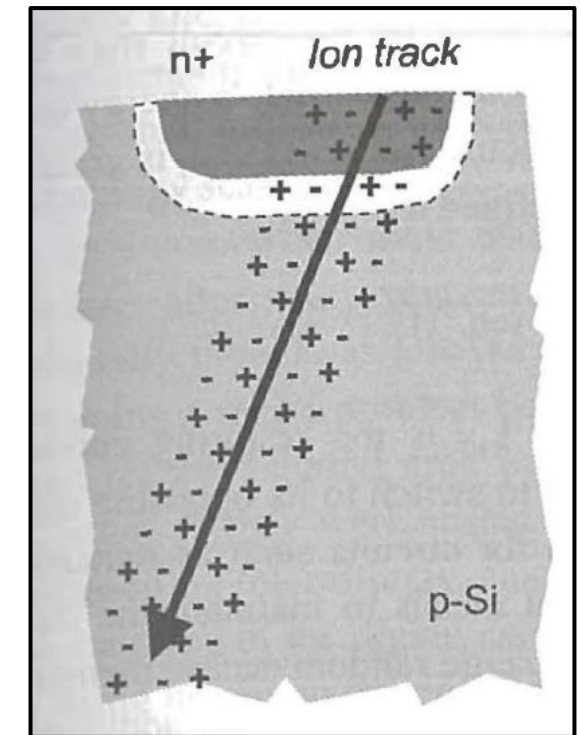
'842 Patent (Ex. 1001) (-00016) at 2:24-27, 3:60-64; Fig. 5B

Wang and Baumann Show that A-Ray Strikes Create carriers as the ray penetrates the substrate

an a-ray generates a stream of millions of carriers (e.g., electrons) that can cause single-event upset (SEU) soft errors



Wang (2009) (Ex. 1009),
Fig. 2(a)

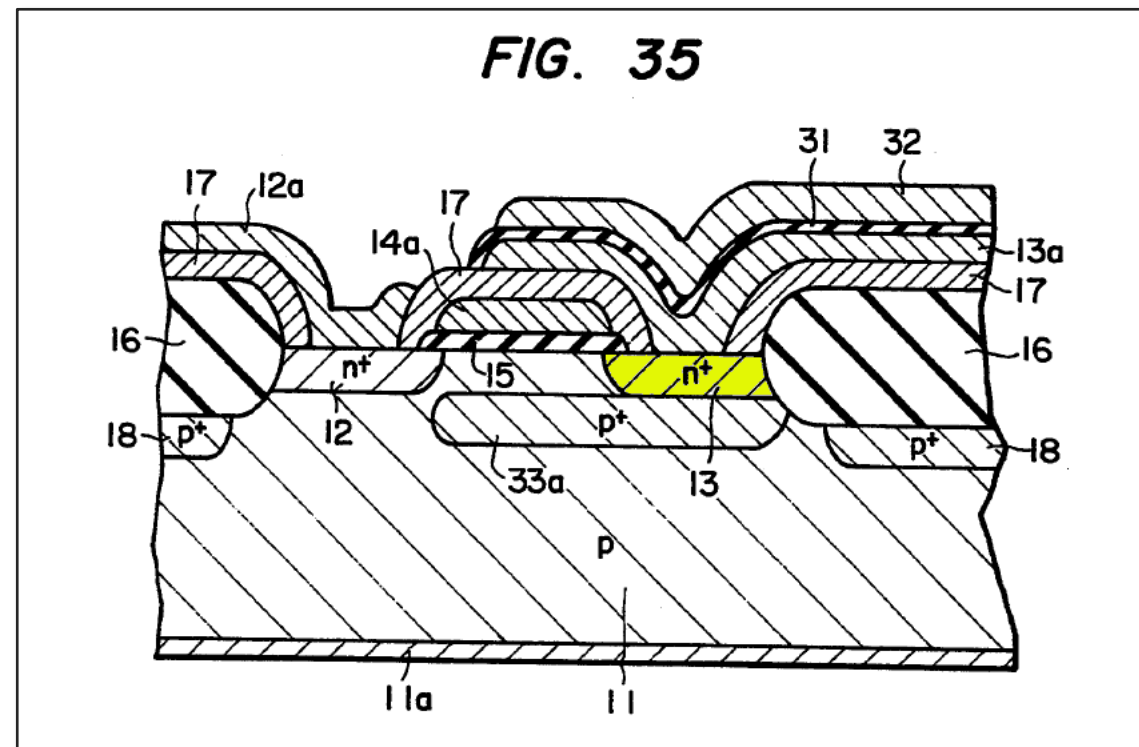


Baumann (2004) (Ex. 1065),
Fig. 1(a)

Nishizawa, cited by Greenthread, confirms that a-ray strikes result in carriers in the active region

Prior Art “Nishizawa”:

The alpha-particle will begin to create electron-hole pairs after it has entered into the semiconductor substrate to a certain distance. ... **[S]everal ten thousand electrons will flow into the n+ type region 13.**



Nishizawa, Ex. 2060, Fig. 35, 19:41-42

See '842 POR at 18-19; '481 POR at 19-20;
'014 POR at 19-20; '222-I POR at 18-19

'842 Reply at 21-22; '481 Reply at 21-22;
'014 Reply at 22; '222-I Reply at 22

COVINGTON

Greenthread Mischaracterizes Warrick and the EDTX / WDTX Claim Construction Orders

Greenthread Mischaracterizes Warrick's Testimony

22 Q. Is there anything that affects the ease of
1 carrier movement in a semiconductor device?

2 A. So the ease of carrier movement in a
3 semiconductor device, you know, the size of the device
4 matters, the doping of the device matters, the
5 potential on the device matters, the -- yeah, all of --
6 I would say it's probably a long list of these type of
7 physics attributes, which affect the movement of
8 carriers.

* * * *

22 Q. (BY MR. MATICH) Have you seen -- Mr. Warrick,
1 have you seen Exhibit 8 before?

2 A. Not in -- maybe not in its entirety. If you
3 go down, maybe I can see if I have seen portions of it.
4 I don't believe I have seen the entirety of it.

* * * *

2 Q. (BY MR. MATICH) Can you tell me if the
3 gradient there would aid carrier movement downward?

4 MR. LIDDELL: Objection, form.

5 THE WITNESS: I cannot tell you that.

Ex. 2056 (Warrick Tr.) at 71:22-
72:8, 91:22-92:4, 95:2-5.

Greenthread Mischaracterizes EDTX Claim Construction Order

- EDTX addressed: whether dopant concentration should *increase* or *decrease* across a drift layer

Disputed Term	Plaintiff's Proposed Construction	Defendants' Proposed Construction
“single drift layer ... having a graded concentration of dopants ... said drift layer further having a first static unidirectional electric drift field” • '195 Patent Claim 1	no construction necessary	single layer whose concentration of dopants either increases across the layer or decreases across the layer
“single drift layer ... having a graded concentration of dopants generating a first static unidirectional electric drift field” • '502 Patent Claim 7		

- Greenthread: No construction necessary
- Samsung: Dopant concentration uniformly *increases* or *decreases* across the drift layer
- Court did **not** evaluate whether “to aid carrier movement” hinges on a minimum magnitude of slope

'842 Reply at 15-16;
'481 Reply at 15-16;
'014 Reply at 15-16;
'222-I Reply at 15-16

Greenthread Mischaracterizes EDTX Claim Construction Order

Taken in context, that the direction of the electrical field and the carrier movement “depends solely on the slope of the graded concentration of dopant” **does not mandate that the slope must be only increasing or only decreasing to maintain a unidirectional drift field.** For example, the slope has both a direction and a magnitude and Defendant suggests that the direction of the drift electric field depends solely on **the direction** of the slope of the graded concentration of dopant. This is not justified by the prosecution history statements that Defendant cites. In fact, the *Grove* reference cited by the patentee in the above-quoted statement includes Figure 7.13 (reproduced and annotated below) which depicts a dopant concentration that both increases and decreases in the “graded base region” that provides an “electric field . . . of such direction as to aid the motion of injected holes.” A.S. Grove, *Physics and Technology of Semiconductor Devices* 224–25 (1967), Dkt. No. 50-13 at 22–23. In other words, **the patentee cited Grove to support that a graded dopant concentration will provide a unidirectional electric drift field to move the minority carriers in a single direction** and *Grove* discloses a dopant concentration that both increases and decreases in the drift layer. **The prosecution history does not state that the dopant concentration must only increase or only decrease** across the drift layer.

Ex. 2075 (EDTX Claim Construction Order) at 15-16

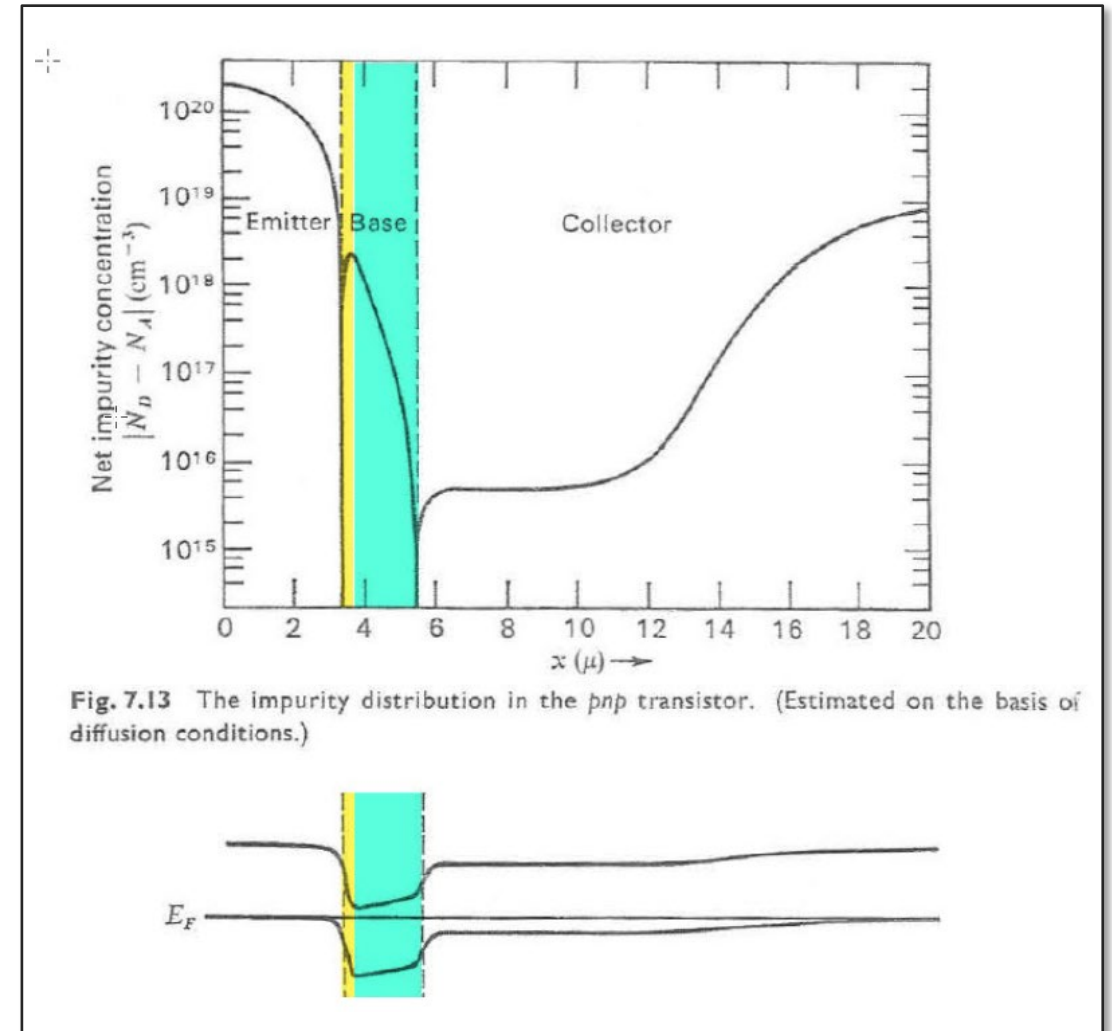


Fig. 7.13 The impurity distribution in the pnp transistor. (Estimated on the basis of diffusion conditions.)

Grove (Ex. 1068) at 225 (annotated);
Ex. 1060 (Banerjee Supp. Declaration) at ¶29.

- EDTX acknowledged that patentee conceded that “a graded dopant concentration “will provide a[n] electric drift field to move minority carriers in a single direction”

Greenthread Mischaracterizes WDTX Claim Construction Order

- Court evaluated whether “graded dopant concentration” is indefinite

Term	Greenthread’s Proposed Construction	Cirrus’s Proposed Construction	Court’s Preliminary Construction
#4: “graded dopant concentration” / “graded dopant region” / “graded dopant acceptor concentration” / “graded donor dopant concentration” / “graded concentration of dopants” / “graded dopant” / “graded concentration”	Not indefinite. Plain and ordinary meaning, where the plain and ordinary meaning is a graded (or varying) concentration of dopants.	Indefinite	Not indefinite. Plain-and-ordinary meaning, which includes a graded concentration of dopants.
#6: “to aid the movement of minority carriers from...to...”	Plain and ordinary meaning	“to aid the movement of minority carriers starting from...and reaching...”	Plain-and-ordinary meaning

Ex. 2074 (WDTX Claim Construction Order) at 15, 83-84.

- Court did not evaluate whether the “graded” term requires a minimum magnitude to aid movement

'842 Reply at 14-15;
'481 Reply at 14-15;
'014 Reply at 14-15;
'222-I Reply at 14-15

Greenthread Mischaracterizes WDTX Claim Construction Order

- Petitioners argued that even a uniform doping has some variations

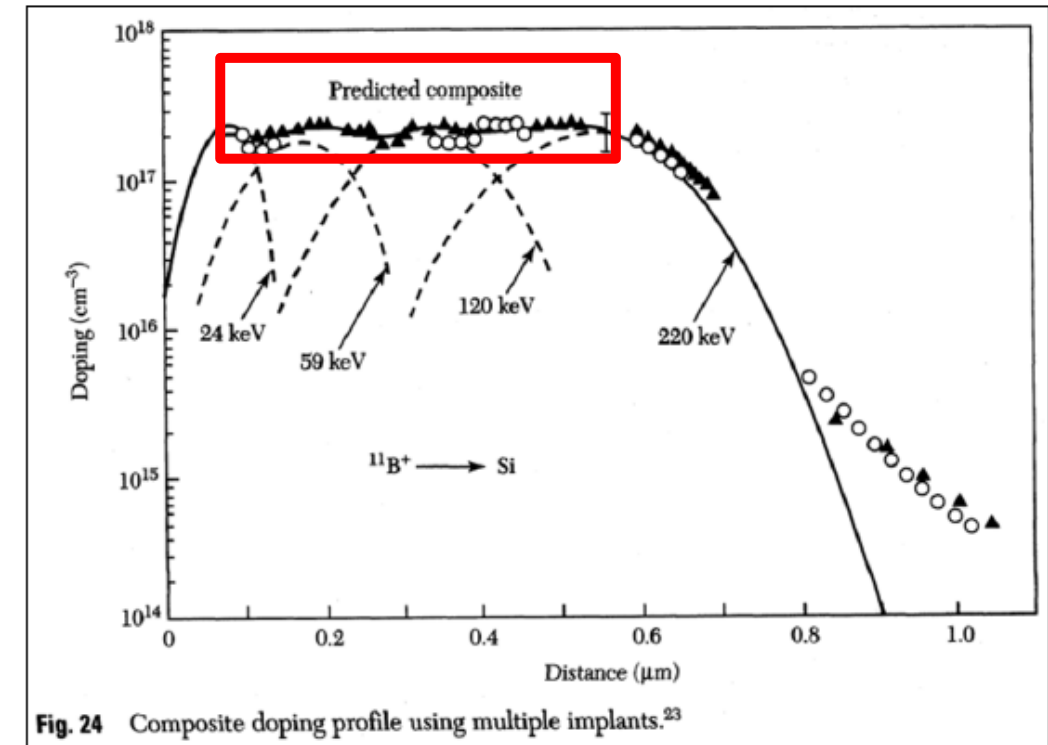
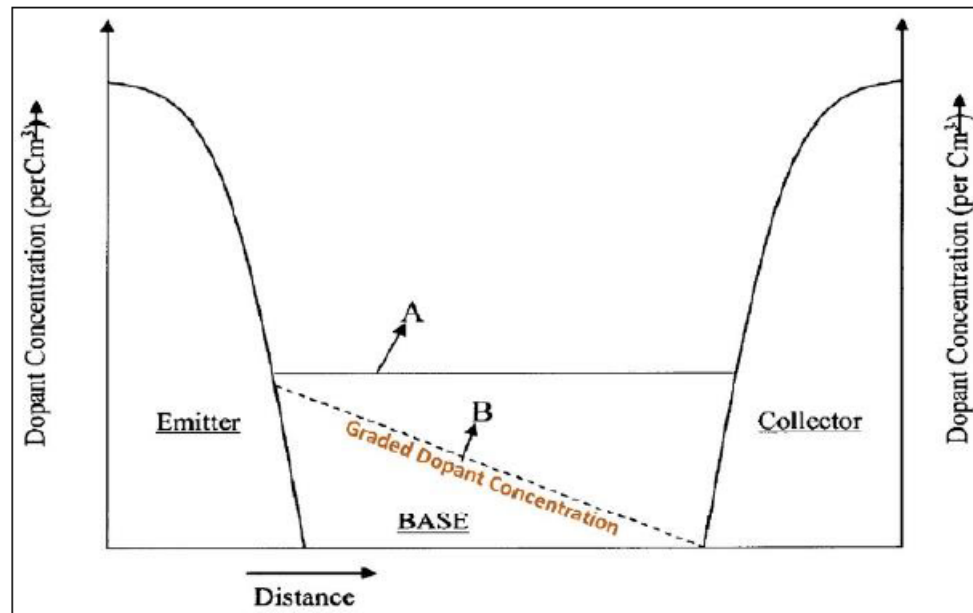


Fig. 24 Composite doping profile using multiple implants.²³

Size textbook.

- Reference to “sufficiently graded” in Order:
 - Contrasts *uniform* concentration with *graded* concentration
 - May refer to the span of the graded doping (e.g., from the surface towards the substrate)

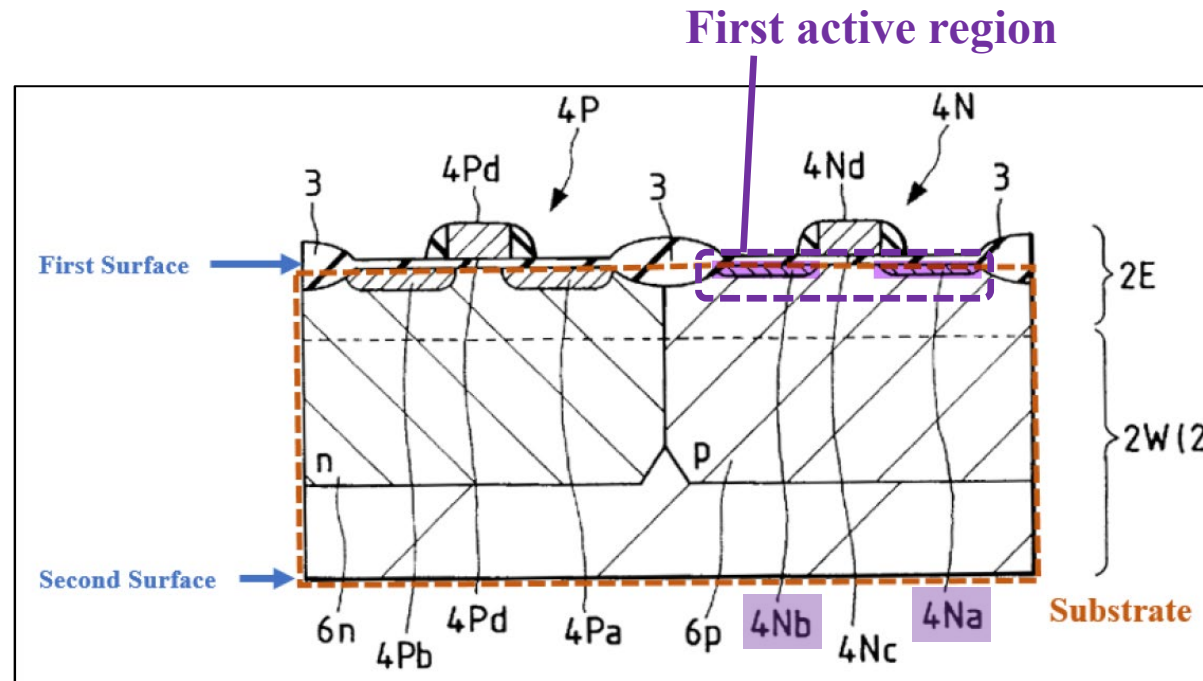
Greenthread’s “Aid Carrier Movement” Arguments Fail

Greenthread’s Argument	Why This Argument Fails
“Aid carrier movement” requires that a carrier move	Claims are directed to a <u>device</u> with structural features, not a method
“Carrier movement” refers to the net movement of carriers when the device is turned ON	Greenthread rewrites the claims. Drift-induced movement (even when device is OFF) is sufficient
Petitioners now argue that “carrier movement” refers to Brownian motion	Red herring; Petitioners merely provided technical context, that that carriers are constantly moving.
The direction of the slope is insufficient to show “aided”	Nothing in the intrinsic record suggests measuring or comparing slope magnitude
Warrick, WDTX, and EDTX confirm that the claims require measuring the magnitude of the slope	Greenthread mischaracterizes each of these documents
Kawagoe does not address carriers in the active region	Greenthread admits, and prior art confirms, that carriers would be present in Kawagoe’s active region
Dr. Banerjee: “3 categories of forces” affect carrier movement	Dr. Banerjee confirmed that these 3 categories of forces don’t alter the carrier movement
Dr. Banerjee: an additional, gate oxide-induced E-field imparts an additional force on the carriers	Claims directed to “ <i>a graded dopant concentration</i> to aid carrier movement”; other E-fields don’t negate this

See generally '842 Reply; '481 Reply; '014 Reply;'222-I Reply;
Ex. 2078 (Dec. 6, 2024 Banerjee Tr.)

The Prior Art Discloses
“a First Active Region ... With a Second Doping Type”

Kawagoe's Device Includes “a First Active Region . . . With a Second Doping Type”



The semiconductor regions **4Na** and **4Nb** are regions for forming the source-drain regions of the nMOS **4N**. The semiconductor regions **4Na** and **4Nb** are doped with an **n-type** impurity such as phosphor (P) or arsenic (As) in a concentration (dose) of about 1×10^{15} atoms/cm². The semiconductor regions **4Na** and **4Nb** are made as deep as about 0.5 μm and formed in the range of the thickness of the epitaxial layer **2E**.

Kawagoe (Ex. 1007), Fig. 23, 8:67-9:3, 14:46-55, 15:26-40

1. A semiconductor device, comprising:

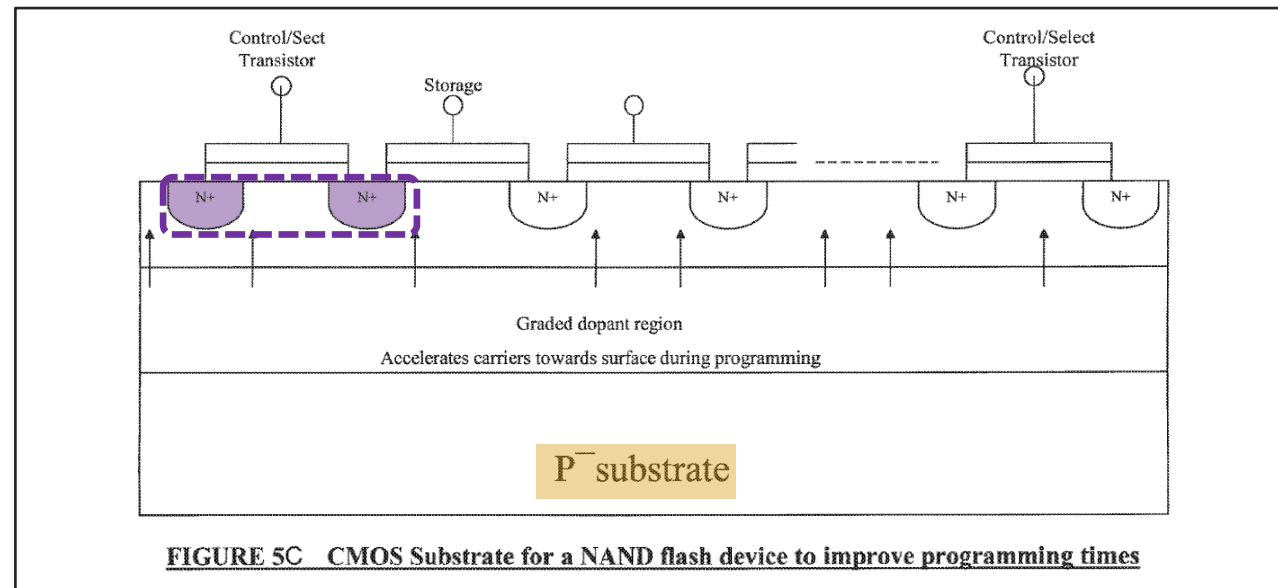
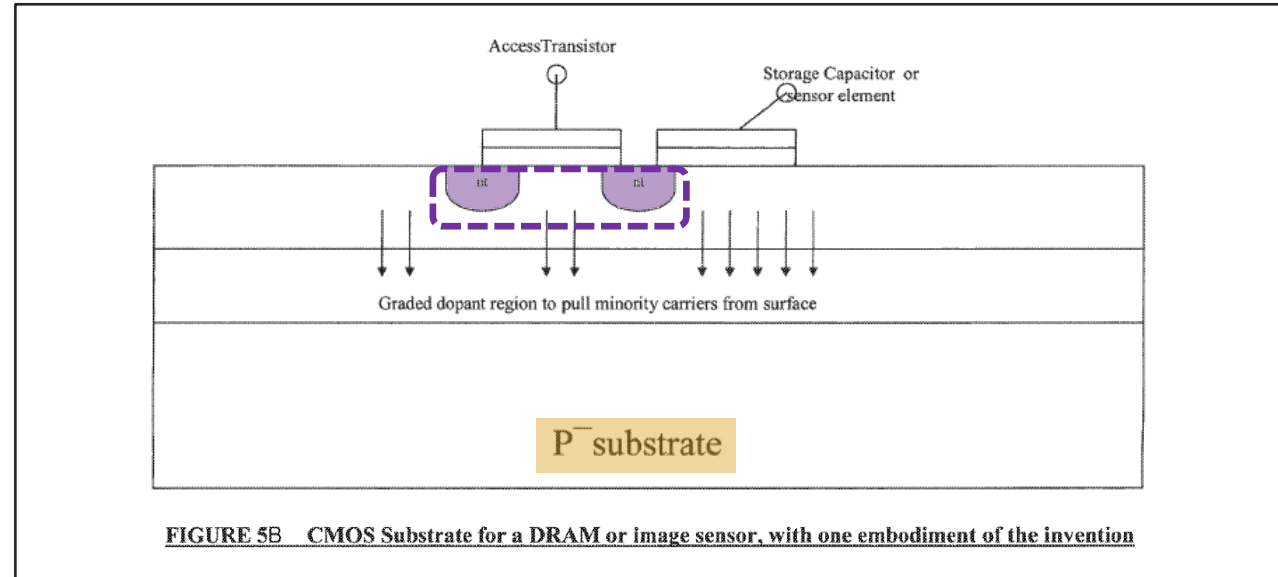
a **substrate** of a **first doping type** at a first doping level having first and second surfaces;

a **first active region** disposed adjacent the first surface of the substrate **with a second doping type opposite in conductivity** to the first doping type and within which transistors can be formed;

* * * *

'842 Patent, Ex. 1001 (-00016), Claim 1

Greenthread's Figures, Which Also Show an NMOS device in a P-type Substrate, Admittedly Have this Requirement



1. A semiconductor device, comprising:

a substrate of a **first doping type** at a first doping level having first and second surfaces;

a first active region disposed adjacent the first surface of the substrate with a **second doping type opposite in conductivity** to the first doping type and within which transistors can be formed;

* * * *

'842 Patent, Ex. 1001 (-00016), Figs. 5B-C, Claim 1

Greenthread's Response:

The claimed **invention is clearly disclosed in, e.g., Figs. 5B-5C** of the Challenged Patent, and the corresponding parts of the specification.

'842 POR at 4; '481 POR at 4;
'014 POR at 4; '222-I POR at 4

Greenthread's Arguments Against the “Second Doping Type” Limitation Hinge on Faulty Claim Construction

- Greenthread argues that active region includes a *channel region*, and that Kawagoe's NMOS (4N) does not include n-type dopants in its channel region.
- Greenthread further suggests that the source and drain are not part of the active region, but are transistors that are *formed later on* in the active region.

See '842 Sur-Reply at 16-17; '481 Sur-Reply at 16-17;
'014 Sur-Reply at 16-17; '222-I Sur-Reply at 16-17

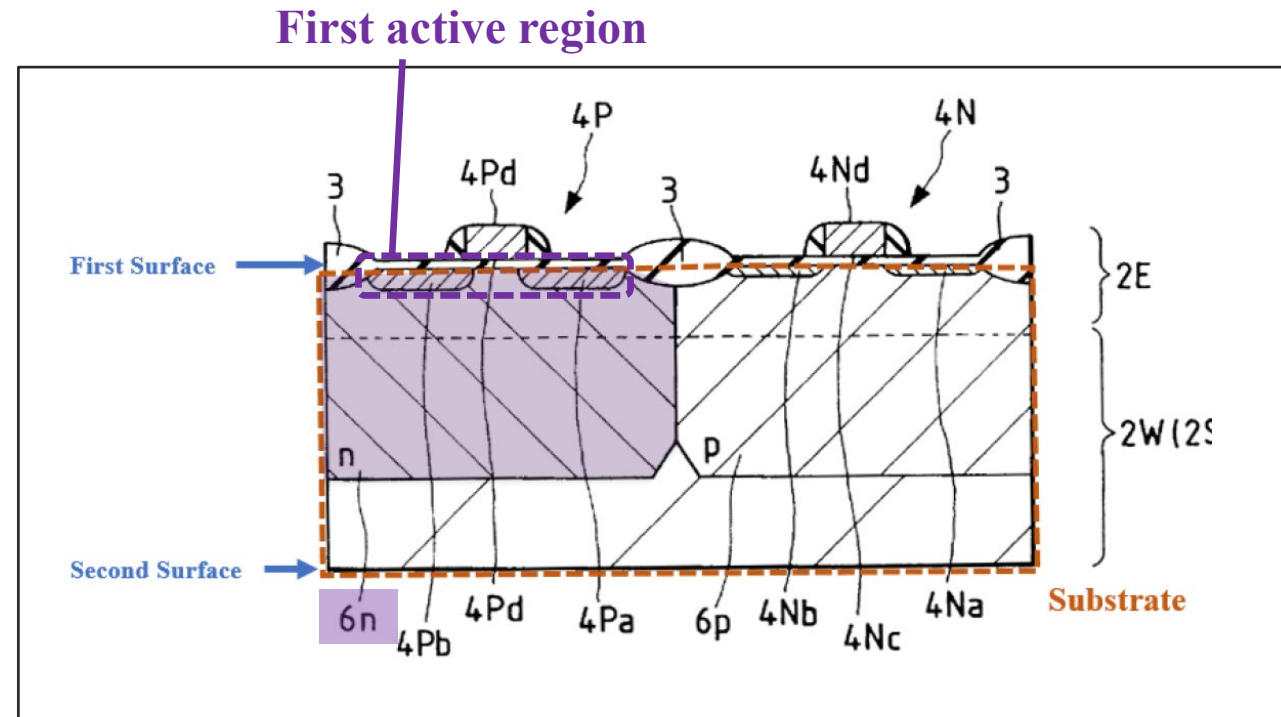
Dr. Glew Deposition (IPR2023-01242/43/44):

Q. In terms of a spatial understanding, the source and drain are physically in the same space as the active region well, right?

A. I'd say generally, **yes, the source and drain are in the well in the active region.**

Ex. 1069 (Jul. 16, 2024 Glew Tr.) at 28:3-9

Regardless, Kawagoe's CMOS Device Meets this Limitation Even Greenthread's Narrowing Construction



Kawagoe (Ex. 1007) at 9:40-54, 17:50-54, 18:15-23, 21:55-61, Fig. 23

1. A semiconductor device, comprising:

a substrate of a **first doping type** at a first doping level having first and second surfaces;

a first active region disposed adjacent the first surface of the substrate with a **second doping type opposite in conductivity** to the first doping type and within which transistors can be formed;

* * * *

'842 Patent, Ex. 1001 (-00016), Claim 1

- Kawagoe's device also includes a PMOS 4P is formed into an *n*-well, which contains *n*-type dopants *throughout* the well (source, drain, channel).

The “Isolation Region” Dependent Claims are Obvious

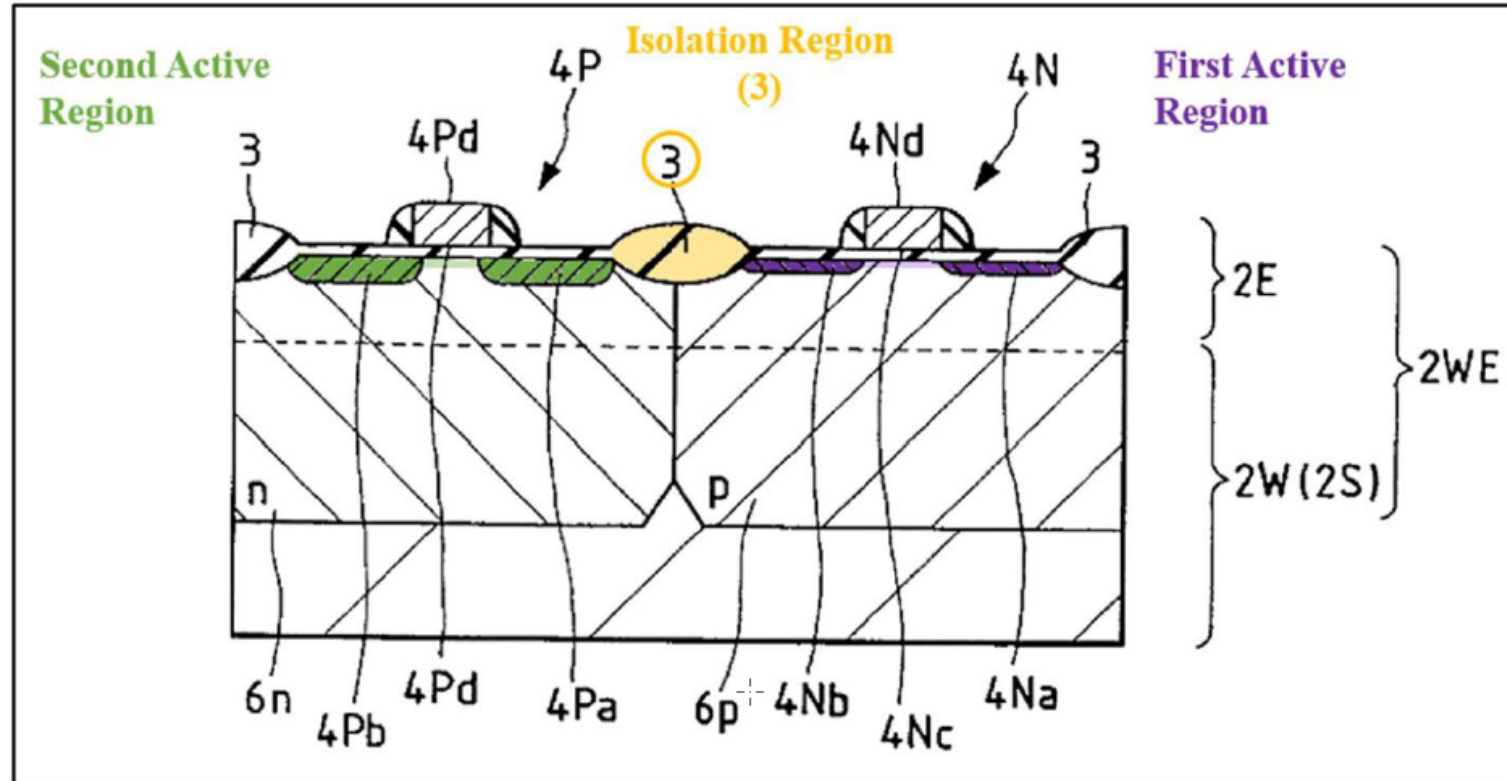
Dependent Claims of '842, '481, '014, and '222 Patents

Patent, Claims	Limitation
842 Patent, Claims 7 and 15	The semiconductor device of claim [1 / 9], wherein the first active region and second active region are each separated by at least one isolation region .
481 Patent, Claims 6 and 26	The semiconductor device of claim [1 / 20], wherein the first active region and second active region are each separated by at least one isolation region .
014 Patent, Claims 6 and 27	The system of claim [1 / 21], wherein the first active region and second active region of the at least one semiconductor device are each separated by at least one isolation region .
222 Patent, Claims 6 and 27	The VLSI semiconductor device of claim [1 / 21], wherein the first active region and second active region are each separated by at least one isolation region .

- Claims do not specify any specific amount of “separation”
- Greenthread presumes complete physical separation is required along the entire depth of the active regions

'842 Pet. at 39; '842 Reply at 25-26;
 '481 Pet. at 41; '481 Reply at 25-26;
 '014 Pet. at 37-38; '014 Reply at 25-26;
 '222-I Pet. at 35; '222-I Reply at 25-26

Kawagoe, Alone or in View of Gupta, Satisfies the “Isolation Region” Requirement Under its Plain Meaning



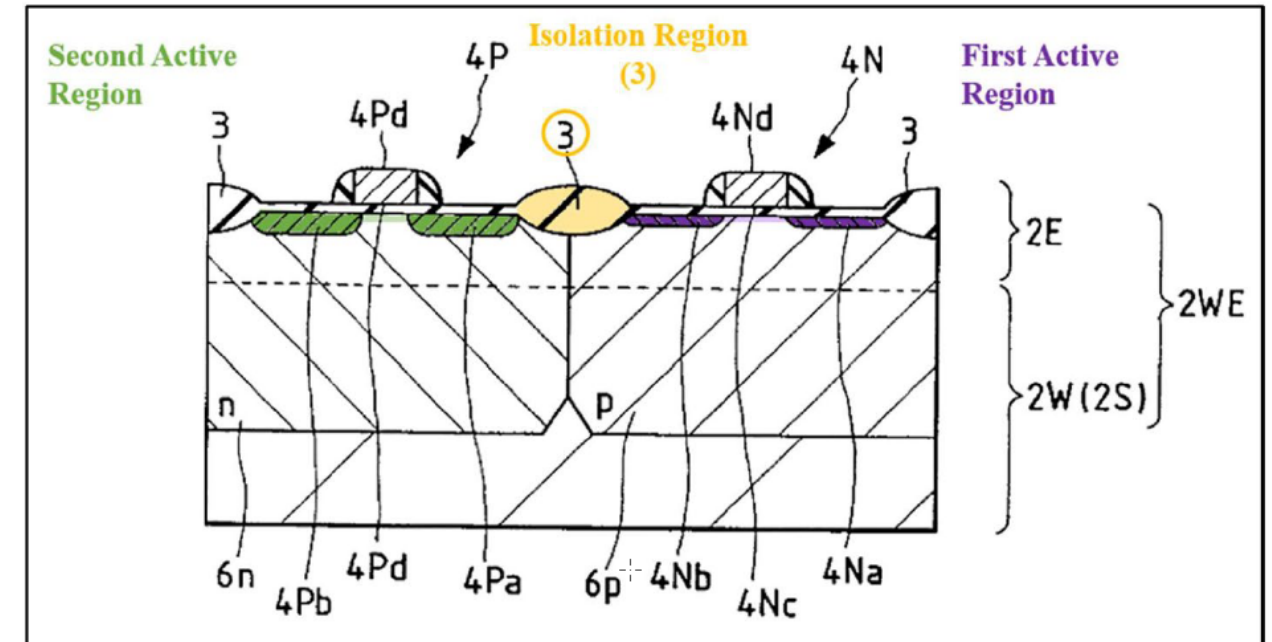
Kawagoe (Ex. 1007) at 8:40-52, 15:37-40, 17:62-18:8, Fig. 23

- Kawagoe’s insulating film (3) provides *some separation* between the first active region and second active region (e.g., surface portions).
- Kawagoe contemplates examples of active regions “formed in the range of the thickness of the epitaxial layer $2E$,” but also teaches active regions having a depth significantly less than that of $2E$ (e.g., active regions $0.5\mu\text{m}$ deep versus epitaxial layer $5\mu\text{m}$ deep).

Even Under Greenthread's Construction, Kawagoe Satisfies the “Isolation Region” Requirement

- ***Channer stopper region*** + field insulating film (3) = “*isolation region*”

Over the principal surface of the epitaxial layer 2E, there is formed a field insulating film 3 which is made of silicon dioxide (SiO_2), for example. Incidentally, a channel stopper region is formed below the field insulating film 3, although not shown.



Kawagoe (Ex. 1007) at 8:40-52, Fig. 23

Even Under Greenthread's Construction, Kawagoe Satisfies the "Isolation Region" Requirement

Dr. Glew Deposition (IPR2023-01242/43/44):

Q. From a design perspective, is there any reason you would have a **channel stopper region** that did not encompass the entire active region depth?

A. Essentially, **its purpose is to stop errant carriers from migrating** from one transistor to another. **It needs to be deep enough to do that**, but not deeper.

Ex. 1069 (Jul. 16, 2024 Glew Tr.) at 142:24-143:6.

Wolf Textbook:

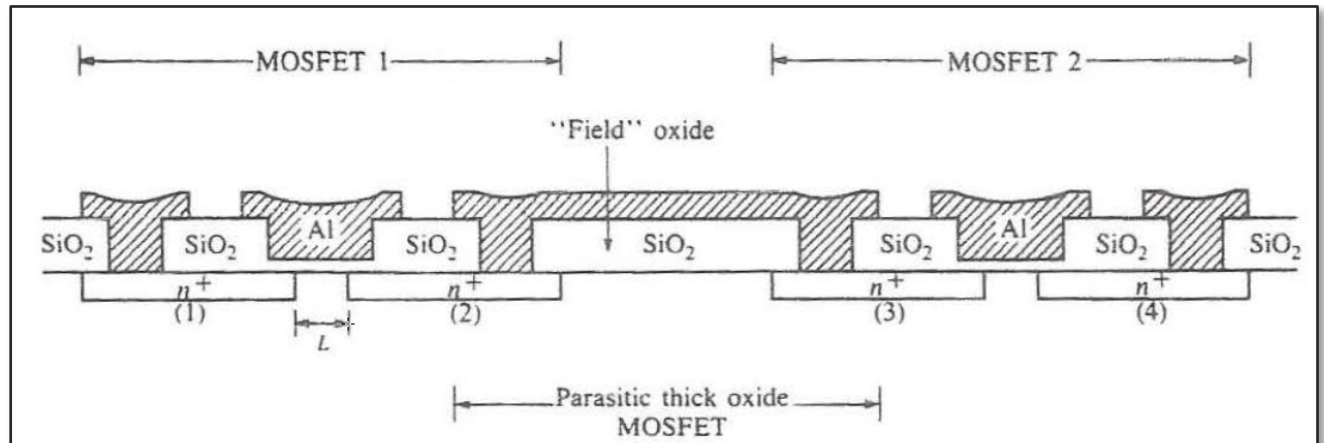


Fig. 2-4 No current should flow between source and drain regions of adjacent MOS transistors. This figure shows the parasitic field transistor with a possible channel under the field oxide if the substrate under this oxide is inverted.¹²⁸ From R. C. Jaeger, *Introduction to Microelectronic Fabrication*. Copyright, 1988, Addison-Wesley. Reprinted with permission.

* * *

The field oxide is nevertheless typically made seven to ten times thicker than the gate oxide in the active regions. (This thick oxide also reduces the parasitic capacitance between the interconnect runners and the substrate, improving the speed characteristics of the circuits.) Normally, **ion implantation is used to increase the doping under the field oxide. This step is called a channel-stop implant. The combination of thick oxide and channel-stop implant can provide adequate isolation** for PMOS and NMOS (and as we shall see, for oxide-isolated bipolar) ICs. Additional isolation considerations that arise in the case of CMOS circuits will be described in chapter 6.

Greenthread's Settlement Agreements Do Not Show Nonobviousness

Evidence of Nexus is Required for License Agreements as Secondary Considerations

“[T]he fact that a patent has been licensed, taken alone, generally is insufficient for purposes of showing commercial success.”

Intron Networked Sols., Inc. v. Acoustic Tech., Inc., No. IPR20170-01031, 2018 WL 10440326, at *10 (P.T.A.B. Aug. 21, 2018).

We “specifically require affirmative evidence of nexus . . . because it is ‘often cheaper to take licenses than to defend infringement suits.’”

Iron Grip Barbell Co. v. USA Sports, Inc., 392 F.3d 1317, 1324 (Fed. Cir. 2004) (cit. omitted).

Litigation Settlements are Not Objective Evidence of Nonobviousness

Greenthread's Response:

Finally, licenses that are part of litigation settlements can also be probative of non-obviousness. ***Fox Factory Inc. v. SRAM LLC*, IPR2017-00472, Paper 64 at 44 (PTAB April 18, 2018).**

'842 POR at 29; '481 POR at 29-30;
'014 POR at 29-30; '222-I POR at 29

The Federal Circuit vacated this *Fox Factory* decision because “the Board **erroneously presumed nexus** between the evidence of secondary considerations and the independent claims.”

Fox Factory, Inc. v. SRAM, LLC, 944 F.3d 1366, 1378 (Fed. Cir. 2019).

On remand, the Board ultimately found **all challenged claims unpatentable**, concluding that “at best, Patent Owner shows a *weak nexus*” for licenses mentioning the challenged patent and “*no nexus* with respect to the remaining licenses” that did not.

Fox Factory, Inc. v. SRAM, LLC, IPR2017-00472, Paper 74, 11, 14-15
(P.T.A.B. Feb. 25, 2021).

'842 Reply at 26-29;
'481 Reply at 26-29;
'014 Reply at 26-28;
'222-I Reply at 26-28

No Evidence that Greenthread's Licensees Valued its Patents (Warrants Excluding Rao's Declaration)

Dr. Rao's Deposition:

Q. You had no direct conversations with any representatives or employees of any of the licensees of the licenses that are the exhibits to your declaration, Exhibit 1; is that correct?

A. Our outside counsel worked with Mr. John and myself in whatever they had to because they represented us. So we, as far as I know, **I did not directly talk to any of them**, and whatever happened between our counsel and us, it's privileged.

Q. My question related to conversations you had, not with your attorneys, but with any representatives or employees of the licensees of the licenses that are exhibits to your declaration, Exhibit 1.

A. I believe I answered it earlier. That's what directly is, **no, I did not talk to any of the employees.**

Q. And am I also -- to your knowledge, that's true of Mr. John, he had no conversations with employees or representatives of any of the licensees of the licenses attached to your declaration, Exhibit 1?

A. To the best of my knowledge, **Mr. John never told me he had any conversations with any employee.**

Ex. 1066 (Rao Dep. Tr.) at 23:5-24:11

RPX's Involvement Shows Licenses Were Motivated by Litigation Costs



FAQs

We are a unique solution to all forms of patent risk

Only RPX has the scale and independence to efficiently acquire patent portfolios pre-litigation and out of active litigation. Only RPX can spread the cost of reducing patent litigation across a large network of participating companies. Only RPX has accurate litigation cost data and a proven actuarial model to provide affordable, comprehensive patent litigation insurance. And only RPX can deliver – to companies of any size and with a patent litigation problem of any severity – significant, quantifiable, and cost-effective reduction of risk.

We provide compelling cost savings

RPX's interests are 100% aligned with those of our clients. We work to ensure that each RPX client avoids more in legal costs and settlements each year than they pay RPX in subscription fees. We quantify the cost savings we have delivered collaboratively with the client. Together, we review the RPX acquisitions relevant to the client and determine a specific "avoided cost". The cumulative avoided cost is applied against the client's annual fee to calculate the dollar savings we have delivered for the year. We have been very successful delivering cost savings to all of the members in our network, a key factor in our consistently strong annual renewal rate.

The Petitions are Timely

The Board and Director Have Already Rejected Greenthread's Arguments

- Petitioners filed these IPR proceedings in response to specific lawsuits filed by Greenthread.

- Arms-length customer/supplier relationships, without more, do not create privity.

See, e.g., WesternGeco LLC v. ION Geophysical Corp., 889 F.3d 1308, 1319-22 (Fed. Cir. 2018);
Wi-Fi One, LLC v. Broadcom Corp., 887 F.3d 1329, 1340-41 (Fed. Cir. 2018);
Samsung Electronics Co. Ltd. v. Netlist Inc., IPR2022-00615, Paper 64 at 22-26 (PTAB, June 30, 2023)

- No evidence showing that any Petitioner is in privity with any prior petitioners.

Worlds, Inc. v. Bungie, Inc., 903 F.3d 1237, 1242-44 (Fed. Cir. 2018)

The Board and Director Have Already Rejected Greenthread's Arguments

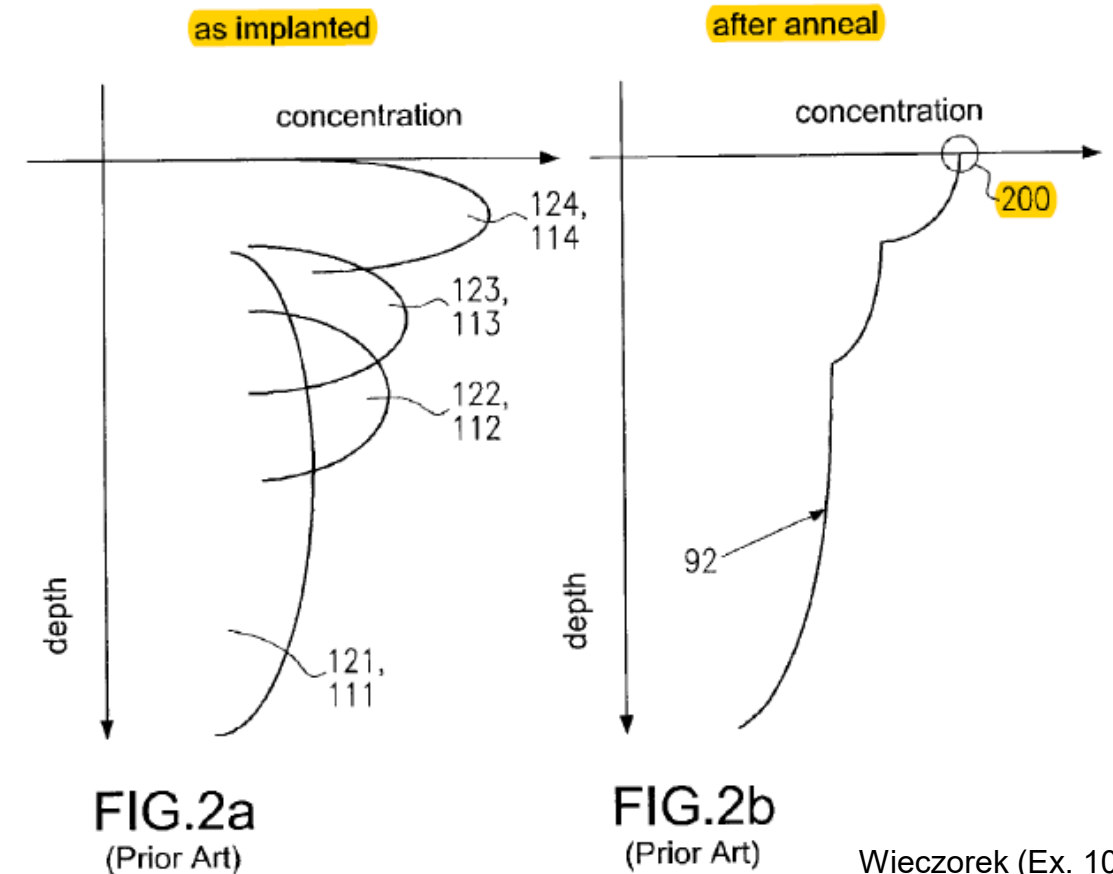
- It would be fundamentally unfair to allow Greenthread to manufacture privity between Petitioners and any prior litigant.
 - Privity arguments hinge on Greenthread's agreement with RPX, as creating a time bar for Petitioners
 - Petitioners were strangers to the RPX agreement, and to prior litigations
- Greenthread's conduct does not warrant denying Petitioners their day in court.

Greenthread's Objections Lack Merit and Are Untimely

Greenthread's Sur-Reply:

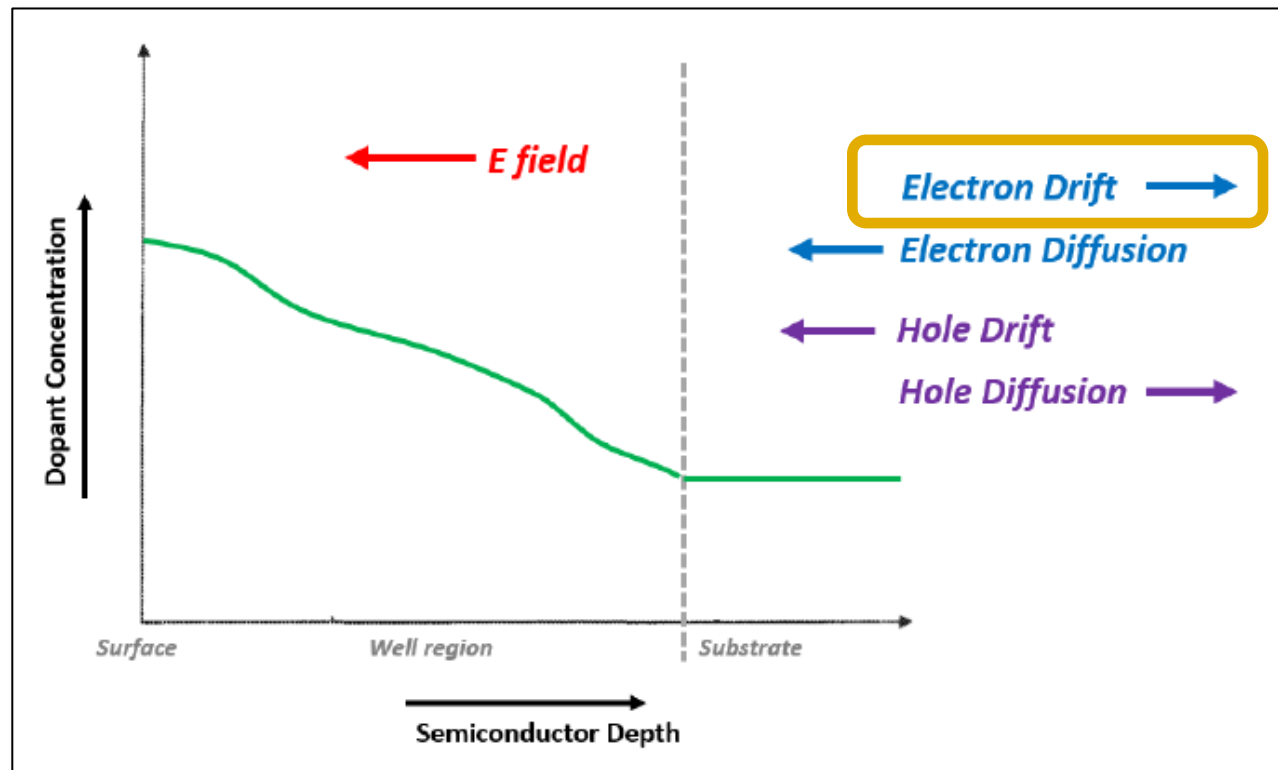
Dr. Banerjee admitted that a flat or non-graded dopant concentration would not create any electric field. *Id.* at 260:6-13 (“There should not be any built-in electric fields in that flat region.”); 209:5-9. **Wieczorek, in fact, does not have a graded dopant concentration in the active region (or surface).** For doping at the active region/ surface, **Wieczorek says the doping “profile in the vicinity of the surface of the semiconductor device 100, as indicated by reference number 200, may have become substantially uniformly distributed.”** Ex. 1006, ¶11 (emphasis added).

'842 Sur-Reply at 22-23; '481 Sur-Reply at 22-23;
'014 Sur-Reply at 22-23; '222-I Sur-Reply at 22-23



Wieczorek (Ex. 1006),
Figs. 2a-b

Carrier Movement in a Doped Semiconductor

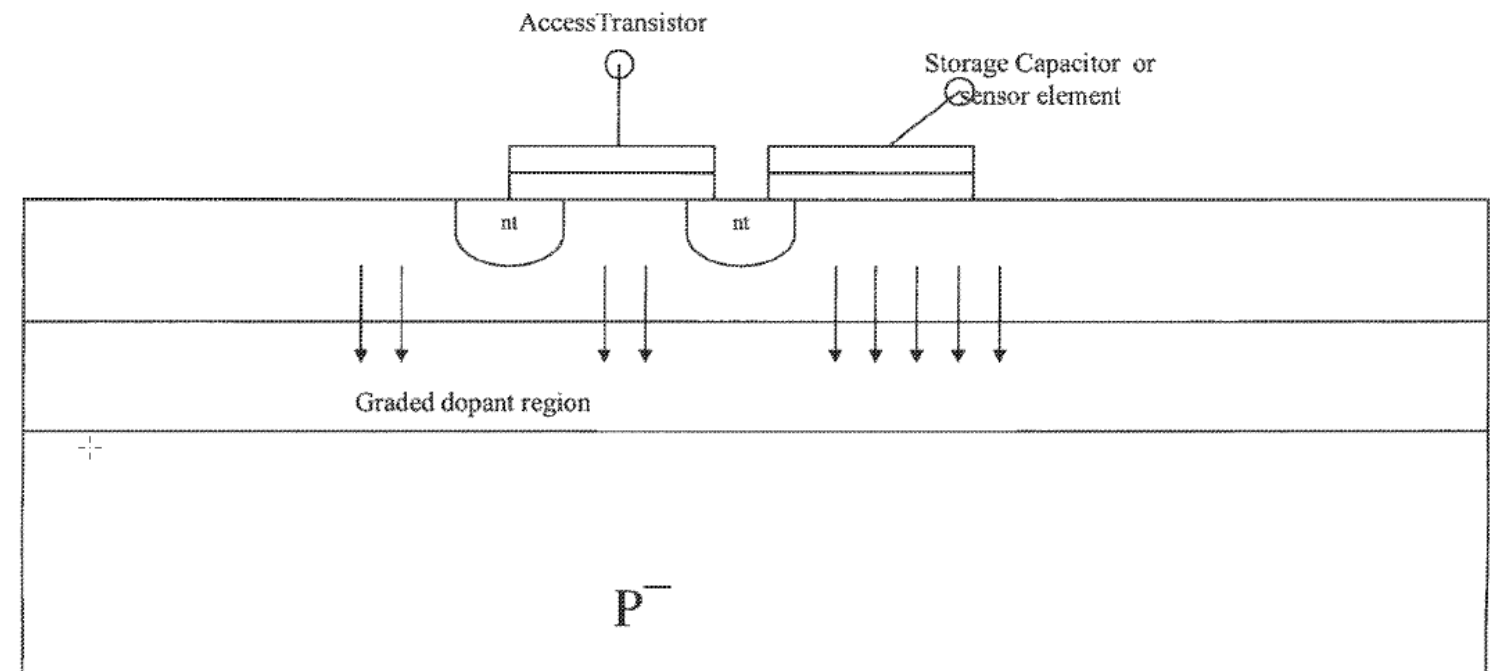
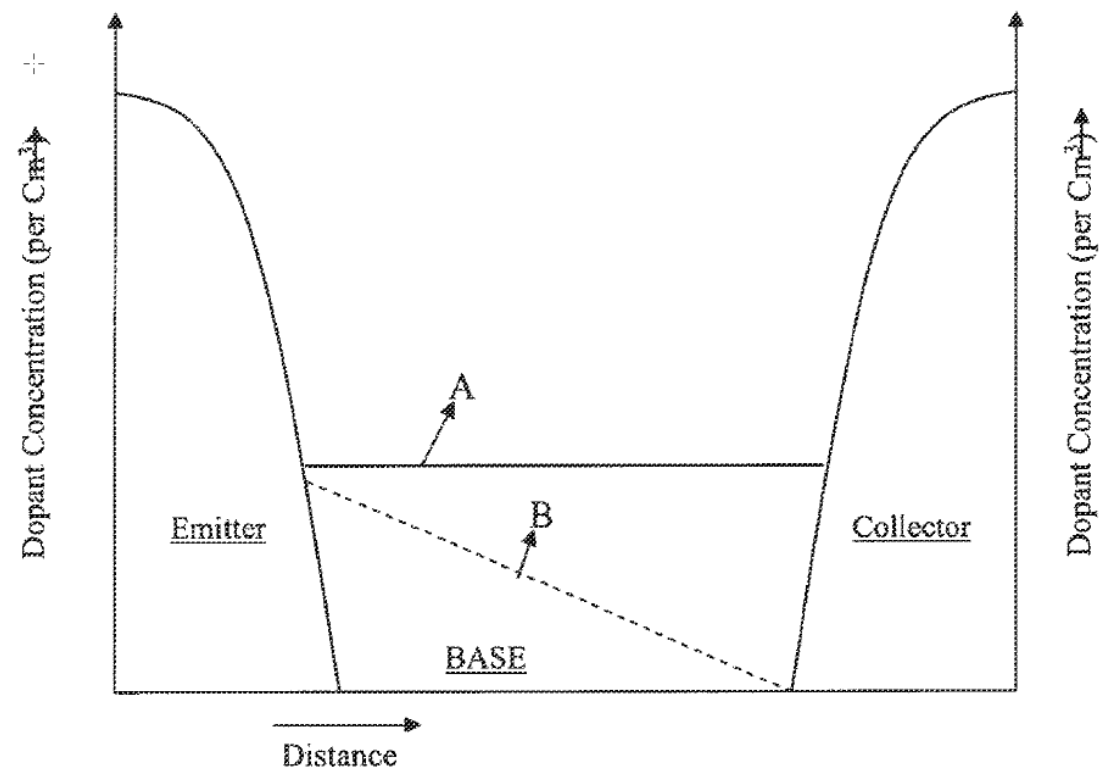


P-type dopants:

- E-field towards the surface
- Minority carrier (electrons) drift from surface towards substrate

Ex. 1060 (Banerjee Supp. Declaration) at ¶¶23-27
(explaining drift and diffusion)

Greenthread's Specification Cites Relate to *Bipolar* Transistors



'842 Patent (Ex.1001) (-00016) at 3:2-5, Figs. 1, 5B

END
