Petitioner Semiconductor Components Industries, LLC (onsemi) Oral Argument for PTAB Hearing

Semiconductor Components Industries, LLC v. Greenthread, LLC

IPR2024-00263 (U.S. Patent No. 11,316,014)

IPR2024-00264 (U.S. Patent No. 10,734,481)

IPR2024-00265 (U.S. Patent No. 9,190,502)

IPR2024-00266 (U.S. Patent No. 8,421,195)

May 6, 2025

BAKER BOTTS

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DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

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OVERVIEW 01

OVERVIEW OF PATENTS AND INSTITUTED GROUNDS

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THE PATENTS

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’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 disclaimer.

(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.

’014 Patent, EX1001 (-00263), 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, EX1001 (-00264), Claim 1

’502 Patent

(12) **United States Patent**
Rao

(10) **Patent No.: US 9,190,502 B2**
(45) **Date of Patent: *Nov. 17, 2015**

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

(71) Applicant: **G. R. Mohan Rao**, Allen, 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 disclaimer.

(21) Appl. No.: **14/515,584**

(22) Filed: **Oct. 16, 2014**

(65) **Prior Publication Data**

US 2015/0035004 A1 Feb. 5, 2015

Related U.S. Application Data

(60) Continuation of application No. 13/854,319, filed on Apr. 1, 2013, now abandoned, which is a continuation of application No. 11/622,496, filed on Jan. 12, 2007, now Pat. No. 8,421,195, which is a division of application No. 10/934,915, filed on Sep. 3, 2004, now abandoned.

7. A semiconductor device comprising:
a surface layer;
a substrate;
an active region including a source and a drain, disposed on one surface of said surface layer;
a single drift layer disposed between the other surface of said surface layer and said substrate, said drift layer having a graded concentration of dopants generating a first static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate; and
at least one well region disposed in said single drift layer, said well region having a graded concentration of dopants generating a second static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate.

’502 Patent, EX1001 (-00265), Claim 1

’195 Patent

(12) **United States Patent**
Rao

(10) **Patent No.: US 8,421,195 B2**
(45) **Date of Patent: Apr. 16, 2013**

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

(76) Inventor: **G. R. Mohan Rao**, McKinney, 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.: **11/622,496**

(22) Filed: **Jan. 12, 2007**

(65) **Prior Publication Data**

US 2007/0158790 A1 Jul. 12, 2007

Related U.S. Application Data

(62) Division of application No. 10/934,915, filed on Sep. 3, 2004, now abandoned.

1. A CMOS Semiconductor device comprising:
a surface layer;
a substrate;
an active region including a source and a drain, disposed on one surface of said surface layer;
a single drift layer disposed between the other surface of said surface layer and said substrate, said drift layer having a graded concentration of dopants extending between said surface layer and said substrate, said drift layer further having a first static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate; and
at least one well region disposed in said single drift layer, said well region having a graded concentration of dopants and a second static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate.

’195 Patent, EX1001 (-00266), Claim 1

INSTITUTED GROUNDS

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Instituted Grounds

IPR2024-00263 (U.S. Patent 11,316,014)			
Ground	**Claims**	**35 U.S.C. §**	**Prior art**
I	1-9, 13-14, 16-28	103(a)	Kawagoe (EX1007)
II	1-2, 4-9, 13-23, 25-28	103(a)	Wieczorek (EX1006), Wolf (EX1008)
III	1-9, 13-14, 16-28	103(a)	Kawagoe, Gupta (EX1014)
IV	1-2, 4-9, 13-23, 25-28	103(a)	Wieczorek, Wolf, Gupta
V	19	103(a)	Kawagoe, Silverbrook (EX1046)
VI	19	103(a)	Wieczorek, Wolf, Silverbrook

Institution Decision, Paper 21 (-00263)

Instituted Grounds

IPR2024-00264 (U.S. Patent 10,734,481)			
Ground	**Claims**	**35 U.S.C. §**	**Prior art**
I	1-9, 13-14, 16-27, 31-36	103(a)	Kawagoe (EX1007)
II	1-2, 4-9, 13-22, 24-27, 31-36	103(a)	Wieczorek (EX1006), Wolf (EX1008)
III	1-9, 13-14, 16-27, 31-36	103(a)	Kawagoe, Gupta (EX1014)
IV	1-2, 4-9, 13-22, 24-27, 31-36	103(a)	Wieczorek, Wolf, Gupta
V	19, 36	103(a)	Kawagoe, Silverbrook (EX1046)
VI	19, 36	103(a)	Wieczorek, Wolf, Silverbrook

Institution Decision, Paper 21 (-00263)

Instituted Grounds

IPR2023-00265 (U.S. Patent 9,190,502)			
Ground	**Claims**	**35 U.S.C. §**	**Prior art**
I	7, 12	103(a)	Payne (EX1005)
II	7-12	103(a)	Sakai (EX1006), Kawagoe (EX1007)
III	9-11	103(a)	Payne, Wolf (EX1008)
IV	8	103(a)	Payne, Parrillo (EX1025)
V	12	103(a)	Payne, Silverbrook (EX1048)
VI	7-12	103(a)	Sakai, Kawagoe, Silverbrook

Institution Decision, Paper 22 (-00265)

Instituted Grounds

IPR2023-00266 (U.S. Patent 8,421,195)			
Ground	**Claims**	**35 U.S.C. §**	**Prior art**
I	1-2, 4-6	103(a)	Payne (EX1005)
II	1-6	103(a)	Sakai (EX1006), Kawagoe (EX1007)
III	2, 3	103(a)	Payne, Wolf (EX1008)
IV	3	103(a)	Payne, Parrillo (EX1025)
V	2	103(a)	Sakai, Kawagoe, Wolf

Institution Decision, Paper 21 (-00266)

THE PRIOR ART DISCLOSES ALL CLAIM LIMITATIONS

02

Kawagoe (U.S. Patent No. 6,043,114) [EX1007]

US006043114A

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**

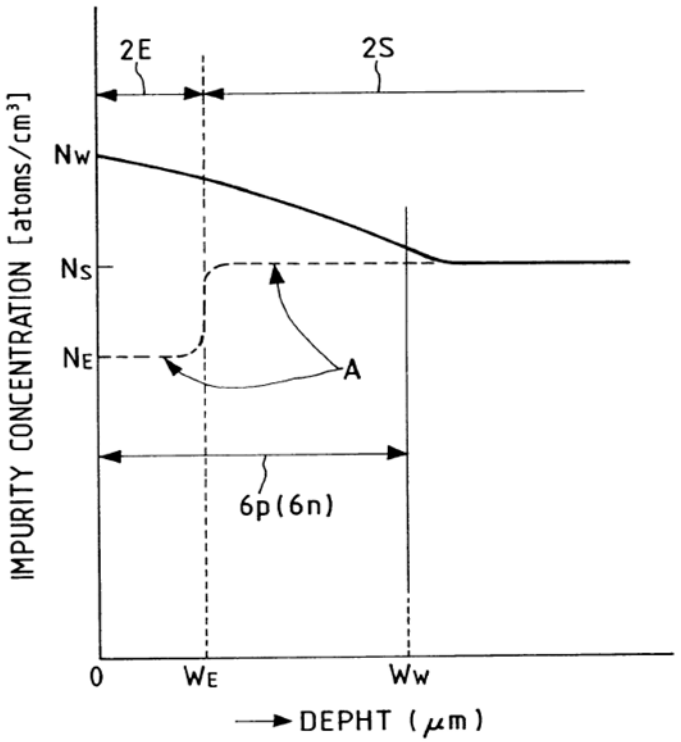
[75] Inventors: **Hiroto Kawagoe**, Hinode-machi; **Tatsumi Shirasu**, Kawasaki; **Shogo Kiyota**, Tateno-machi; **Norio Suzuki**, Higashimurayama; **Eiichi Yamada**, Kumage-gun; **Yuji Sugino**, Nakakoma-gun; **Manabu Kitano**, Yanai; **Yoshihiko Sakurai**; **Takashi Naganuma**, both of Nakakoma-gun;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

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

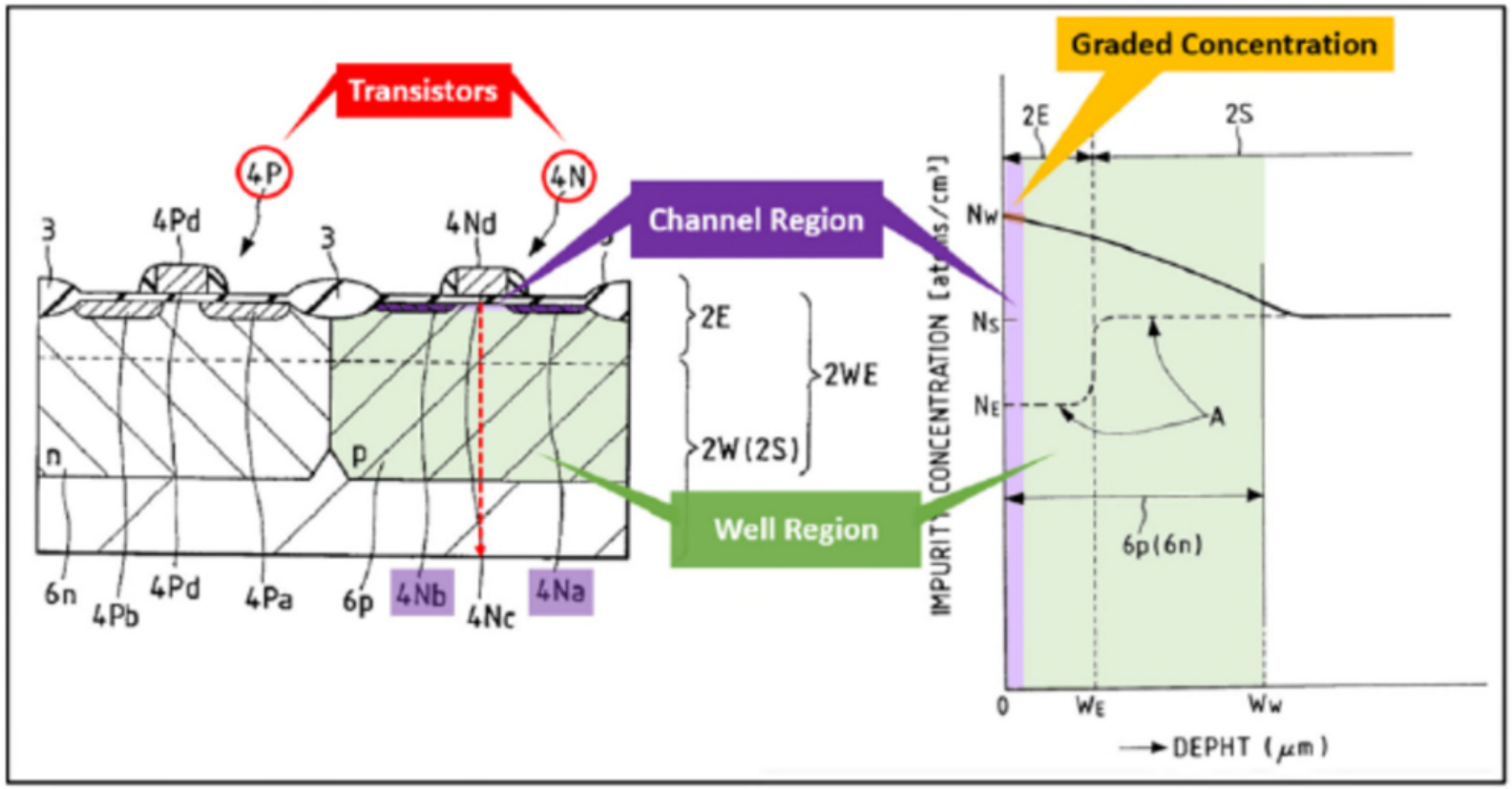
[21] Appl. No.: **08/934,774**

[22] Filed: **Sep. 22, 1997**

FIG. 17



Kawagoe has a graded dopant concentration to aid carrier movement



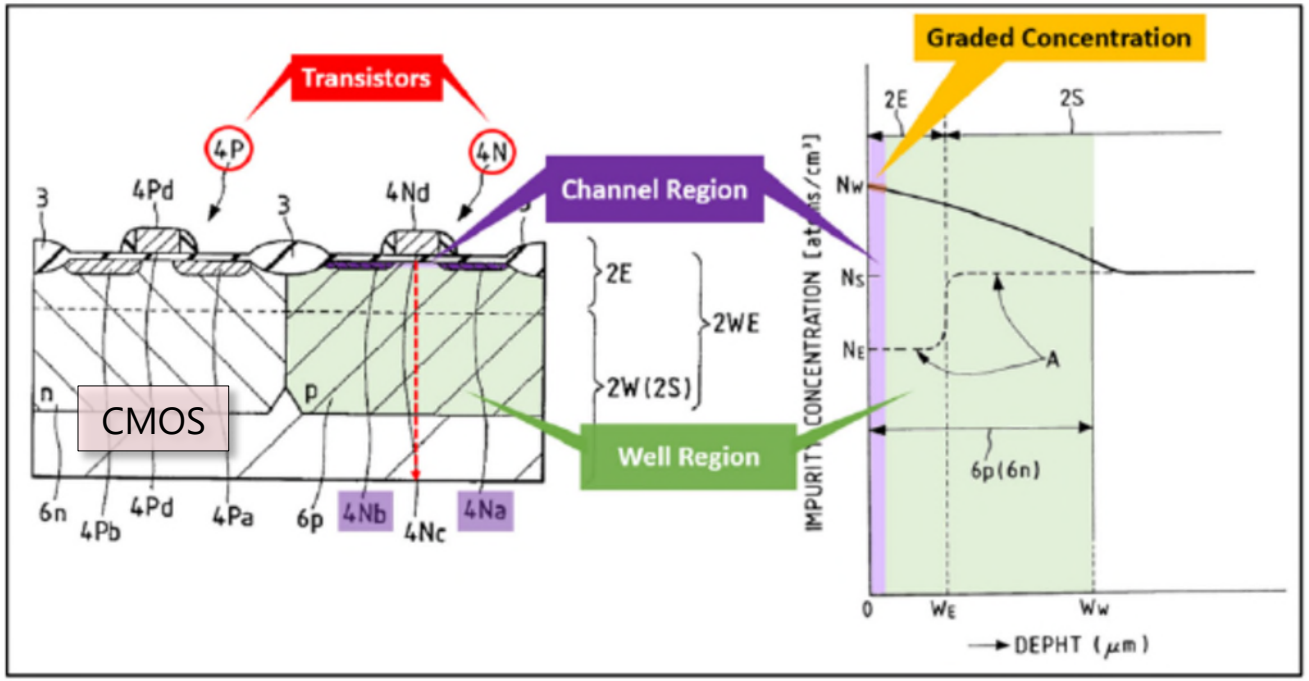
Kawagoe, EX1007, Figs. 17, 23 (annotated)

"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, EX1007, 16:2-11

Petition, Paper 1 (-00263), 18-28;
Petition, Paper 1 (-00264), 19-29;
Petition, Paper 1 (-00265), 53-68;
Petition, Paper 1 (-00266), 65-74.

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



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;

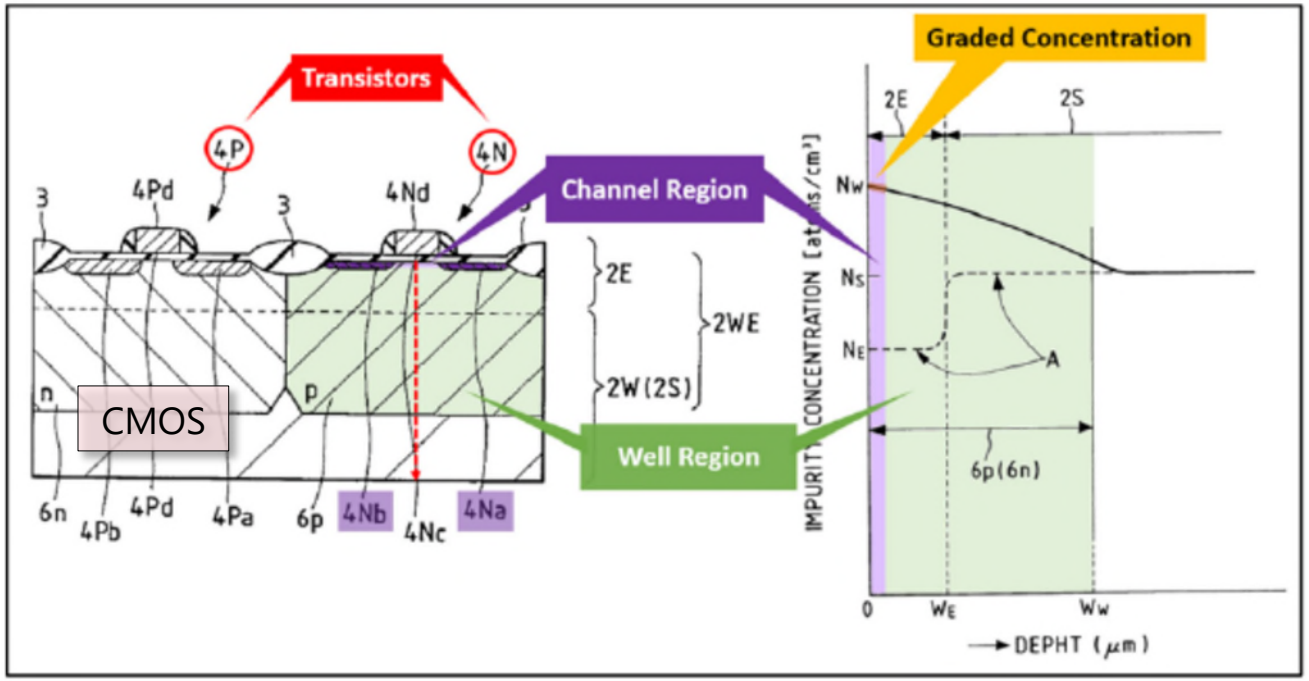
transistors formed in at least one of the first active region or second active region;

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.

Petition, Paper 1 (-0023), 7-28

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;

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.

Petition, Paper 1 (-00264), 7-29

Wieczorek (U.S. Patent App. Pub. 2003/0183856) [EX1006]

US 20030183856A1

(19) **United States**

(12) **Patent Application Publication**

Wieczorek et al.

(10) **Pub. No.: US 2003/0183856 A1**

(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**

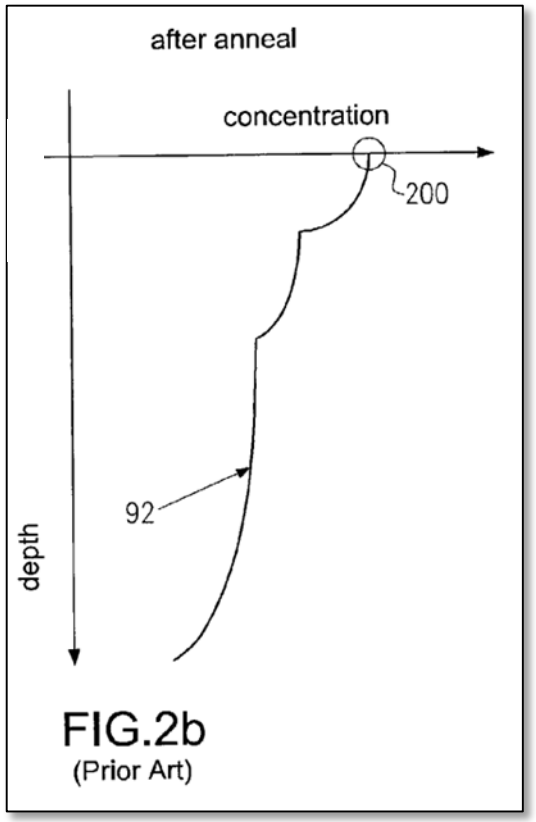
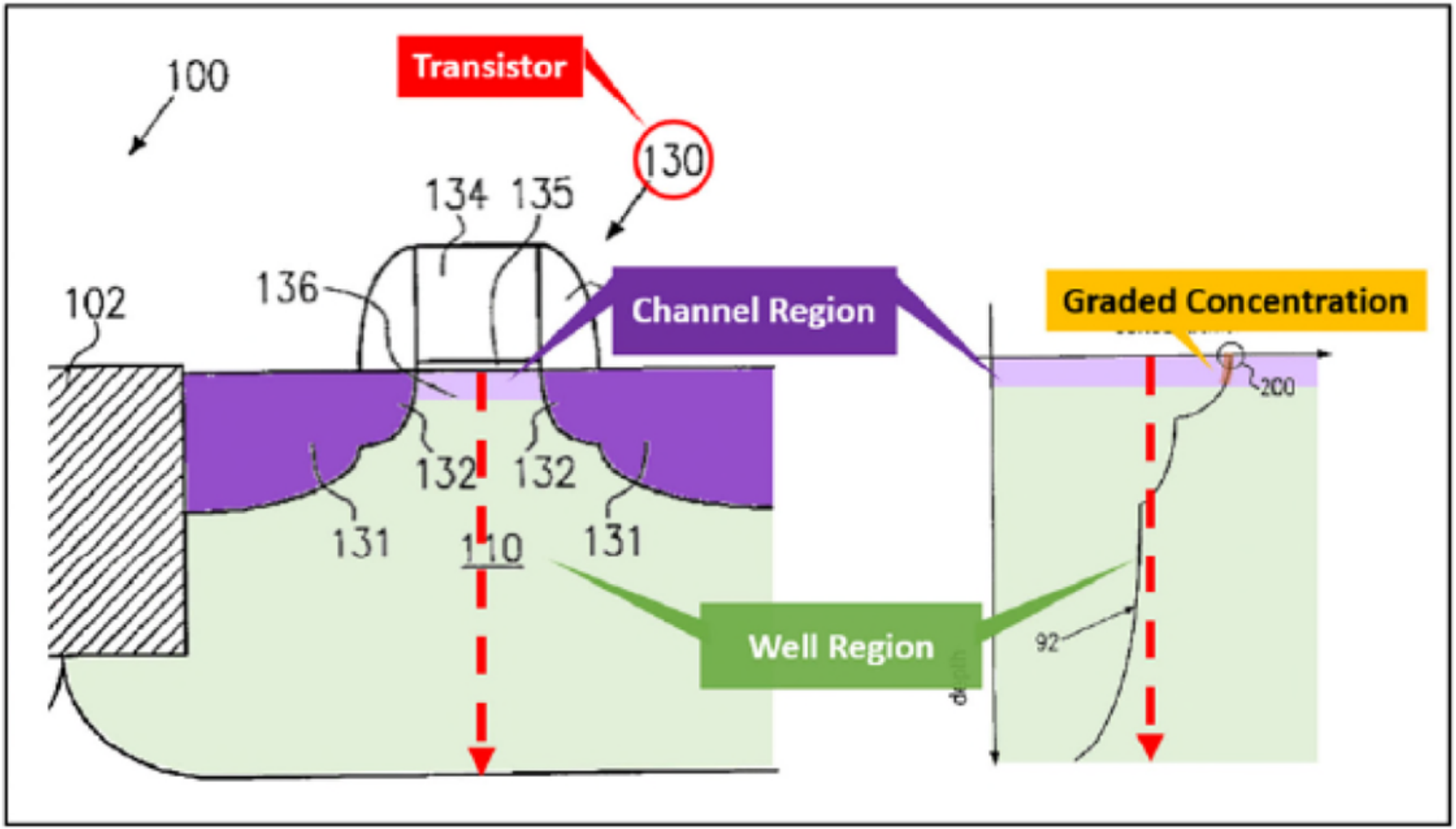


FIG.2b
(Prior Art)

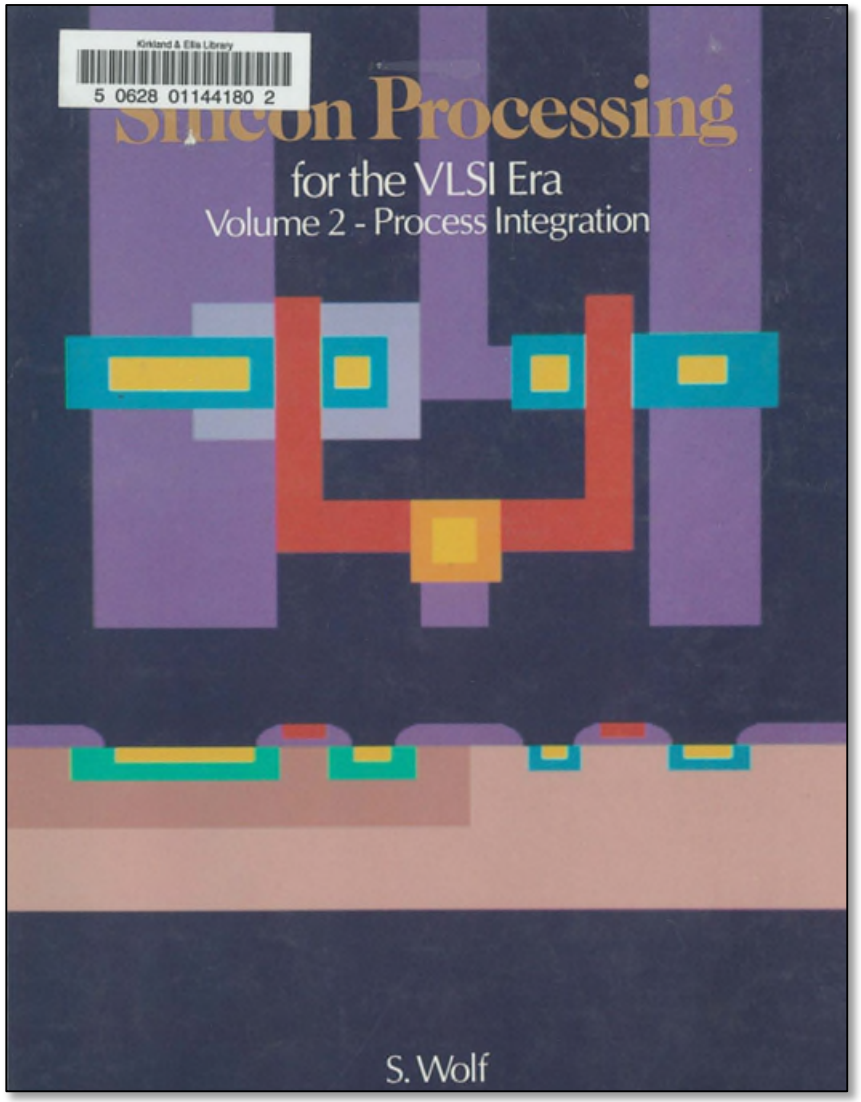
Wieczorek has a graded dopant concentration to aid carrier movement



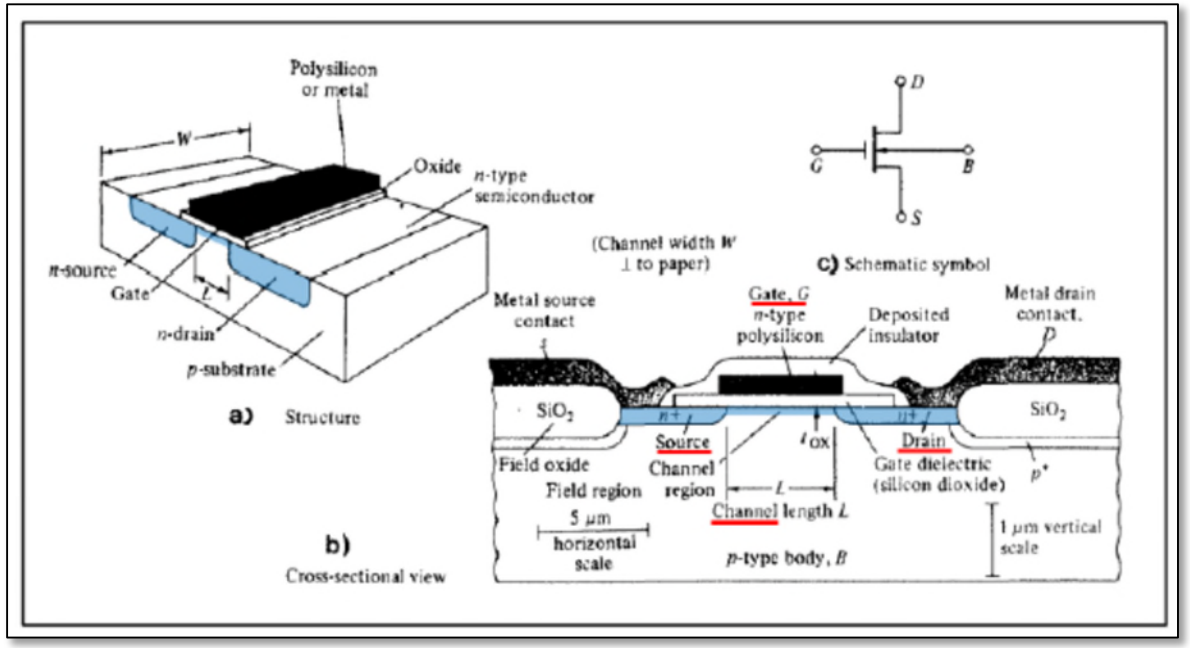
Wieczorek, EX1006, Fig. 1b/2b (annotated)

Petition, Paper 1 (-00263), 51-58;
Petition, Paper 1 (-00264), 51-58.

Wolf (*Silicon Processing for the VLSI Era*) (2000) [EX1008]

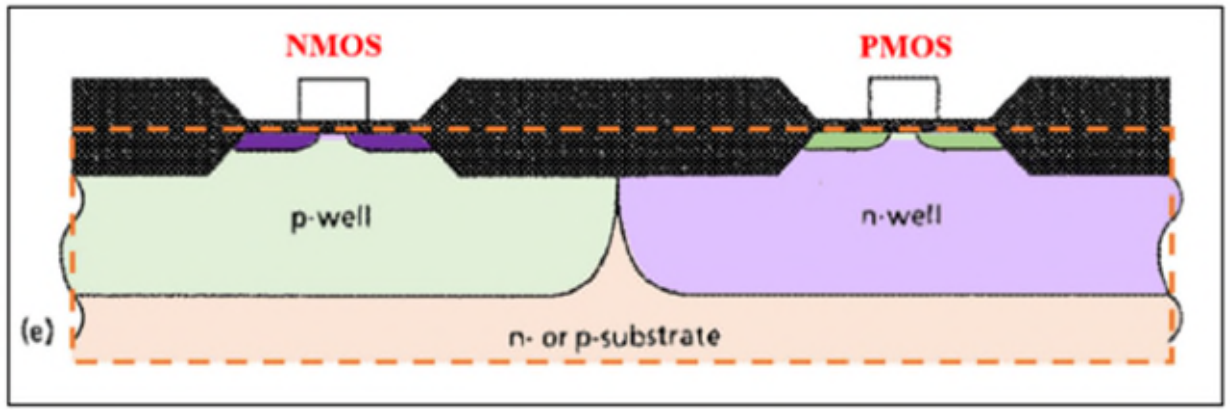


Wolf: active regions include source, drain, and channel of transistor; twin-well CMOS devices use n or p type substrate



"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, EX1008B, pp. 299-300
(Figure annotated)

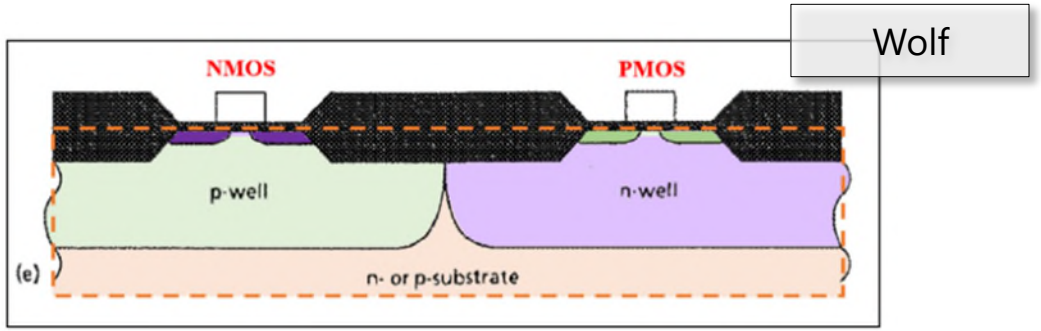


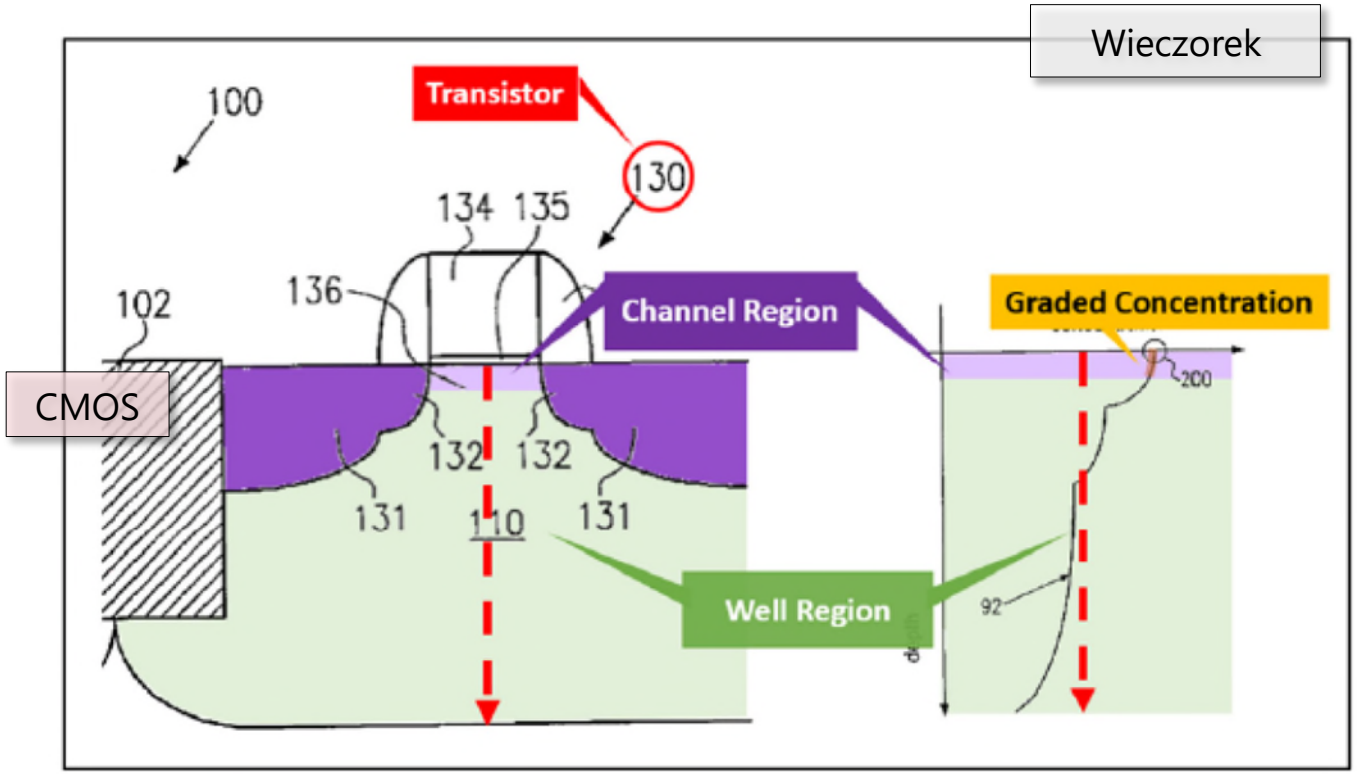
A "uniform, lightly doped *p*- or *n*-type substrate" is commonly used in twin-well CMOS devices

Wolf, EX1008C, pp. 523, 525, 530
(Figure annotated)

Petition, Paper 1 (-00263), 42-58;
Petition, Paper 1 (-00264), 42-58.

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;

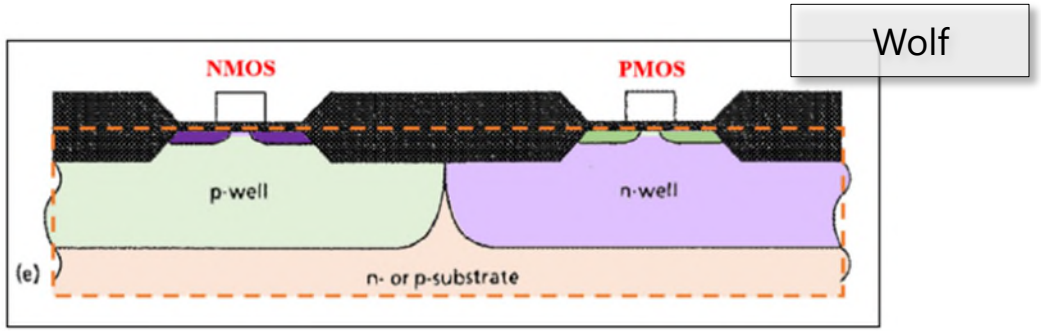
transistors formed in at least one of the first active region or second active region;

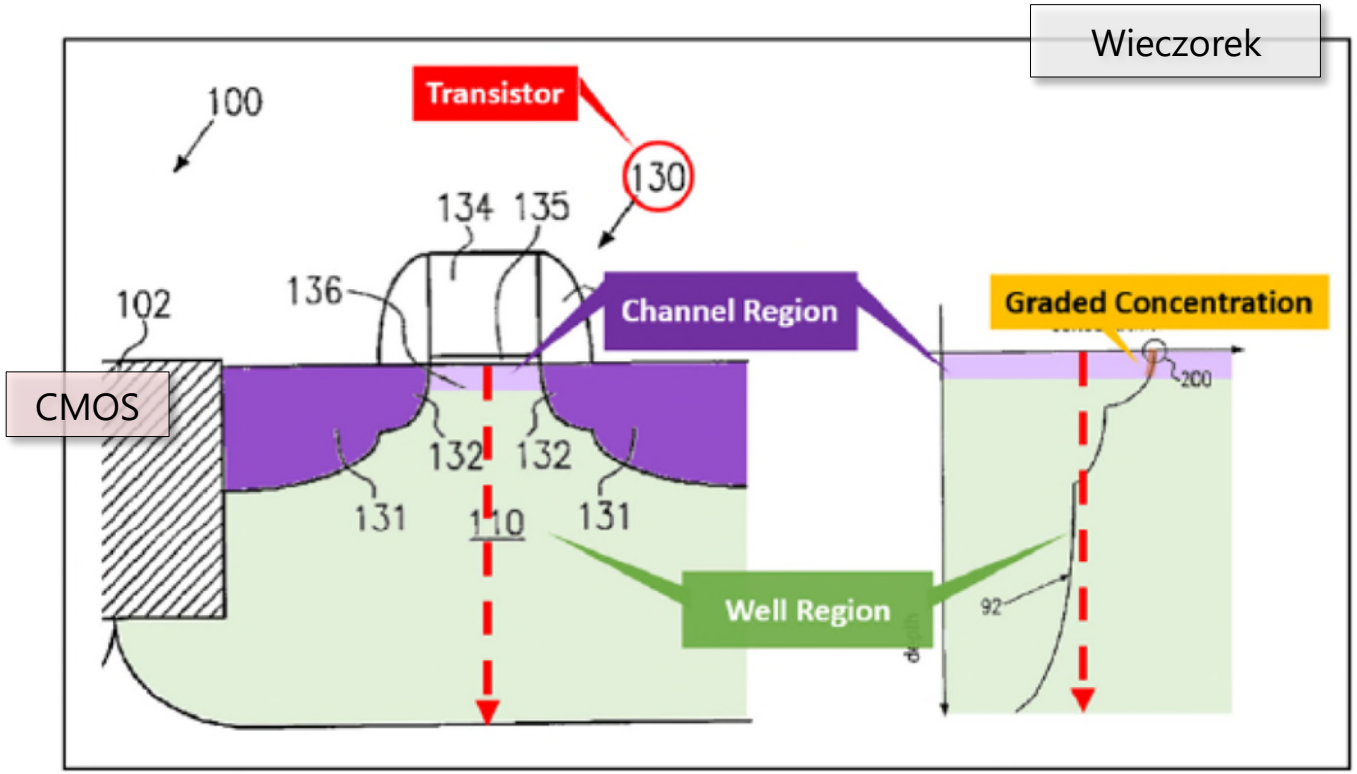
at least a portion of at least one of the first and second active regions having at least one graded dopant concentration to aid carrier movement from the first and second active regions towards an area of the substrate where there are no active regions; and

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.

Petition, Paper 1 (-00263), 42-58.

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;

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.

Petition, Paper 1 (-00264), 42-58.

Payne (U.S. Patent 4,684,971) [EX1005]

United States Patent [19]

Payne

[11] **Patent Number: 4,684,971**

[45] **Date of Patent: Aug. 4, 1987**

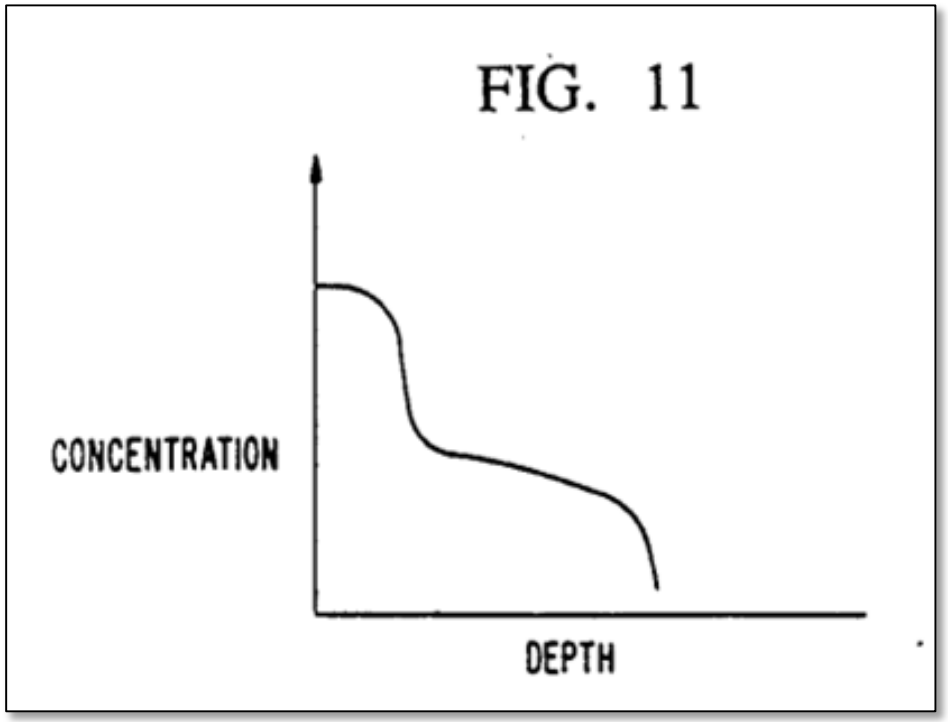
[54] **ION IMPLANTED CMOS DEVICES**

[75] Inventor: **Richard S. Payne**, Andover, Mass.

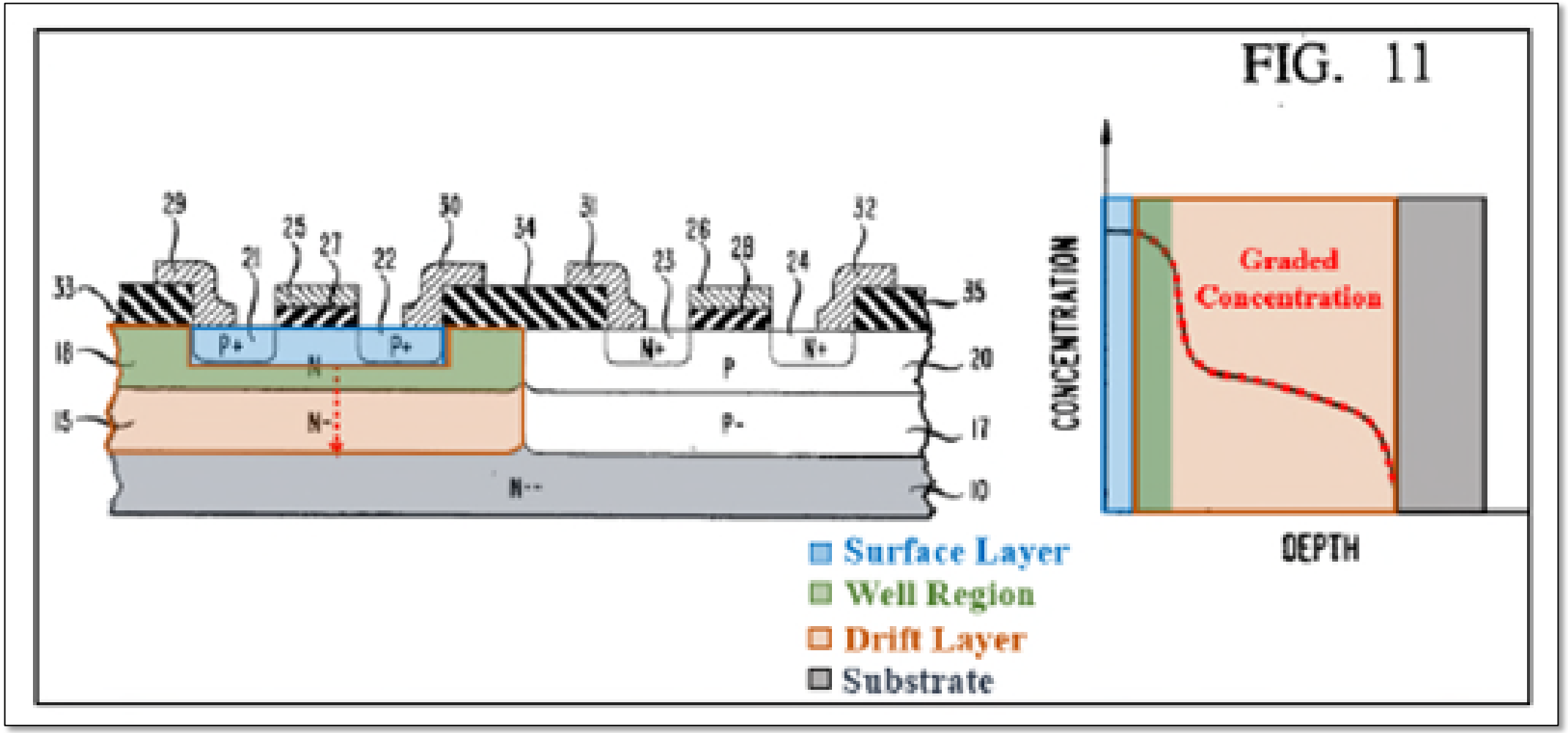
[73] Assignee: **American Telephone and Telegraph Company, AT&T Bell Laboratories,** Murray Hill, N.J.

[21] Appl. No.: **243,621**

[22] Filed: **Mar. 13, 1981**



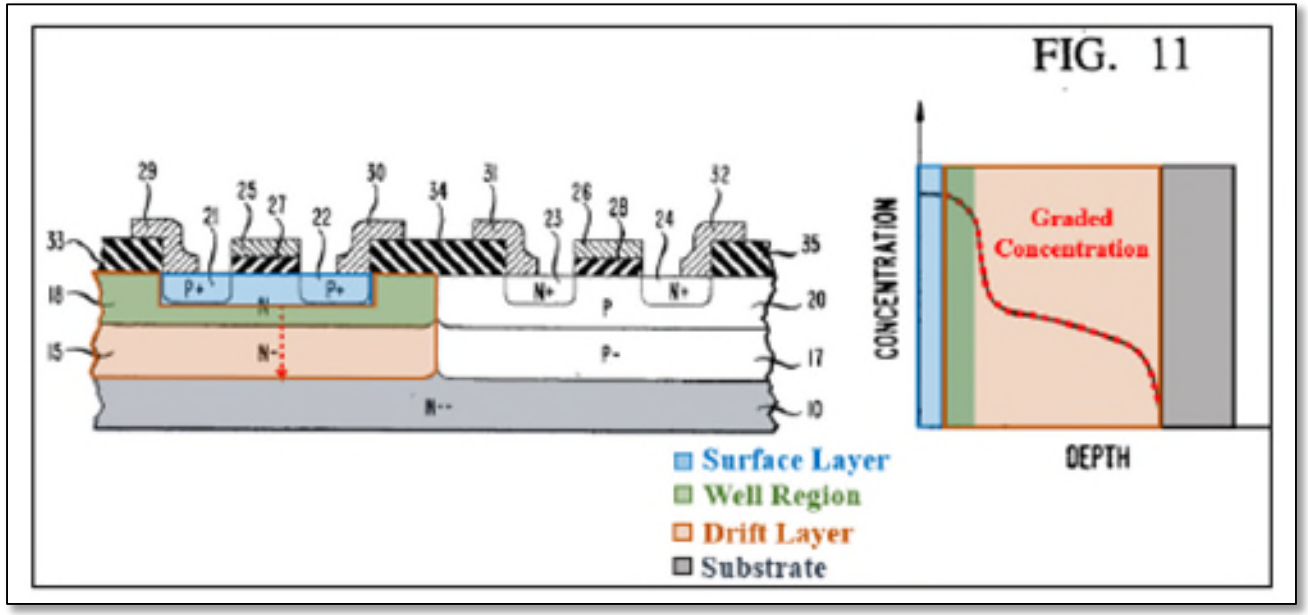
Payne has a graded dopant concentration to aid carrier movement



Payne, EX1005, Figs. 10, 11 (annotated)

Petition, Paper 1 (-00266), 13-41

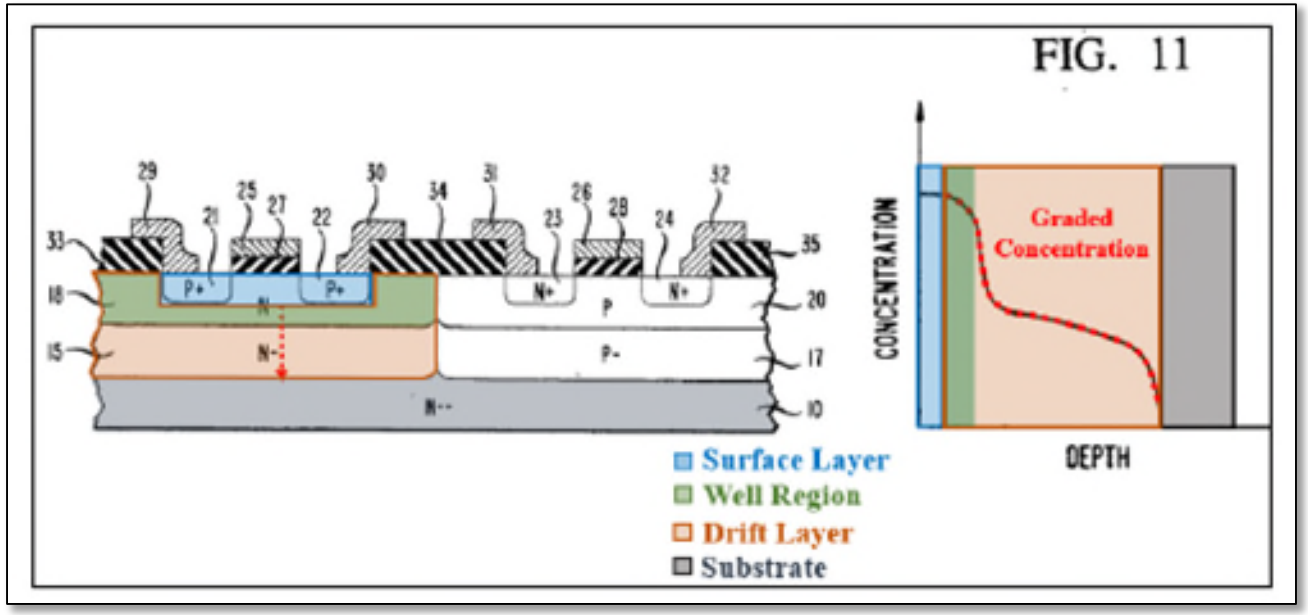
Payne discloses the elements of Claim 7 ('502 Patent)



7. A semiconductor device comprising:
a surface layer;
a substrate;
an active region including a source and a drain, disposed on one surface of said surface layer;
a single drift layer disposed between the other surface of said surface layer and said substrate, said drift layer having a graded concentration of dopants generating a first static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate; and
at least one well region disposed in said single drift layer, said well region having a graded concentration of dopants generating a second static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate.

Petition, Paper 1 (-00265), 13-41

Payne discloses the elements of Claim 1 ('195 Patent)



1. A CMOS Semiconductor device comprising:

a surface layer;

a substrate;

an active region including a source and a drain, disposed on one surface of said surface layer;

a single drift layer disposed between the other surface of said surface layer and said substrate, said drift layer having a graded concentration of dopants extending between said surface layer and said substrate, said drift layer further having a first static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate; and

at least one well region disposed in said single drift layer, said well region having a graded concentration of dopants and a second static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate.

Petition, Paper 1 (-00266), 13-41

Sakai (U.S. Patent 4,907,058) [EX1006]

United States Patent [19]

Sakai

[11] **Patent Number: 4,907,058**

[45] **Date of Patent: Mar. 6, 1990**

[54] **COMPLEMENTARY SEMICONDUCTOR DEVICE HAVING A DOUBLE WELL**

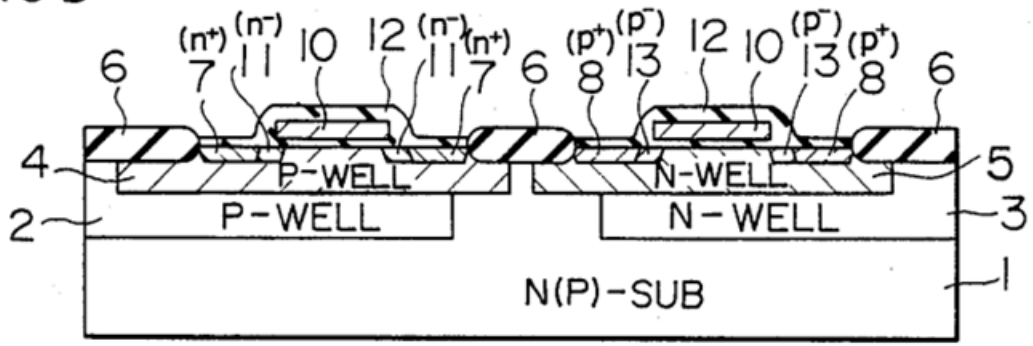
[75] Inventor: **Yoshio Sakai**, Tsukui, Japan

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

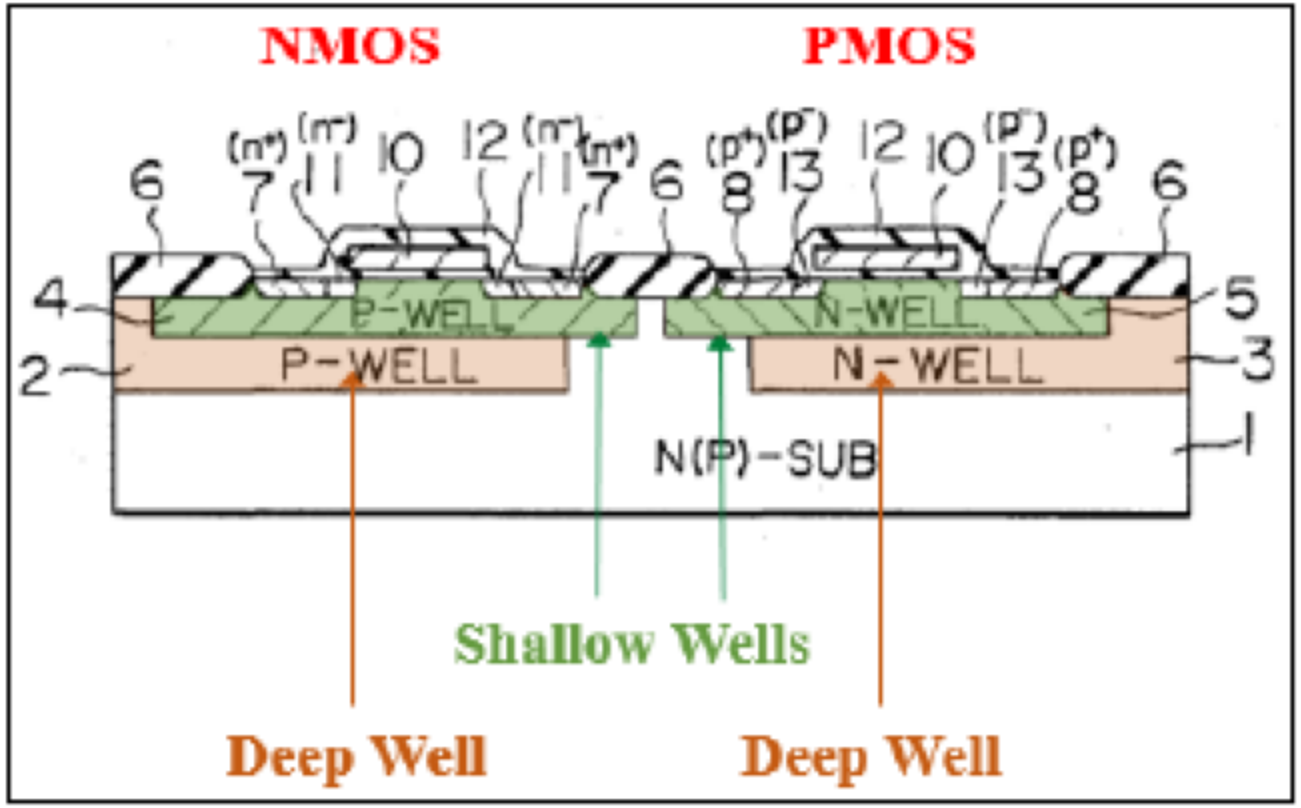
[21] Appl. No.: **214,674**

[22] Filed: **Jul. 1, 1988**

FIG. 10D



Sakai has twin double wells and high-to-low dopant concentrations



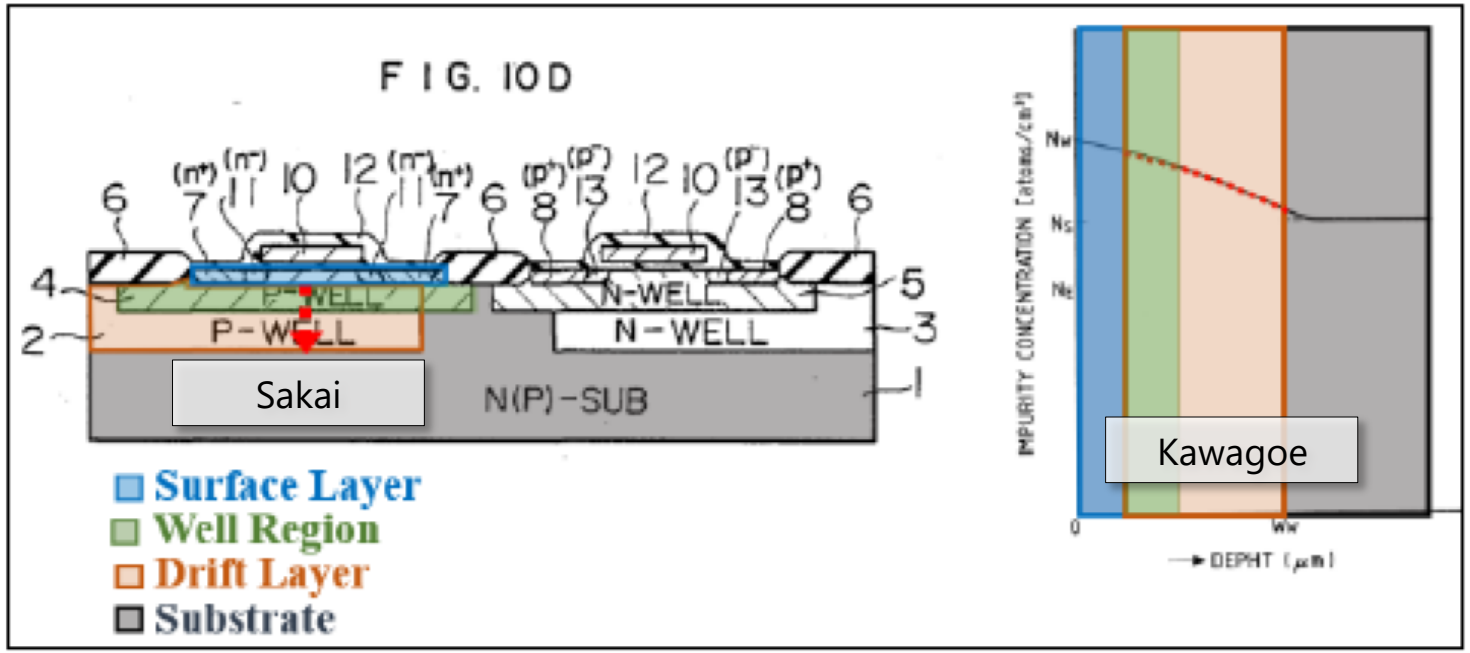
Sakai, EX1006, Fig. 10D (annotated)

"At first, a P-well region 2 and an N-well region 3 each **having an impurity concentration of 10^{15} to 10^{16} atoms per cm^3** and a depth of 3 to 5μm are formed in a surface portion of an N- or P-silicon substrate 1 [...]. Next, a P-type impurity and an N-type impurity are implanted [...], and the impurity-doped regions thus obtained are extended [...] to form a shallow P-well region 4 and a shallow N-well region 5 each having a depth of 0.5 to 1.5μm and **an impurity concentration of $5x10^{16}$ to 10^{18}** atoms per cm^3[.]"

Sakai, EX1006, 5:56-6:4

Petition, Paper 1 (-00265), 43-68

Sakai/Kawagoe discloses the elements of Claim 7 ('502 Patent)



7. A semiconductor device comprising:

a surface layer;

a substrate;

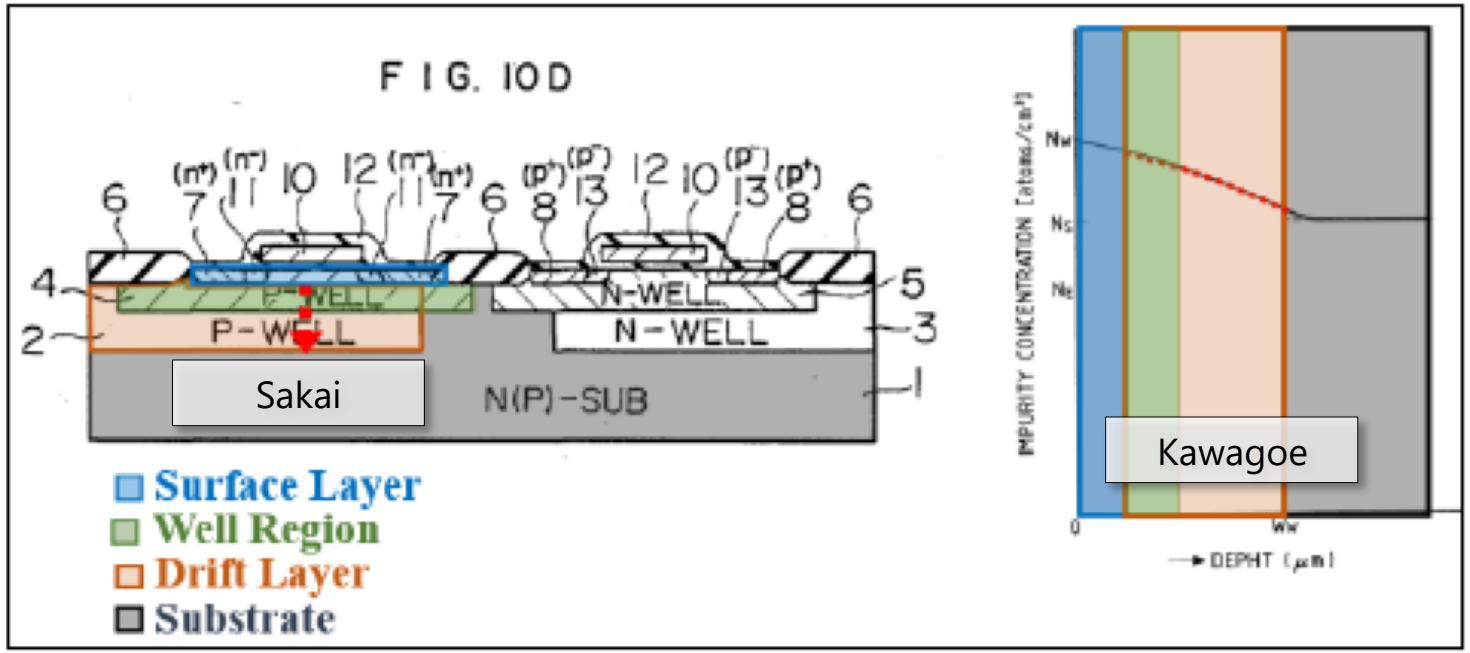
an active region including a source and a drain, disposed on one surface of said surface layer;

a single drift layer disposed between the other surface of said surface layer and said substrate, said drift layer having a graded concentration of dopants generating a first static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate; and

at least one well region disposed in said single drift layer, said well region having a graded concentration of dopants generating a second static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate.

Petition, Paper 2 (-00265), 43-68

Sakai/Kawagoe discloses the elements of Claim 1 ('195 Patent)



1. A CMOS Semiconductor device comprising:

a surface layer;

a substrate;

an active region including a source and a drain, disposed on one surface of said surface layer;

a single drift layer disposed between the other surface of said surface layer and said substrate, said drift layer having a graded concentration of dopants extending between said surface layer and said substrate, said drift layer further having a first static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate; and

at least one well region disposed in said single drift layer, said well region having a graded concentration of dopants and a second static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate.

Petition, Paper 1 (-00266), 49-74

Gupta (U.S. Patent 6,163,877) [EX1014] (-00263, -00264)

US006163877A

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**

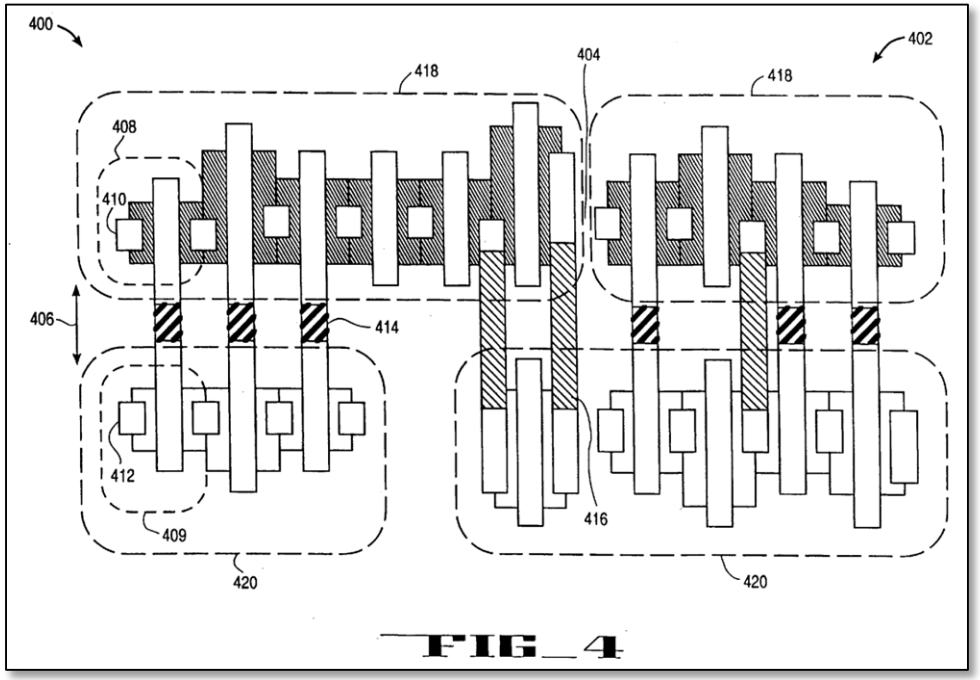
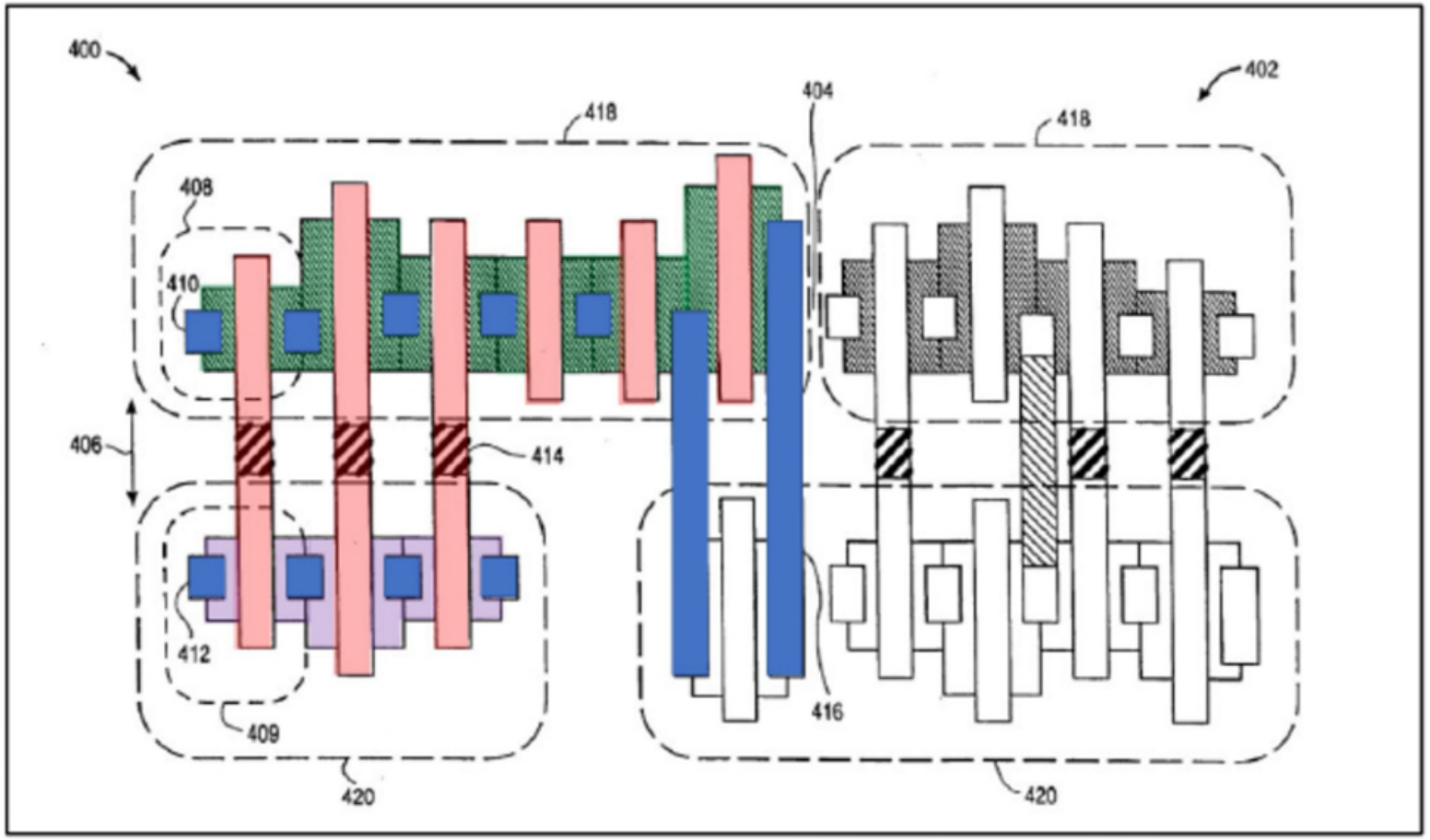


FIG_4

Gupta, EX1014
(-00263, -00264)

Gupta: a plurality of "transistors" or "devices" was well known



Gupta, EX1014, Fig. 4 (annotated)

"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."

Gupta, EX1014, 4:12-43

Petition, Paper 1 (-00263, 72-77;
Petition, Paper 1 (-00264), 71-76

Silverbrook (U.S. Patent 6,614,560) [EX1042] (-00263, -00264)/[EX1048] (-00265)

US006614560B1

(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**

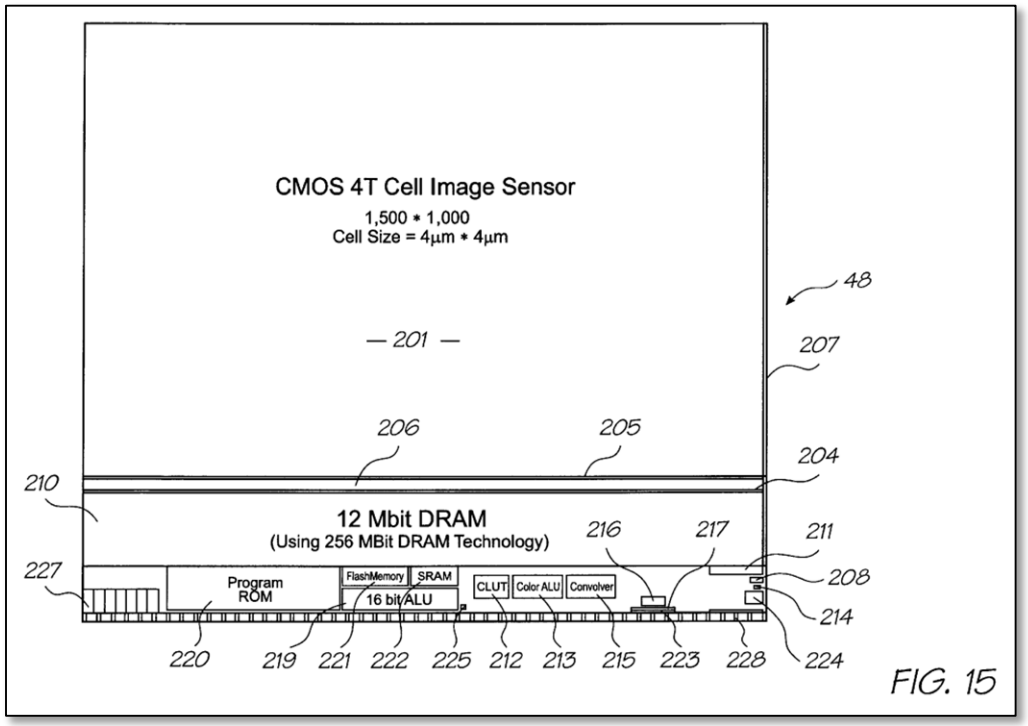
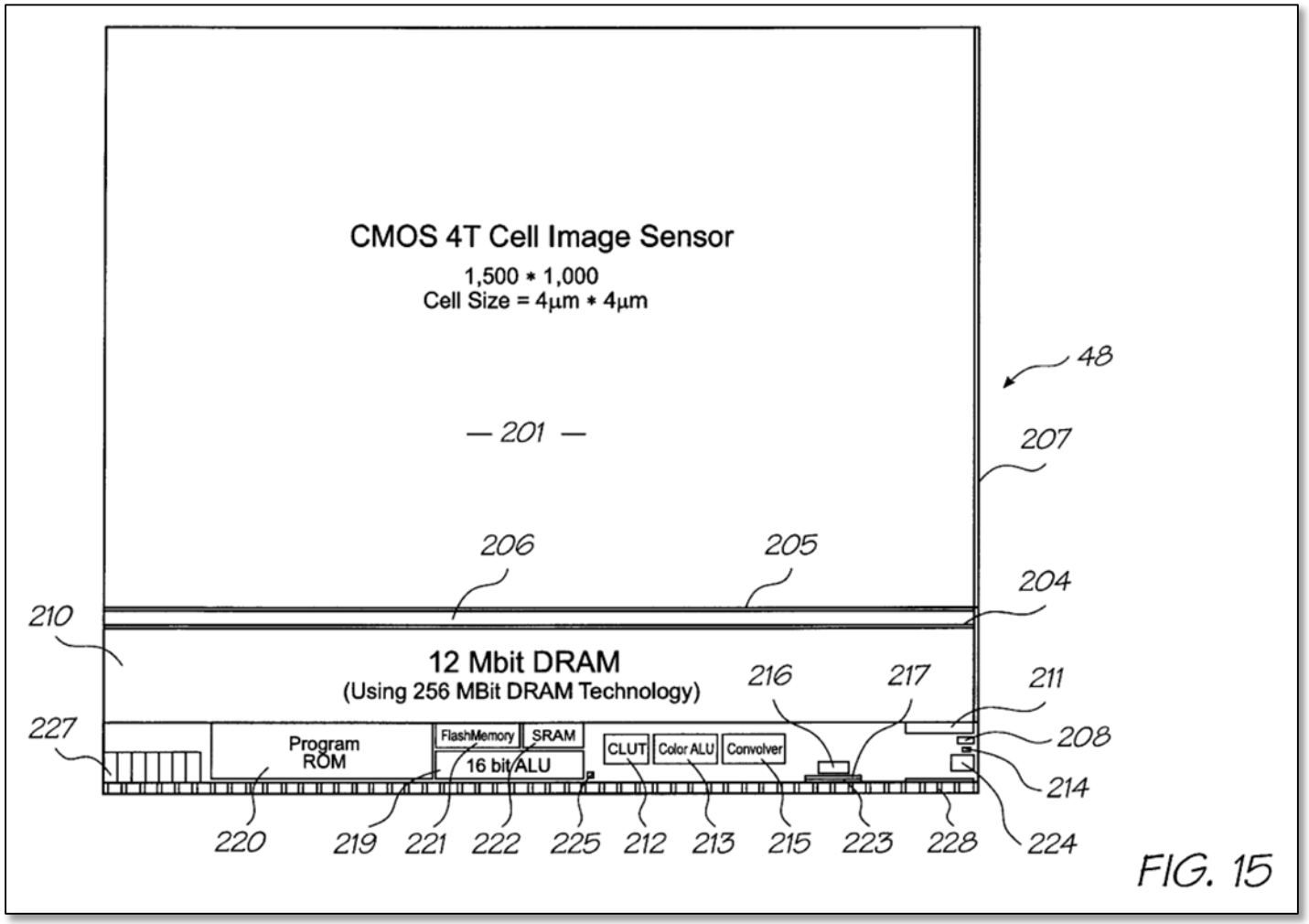


FIG. 15

Silverbrook, EX1042/EX1048

Silverbrook: "CMOS image sensors" were well known



Silverbrook, EX1042/EX1048, Fig. 15

"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."

Silverbrook, EX1042/EX1048, 6:41-49

Petition, Paper 1 (-00263), 37-39, 68-70, 77-78
Petition, Paper 1 (-00264), 37-39, 68-69, 76-77
Petition, Paper 1 (-00265), 41-43, 73-74, 85-88

Parrillo (U.S. Patent 4,435,896) [EX1025] (-00265, -00266)

United States Patent [19]

Parrillo et al.

[11] **4,435,896**

[45] **Mar. 13, 1984**

[54] **METHOD FOR FABRICATING COMPLEMENTARY FIELD EFFECT TRANSISTOR DEVICES**

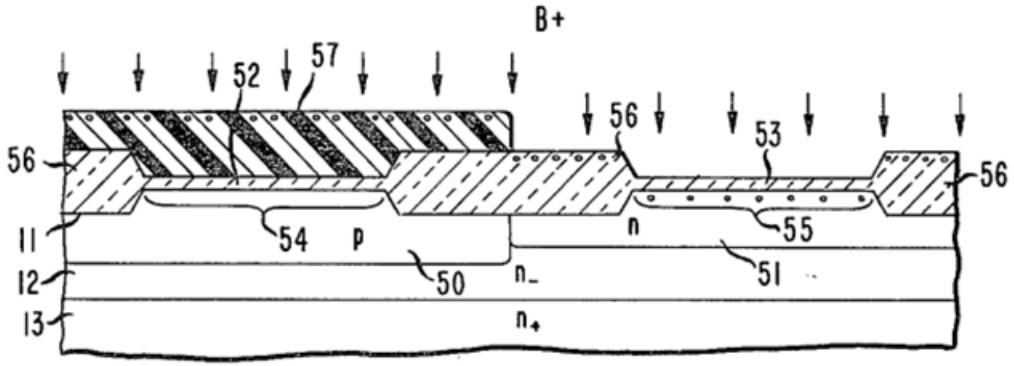
[75] Inventors: **Louis C. Parrillo**, Warren, N.J.; **Richard S. Payne**, Andover, Mass.

[73] Assignee: **Bell Telephone Laboratories, Incorporated**, Murray Hill, N.J.

[21] Appl. No.: **508,923**

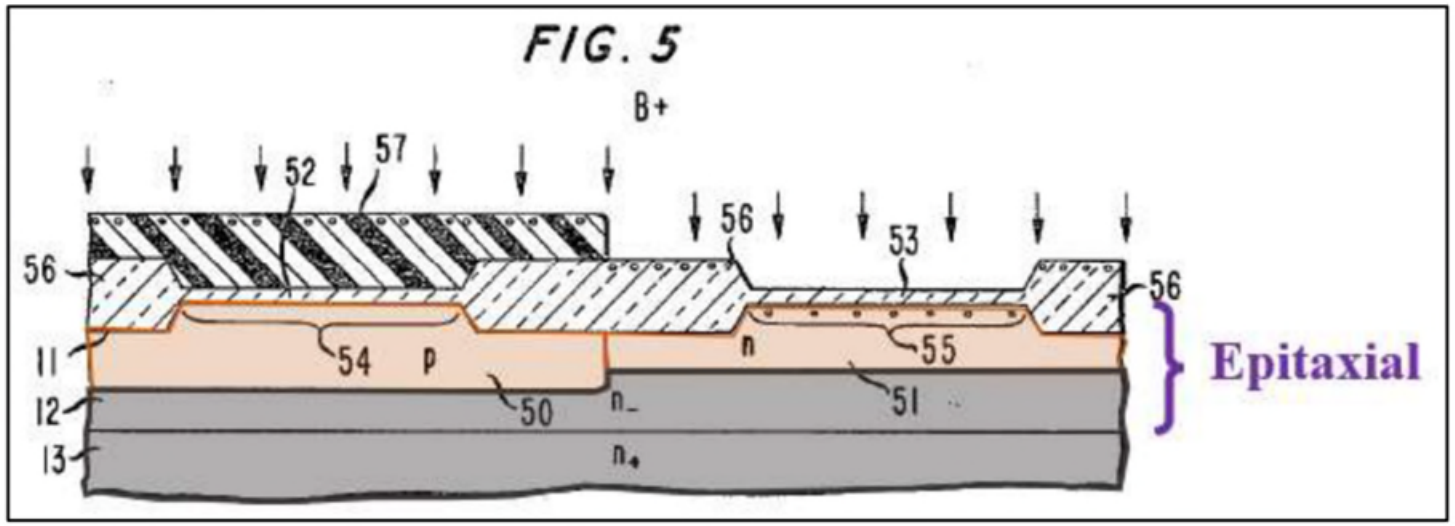
[22] Filed: **Jun. 29, 1983**

FIG. 5



Parrillo, EX1025
(-00265, -00266)

Parrillo: Twin well CMOS semiconductor devices with multiple transistors and epitaxial layers were well known



Parrillo, EX1025, Fig. 5 (annotated)

"The device may, for example, be a VLSI circuit in which case there would be a large number of tubs of each type, each of which might contain one or more transistors."

Parrillo, EX1025, 3:22-25

"The use of a relatively lightly doped (n-) epitaxial layer on a relatively doped (n+) substrate provides protection against SCR latch-up in the device."

Parrillo, EX1025, 3:38-41

Petition, Paper 1 (-00265), 79-84
Petition, Paper 1 (-00266), 88-90

CLAIM CONSTRUCTION 03

The challenged apparatus claims do not require an active step of affirmatively moving carriers

Patent Owner: "the plain and ordinary meaning of 'aid carrier movement' requires that a carrier move in the specified direction."

- The claim language does not require moving a carrier
- The prosecution history does not show that a carrier must be moved
- The prior district court constructions do not require moving a carrier

Kawagoe discloses "aid[ing] carrier movement" even under Patent Owner's construction

Reply, Paper 38 (-00263), 1-7;
Reply, Paper 39 (-00264), 1-7;
Reply, Paper 39 (-00265), 1-7;
Reply, Paper 41 (-00266), 1-7.

The challenged apparatus claims do not require an active step of affirmatively moving carriers

"Under *ParkerVision*, the relevant inquiry is whether the graded dopant concentration is capable of performing the claimed limitation, not how likely the claimed limitation is to be performed or occur."

IPR2023-01243 (parallel IPR on related patent),
Paper 82 (Final Written Decision), 44

"[A]pparatus claims cover what a device is, not what a device does."

ParkerVision, Inc. v. Qualcomm Inc., 903 F.3d 1354, 1361 (Fed. Cir. 2018) (emphasis original)
(quoting *Hewlett-Packard Co. v. Bausch & Lomb Inc.*, 909 F.2d 1464, 1468 (Fed. Cir. 1990))

"[W]e presume, unless otherwise compelled, that the same claim term in the same patent or related patents carries the same construed meaning."

Omega Eng'g, Inc, v. Raytek Corp., 334 F.3d 1314, 1334 (Fed. Cir. 2003)

Reply, Paper 38 (-00263), 1-7;
Reply, Paper 39 (-00264), 1-7;
Reply, Paper 39 (-00265), 1-7;
Reply, Paper 41 (-00266), 1-7.

The claim language does not require actually moving a carrier

Patent Owner's misinterprets *INVT SPE LLC v. Int'l Trade Comm'n* , 46 F.4th 1361, (Fed. Cir. 2022)

> Patent Owner: "The Federal Circuit has recognized that for 'mechanical apparatus claims' (as opposed to computer or software claims), the claims are 'configuration-type claims.' Here, the claims are clearly "mechanical apparatus claims.'" (Internal citations omitted)

Patent Owner is citing dicta because *INVT* involved software claims:

> "[W]e find that the asserted [] claims are directed to capability—as in a device that includes 'software components with specific purposes,' programmed to have the ability to perform the operative steps." *INVT*, 46 F.4 at 1374.

The Federal Circuit **did not** create a rule in *INVT* that all mechanical apparatus claims must be construed as requiring active steps—the focus is always on the claim language.

> "Our cases have held that sometimes a device only needs to be 'capable of operating' according to a claimed limitation, for a finding of infringement. Other times, a device does not infringe unless it actually operates as claimed. Whether infringement requires actual performance of the recited functions by the accused device depends on the claim language." *INVT*, 46 F.4 at 1371 (internal citations omitted).

Sur-Reply, Paper 43 (-00263), 2-5; Sur-Reply, Paper 44 (-00264), 2-5; Sur-Reply, Paper 44 (-00265), 2-5; Sur-Reply, Paper 45 (-00266), 2-5.

The claim language does not require actually moving a carrier

Claims 1/21 (014): An electronic system, the system comprising…

"…at least one graded dopant concentration to aid carrier movement…"

Claim 7 (502): A semiconductor device, comprising…

"…a graded concentration of dopants generating a first static unidirectional electric drift field to aid the movement of minority carriers…"

Claims 1/20 (481): A semiconductor device, comprising…

"…at least one graded dopant concentration to aid carrier movement…"

Claim 1 (195): A CMOS Semiconductor device, comprising…

"… said drift layer further having a first static unidirectional electric drift field to aid the movement of minority carriers …"

Reply, Paper 38 (-00263), 3-7; Reply, Paper 39 (-00264), 3-7; Reply, Paper 39 (-00265), 2-7; Reply, Paper 41 (-00266), 2-7.

Prosecution history does not support external parameters required for "aid carrier movement" term

Patent Owner: "[D]uring prosecution, the examiner [] said … that 'without knowing other parameters of the device' one cannot say whether the field would aid carrier movement."

POR, Paper 31 (-00263), 16;
POR, Paper 32 (-00264), 16;
POR, Paper 32 (-00265), 16;
POR, Paper 32 (-00266), 16.

What the Examiner ***actually*** said:

"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."

Reply, Paper 38 (-00263), 4-5;
Reply, Paper 39 (-00264), 4-5;
Reply, Paper 39 (-00265), 4-5;
Reply, Paper 41 (-00266), 4-5.

Prosecution history does not support external parameters required for "aid carrier movement" term

a single drift layer disposed between the other surface of said surface layer and said substrate, said drift layer having a graded concentration of dopants extending between said surface layer and said substrate to create and maintain a single static unidirectional electric drift field to aid the movement of ~~drawing all~~ minority carriers from said surface layer to said substrate.

EX1016 (-00263), 286, 289-290;
EX1016 (-00264), 286 , 289-290;
EX1040 (-00265), 286 , 289-290;
EX1002 (-00266), 286 , 289-290.

"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[.] […] 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."

Reply, Paper 38 (-00263), 4-5;
Reply, Paper 39 (-00264), 4-5;
Reply, Paper 39 (-00265), 4-5;
Reply, Paper 41 (-00266), 4-5.

Prosecution history confirms that focus is on direction of slope

Prosecution history (underlining in original):

"[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. [...] 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)"

EX1016 (-00263, -00264), EX1040 (-00265), EX1002 (-00266), 289; *id.*, 286, 289-290.

- The prosecution history describes the impact of a graded dopant concentration on **all** minority carriers as binary, "up" or "down"
- For a binary outcome, "particular slope" must mean "increasing" or "decreasing" – the magnitude is irrelevant

POR, Paper 31 (-00263), 9-13, 19-21; POR, Paper 32 (-00264), 9-13, 19-21; POR, Paper 32 (-00265), 9-13, 19-21; POR, Paper 32 (-00266), 9-13, 19-21. Reply, Paper 38 (-00263), 3-7; Reply, Paper 39 (-00264), 3-7; Reply, Paper 39 (-00265), 2-7; Reply, Paper 41 (-00266), 2-7.

Prosecution history confirms that focus is on direction of slope

Related U.S. Patent Application 17/728,588 – Response filed **August 1, 2024**

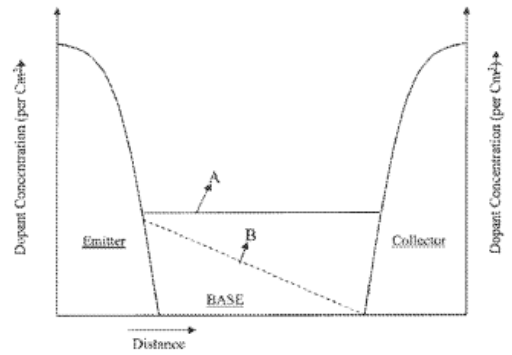


Figure 1 Prior Art

EX1058 (-00263, -00264), EX1065 (-00265), EX1056 (-00266), 12;
EX1059 (-00263, -00264), EX1066 (-00265), EX1057 (-00266), 5

"'relative slope' [] means nothing more than the fact that one-side is relatively lower than the other side."

EX1058 (-00263, -00264), EX1065 (-00265), EX1056 (-00266), 12;
EX1059 (-00263, -00264), EX1066 (-00265), EX1057 (-00266), 5

Reply, Paper 38 (-00263), 4-5; Reply, Paper 39 (-00264), 4-5;
Reply, Paper 39 (-00265), 4-5; Reply, Paper 41 (-00266), 4-5.

No district court said "to aid carrier movement" means "to cause movement"

Patent Owner misquotes the district court orders:

"The Western District of Texas unequivocally stated, 'a graded concentration…that is [not 'sufficiently graded'] will not aid movement.'" (Alterations by Patent Owner)

POR, Paper 31 (-00263), 10; POR, Paper 32 (-00264), 10;
POR, Paper 32 (-00265), 10; POR, Paper 32 (-00266), 10.

This partial quote is from indefiniteness ruling on "graded concentration":

> "The Court concludes that a person of skill would understand that the graded concentration has to be sufficiently graded to result in a 'static unidirectional electric drift field to aid the movement of minority carriers.' This establishes a minimum graded concentration of dopants, *i.e.*, a graded concentration of dopants that is below this minimum will not aid in the movement of minority carriers **and thus is not a graded concentration**."

EX2080, 39-40; *see also* 32-41
Reply, Paper 38 (-00263), 3-7; Reply, Paper 39 (-00264), 3-7;
Reply, Paper 39 (-00265), 2-7; Reply, Paper 41 (-00266), 2-7

No district court said "to aid carrier movement" means "to cause movement"

Patent Owner told the WDTX court that the only requirement for a graded dopant concentration to aid carrier movement is to be non-uniform:

> "The claims themselves specify that the graded dopants generate a 'first static unidirectional electric field' that 'aids the movement of minority carriers.' **In order for the graded dopants to do this they must change or vary (as opposed to being uniform)**."

> "Anyone that has taken high school math knows that 'slope' measures how much the line changes. **If there is zero slope, the line is flat. On the other hand, if there is slope, the line goes up or down (i.e., it varies or changes)**."

EX1061 (-00263, -00264)/EX1068 (-00265)/EX1059 (-00266) (*Greenthread's Surreply Claim Construction Brief, Greenthread, LLC v. Cirrus Logic, Inc.*), 17-18 (emphasis added)

Reply, Paper 38 (-00263), 3-7;
Reply, Paper 39 (-00264), 3-7;
Reply, Paper 39 (-00265), 2-7;
Reply, Paper 41 (-00266), 2-7.

No district court said "to aid carrier movement" means "to cause movement"

The EDTX court did not address "to aid carrier movement." The court only addressed whether dopant concentration must be *only increasing* or *only decreasing*

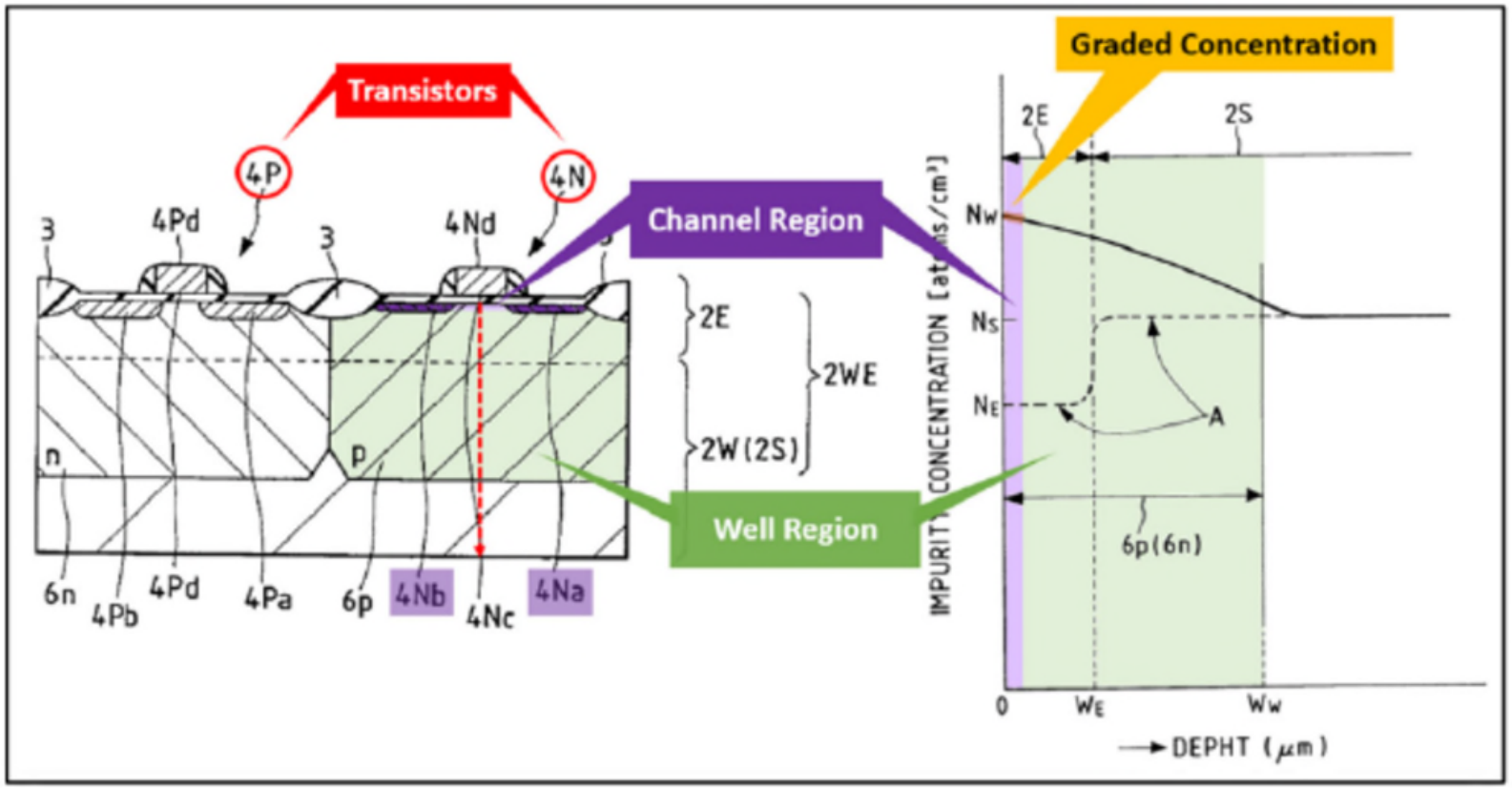
"Taken in context, that **the direction of the electrical field and the carrier movement 'depends solely on the slope of the graded concentration of dopant'** does not mandate that the slope must be only increasing or only decreasing to maintain a unidirectional drift field. For example, the slope has 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."

EX2082 (*Claim Construction Memorandum and Order, Greenthread v. Samsung Electronics Co., Ltd. et al.*), 13-15

Reply, Paper 38 (-00263), 3-7;
Reply, Paper 39 (-00264), 3-7;
Reply, Paper 39 (-00265), 2-7;
Reply, Paper 41 (-00266), 2-7.

Kawagoe's graded dopant concentration actually moves carriers

Even under PO's narrow construction requiring actual movement (and without relying on inherency), Kawagoe would still meet the "to aid carrier movement" limitation.



Kawagoe, EX1007, Figs. 17, 23 (annotated)

"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, EX1007, 16:2-11

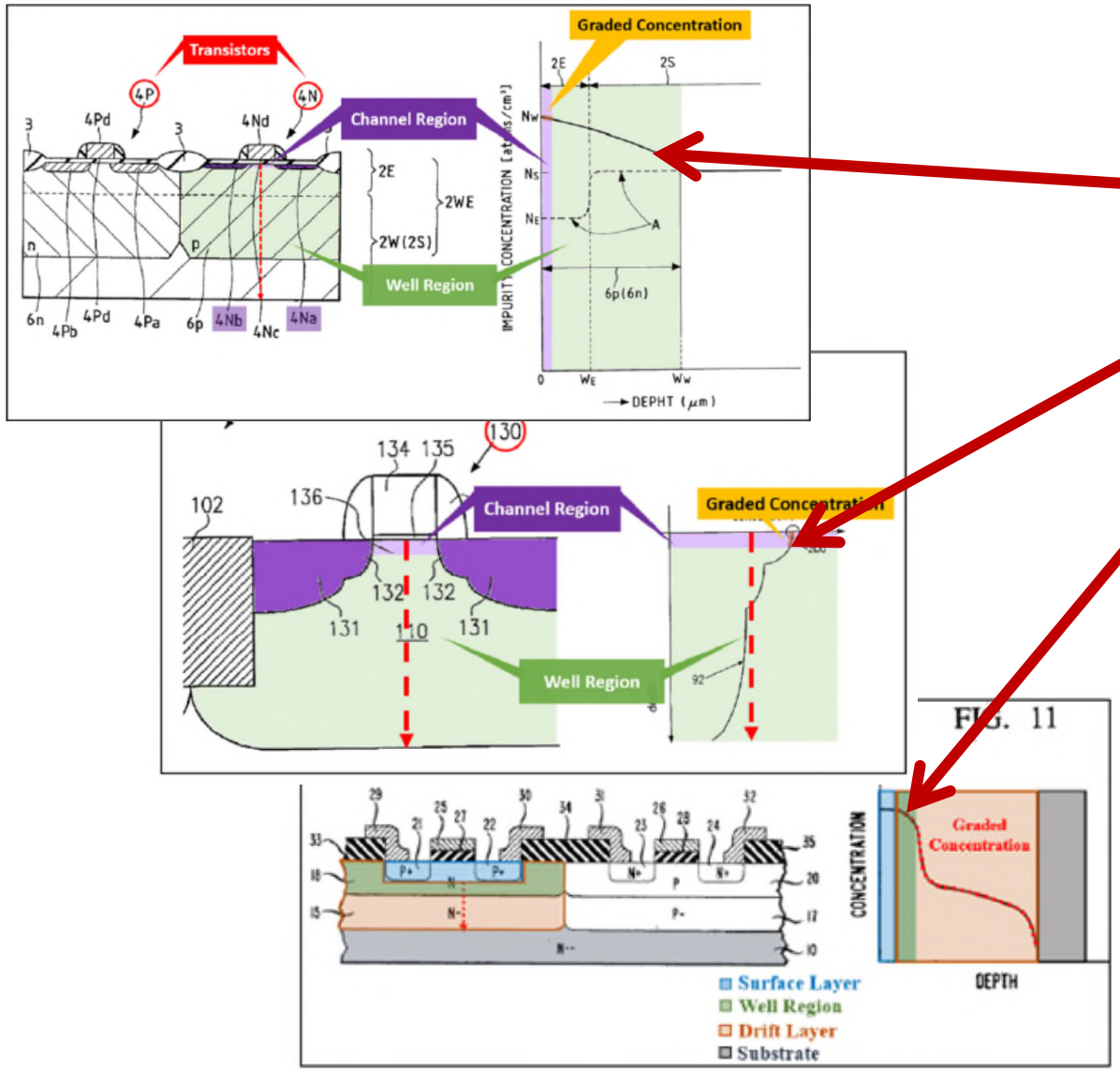
Reply, Paper 38 (-00263), 3-7;
Reply, Paper 39 (-00264), 3-7;
Reply, Paper 39 (-00265), 2-7;
Reply, Paper 41 (-00266), 2-7.

THE "AID CARRIER MOVEMENT" LIMITATIONS ARE OBVIOUS

04

BAKER BOTTS

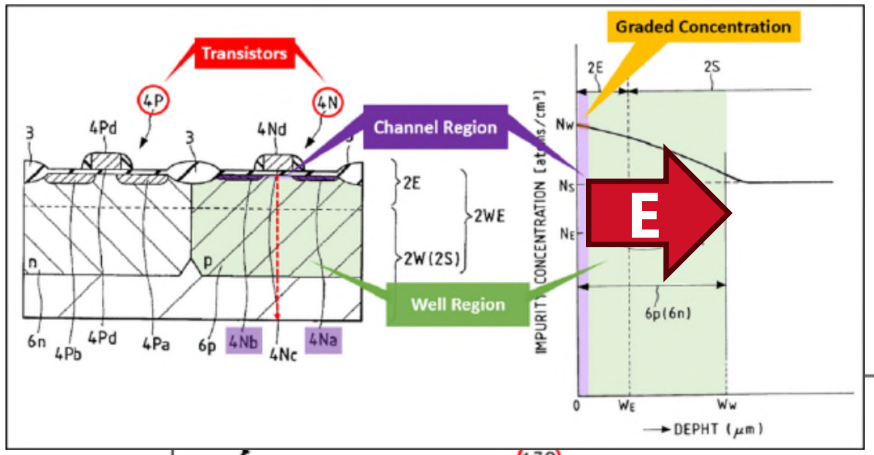
The prior art gradients aid carrier movement

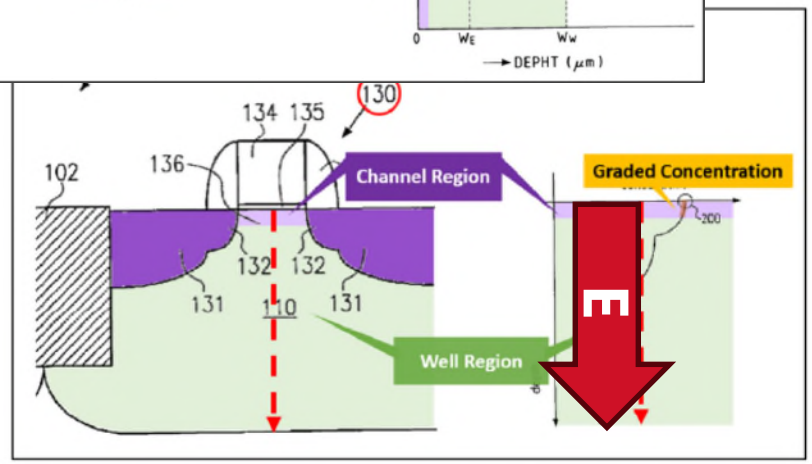


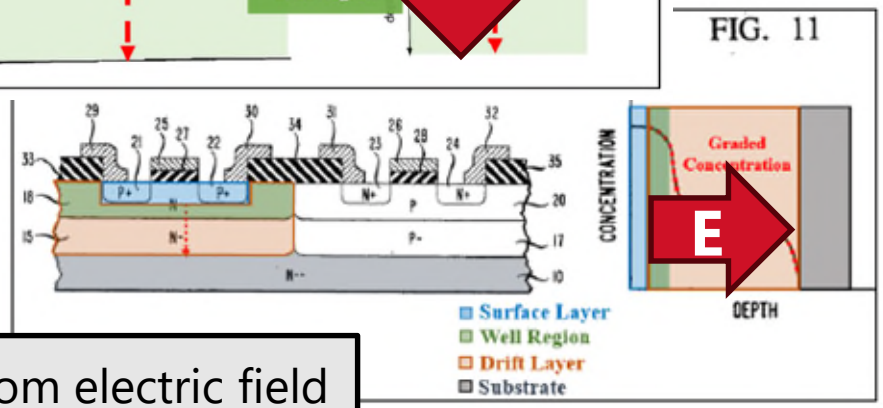
- No dispute that there are graded dopant concentrations in Kawagoe, Wieczorek, and Payne
- No dispute that graded dopant concentrations generate electric fields
- No dispute that electric fields provide a force in the same direction of field

Reply, Paper 38 (-00263), 8-18;
Reply, Paper 39 (-00264), 8-18;
Reply, Paper 39 (-00265), 8-17;
Reply, Paper 41 (-00266), 8-17.

No dispute that graded concentrations generate electric fields







EX1056 (-00263, -00264)/
EX1063 (-00265)/
EX1054 (-00266),
83:24-84:23

Q. And how does the -- how does a graded dopant concentration relate to the idea of carrier drift?

A. There's really two things that go on, but one is **the gradient of a charge causes electrical -- electrical field**...The gradient is just the first derivative. It's a differential operator. So it's the slope, literally. **So the slope of the charge densities are proportional to the field that's given off. So this charge gradient produces a field which will act upon other charge particles**.

Reply, Paper 38 (-00263), 15-16;
Reply, Paper 39 (-00264), 15-16;
Reply, Paper 39 (-00265), 14-15;
Reply, Paper 41 (-00266), 14-15.

E = Force from electric field

No dispute that electric fields "provide a force … aiding movement in the direction of the force"

EX2058, 165:17-166:6

Q. And you relied on that logic, […] if slope is downward, then carriers will move; is that basically the logic that you applied? […]

A. No. As I've said, if […] you have a downward-sloping graded dopant concentration, we know from **the basic physics** that that will lead to an electric field and that will create a force, which tends to move the carriers.

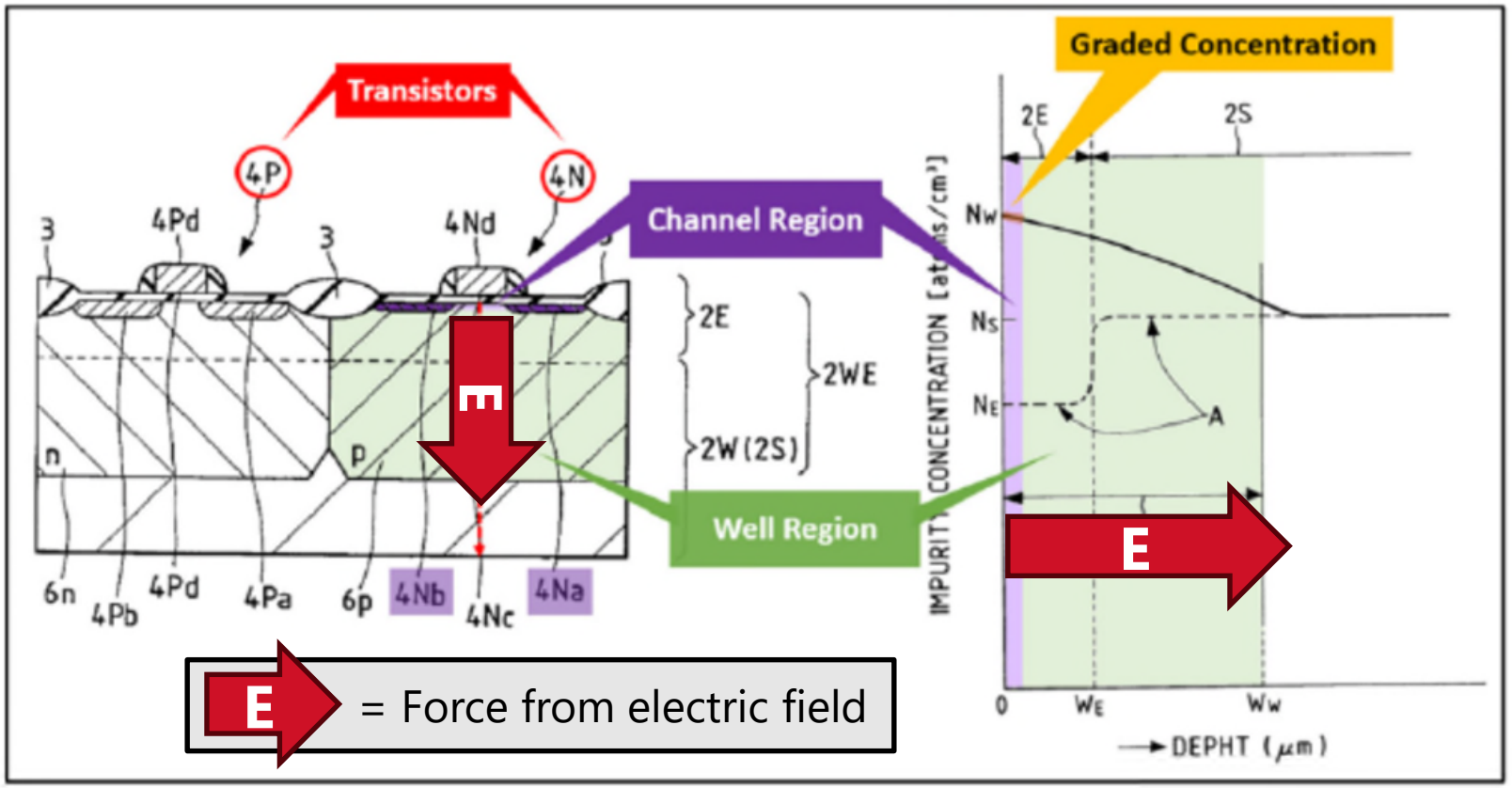
EX1056 (-00263, -00264)/ EX1063 (-00265)/ EX1054 (-00266), 108:15-23

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**.

Reply, Paper 38 (-00263), 8-9; Reply, Paper 39 (-00264), 8-9; Reply, Paper 39 (-00265), 8-9; Reply, Paper 41 (-00266), 8-9.

There is an electric field in Kawagoe pushing electrons downward



Kawagoe, EX1007, Figs. 17, 23; 15:26-36

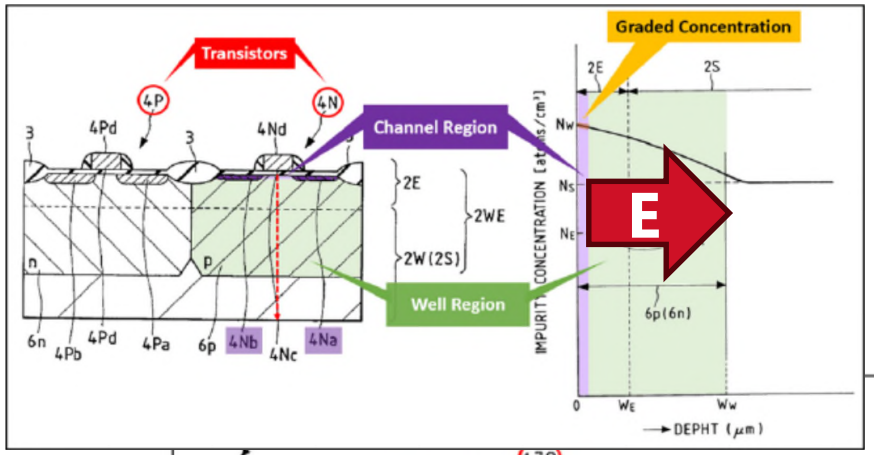
Reply, Paper 38 (-00263), 16;
Reply, Paper 39 (-00264), 16;
Reply, Paper 39 (-00265), 14-15;
Reply, Paper 41 (-00266), 15.

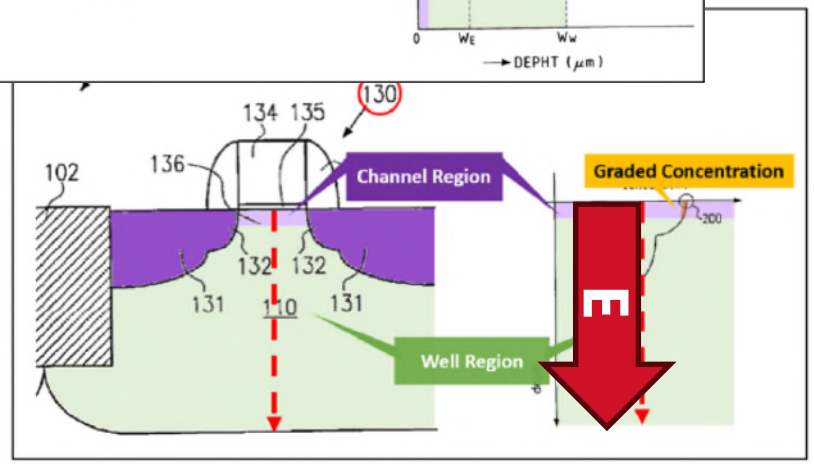
Q. So throughout the depth in Kawagoe from 0 past WW, there is an electric field pushing electrons downward?

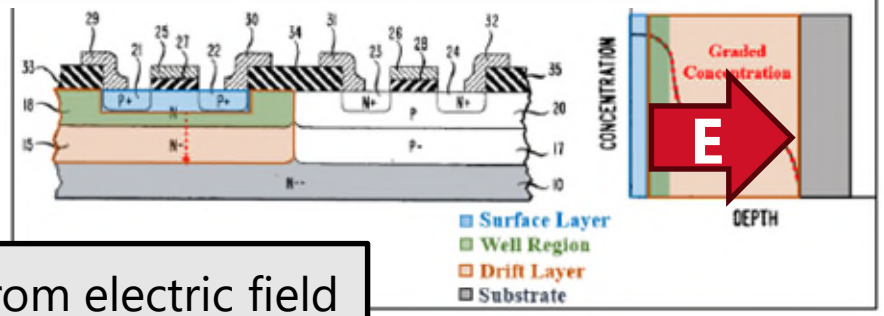
A. **Yes**, there's that field shown in Figure 17.

EX1056 (-00263, -00264)/
EX1063 (-00265)/
EX1054 (-00266),
113:12-16

It should be undisputed that these forces "aid carrier movement"







Petitioner's Expert

"[W]e know from **the basic physics** that that will lead to an electric field and that will create a force, which tends to move the carriers."

EX2058, 165:17-166:6

PO's Expert

"[A] field will provide a force in a direction aiding -- direction -- aiding movement in the direction of the force. **That's just basic physics**."

EX1056 (-00263, -00264)/
EX1063 (-00265)/
EX1054 (-00266),
108:15-23

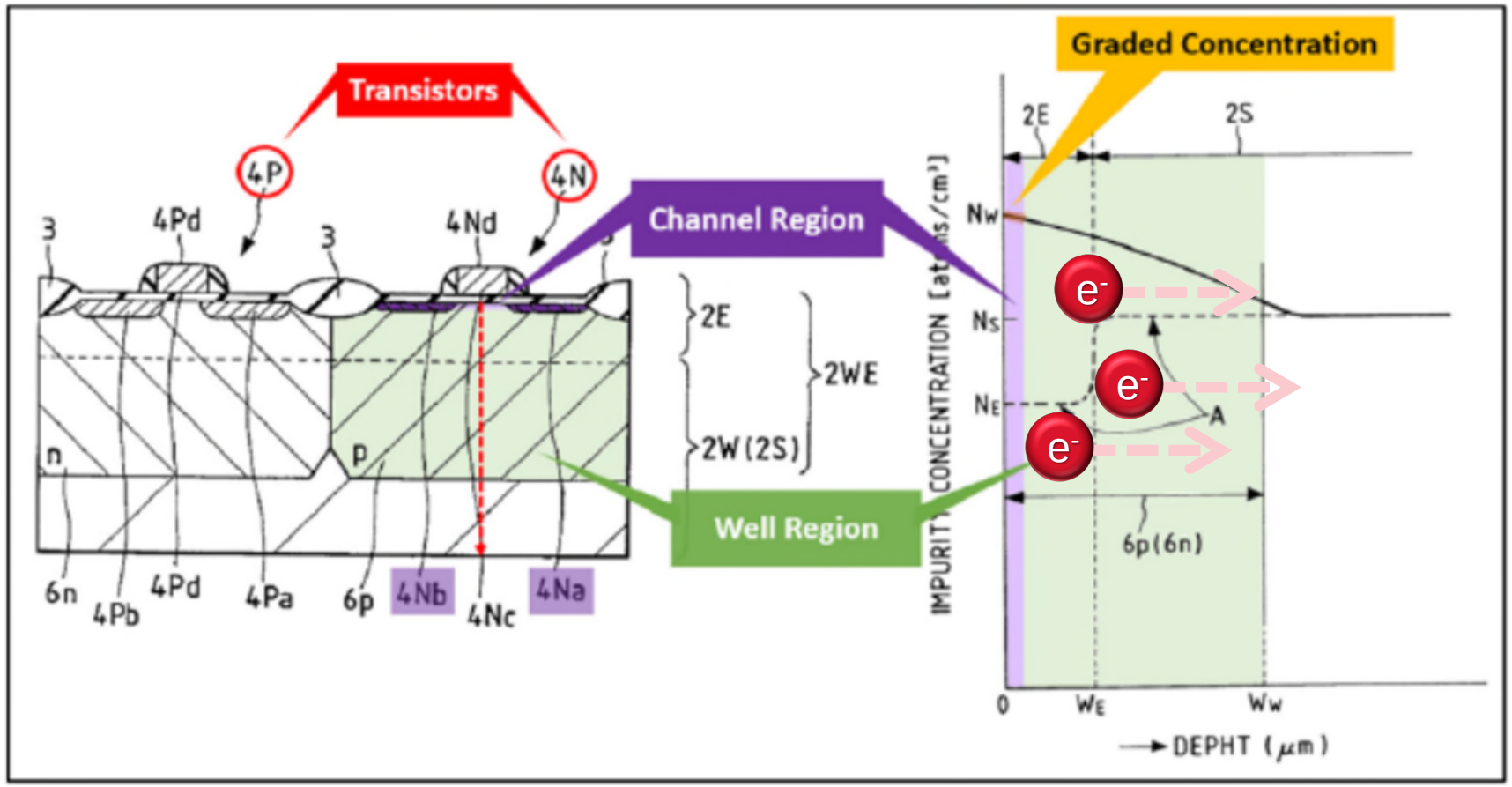
Reply, Paper 38 (-00263), 8-9; Reply, Paper 39 (-00264), 8-9;
Reply, Paper 39 (-00265), 8-9; Reply, Paper 41 (-00266), 8-9.

E = Force from electric field

It should be undisputed that these forces "aid carrier movement"

Kawagoe: "electrons produced by the α-ray are **attracted to the substrate body 2S by that concentration gradient** and prevented from entering the p-well"

Kawagoe, EX1007, 16:2-11, Figs. 17, 23



Kawagoe, EX1007, Figs. 17, 23 (annotated)

Reply, Paper 38 (-00263), 9, 14-16;
Reply, Paper 39 (-00264), 9, 14-16;
Reply, Paper 39 (-00265), 9, 13-15;
Reply, Paper 41 (-00266), 9, 13-15.

Patent Owner's flawed arguments about "aid carrier movement"

What Patent Owner says:	Why this argument fails:
• External hypothetical forces may overcome internal electric field from gradient	• *The prior art does not have such external forces*
• Kawagoe does not address carriers in the active region	• *The same electric field in Kawagoe extends through active region and well*
• The Sakai and Kawagoe combination does not address minority carriers	• *Electrons are minority carriers and Kawagoe's Figure 17 is not limited to NMOS*
• Wieczorek does not disclose a graded dopant concentration in the active region	• *The active region extends beyond region 200 in Wieczorek*

Reply, Paper 38 (-00263), 3-16;
Reply, Paper 39 (-00264), 3-16;
Reply, Paper 39 (-00265), 2-15;
Reply, Paper 41 (-00266), 2-15.

THE PRIOR ART DOES NOT HAVE EXTERNAL FORCES

BAKER BOTTS

External forces are not applied to prior art devices

Q. So you mentioned that if there aren't other fields present and the carrier was introduced into that field, you'll move the carrier. Where could other fields come from?

A. Externally applied voltages from the circuit, if the structure's in a circuit, things like that. Or I suppose some environmental effect. I don't know.

Q. Is anything like that described in the prior art reference that you are relying on, Kawagoe?

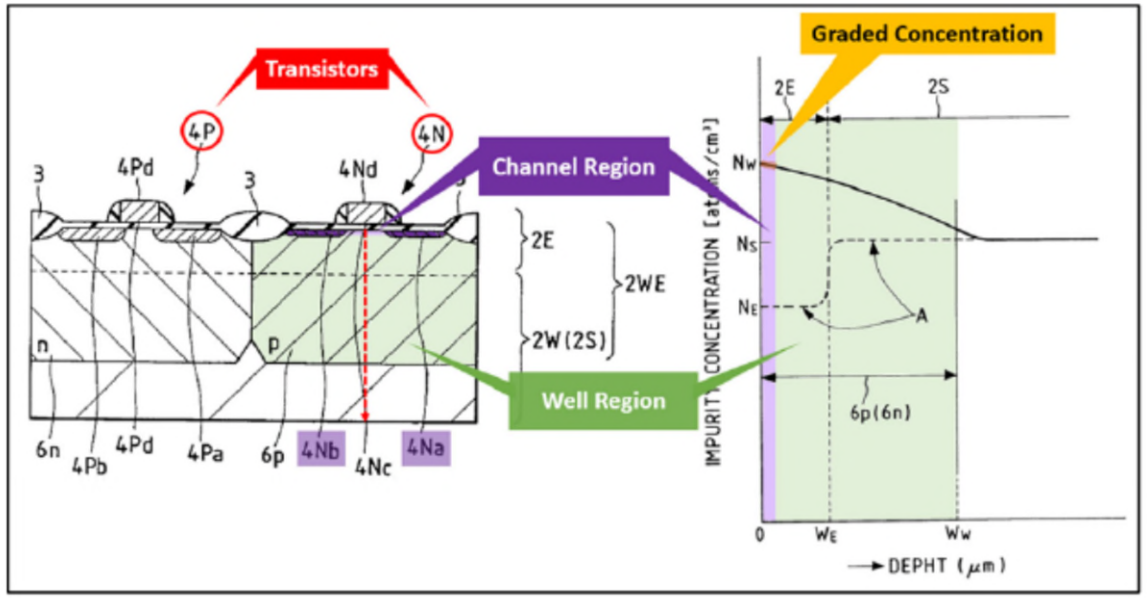
A. As I said, **none of that is** -- all these discussions are about we built this device and we put in a gradient to create this electric field, which tends to move carriers down into the substrate. And we don't need to get into the rest of it. [...]

EX2058, 132:6–22

Reply, Paper 38 (-00263), 4-10, 14-18; Reply, Paper 39 (-00264), 4-10, 14-18; Reply, Paper 39 (-00265), 4-10, 13-17; Reply, Paper 41 (-00266), 4-10, 13-17.

Electrons prevented from entering p-well because there are no external forces stronger than the concentration gradient

Kawagoe: "electrons produced by the α-ray are attracted to the substrate body 2S by that concentration gradient **and prevented from entering the p-well**"



Kawagoe, EX1007, 16:2-11, Figs. 17, 23

Institution Decision, Paper 21 (IPR2024-00263), 19:

"Indeed, the fact that carriers are prevented from entering the active regions in Kawagoe, such as p-well 6p, appears to be **strong evidence that the downward facing electric field is not negated** or reversed by other fields or forces."

Reply, Paper 38 (-00263), 10; Reply, Paper 39 (-00264), 10; Reply, Paper 39 (-00265), 10; Reply, Paper 41 (-00266), 10.

KAWAGOE HAS GRADIENT AND CARRIERS IN THE ACTIVE REGION

BAKER BOTTS

Carriers are present throughout Kawagoe's device

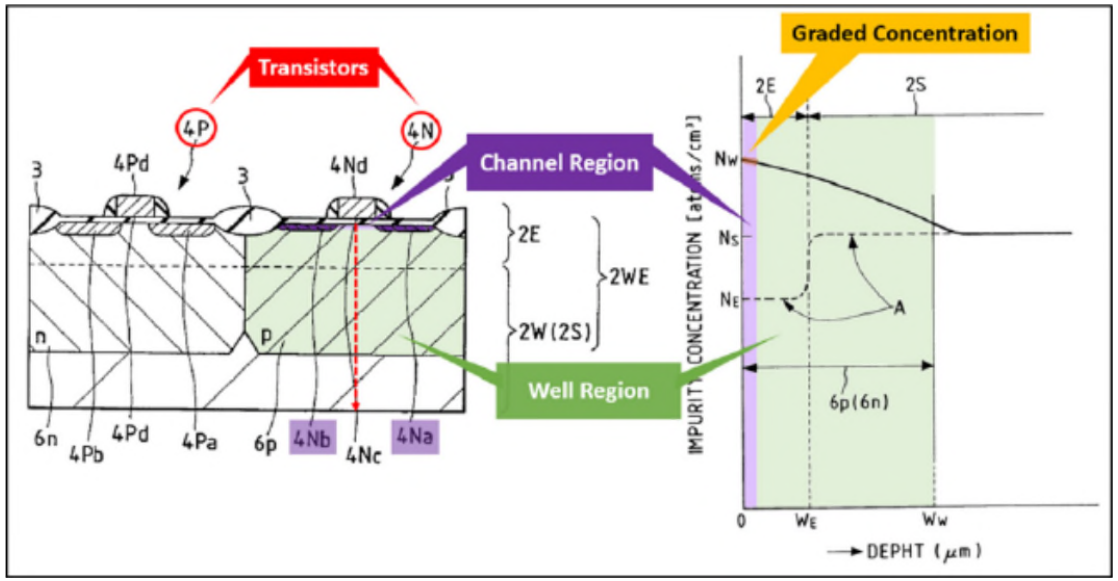
EX1056 (-00263, -00264)/
EX1063 (-00265)/
EX1054 (-00266),
118:9-13, 120:11-17

Q. Okay. Electrons from a variety of sources would be found throughout the Kawagoe device, right?

A. There are other electrons generated from other things, yes.

Q. For the device shown in Figure 17 of Kawagoe, along the depth 0 to WW, is there any region where there would not be electrons?

A. This is a p-well, so it is substantially holes. There are electrons as minority species.



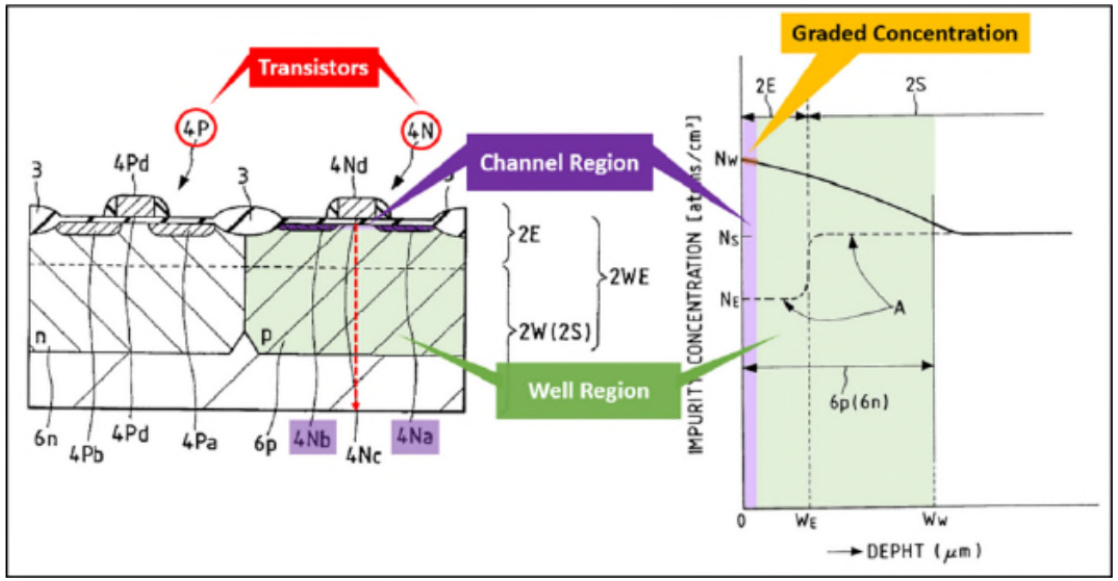
Kawagoe, EX1007, 16:2-11, Figs. 17, 23

Reply, Paper 38 (-00263), 10-14;
Reply, Paper 39 (-00264), 10-14;
Reply, Paper 39 (-00265), 10-13;
Reply, Paper 41 (-00266), 10-13.

Patent Owner says it would be "so silly" to dispute that Kawagoe has carriers in the active region

"According to Petitioner, Greenthread 'suggest[s] that Kawagoe does not have carriers in the active region.'

Greenthread never said anything so silly."

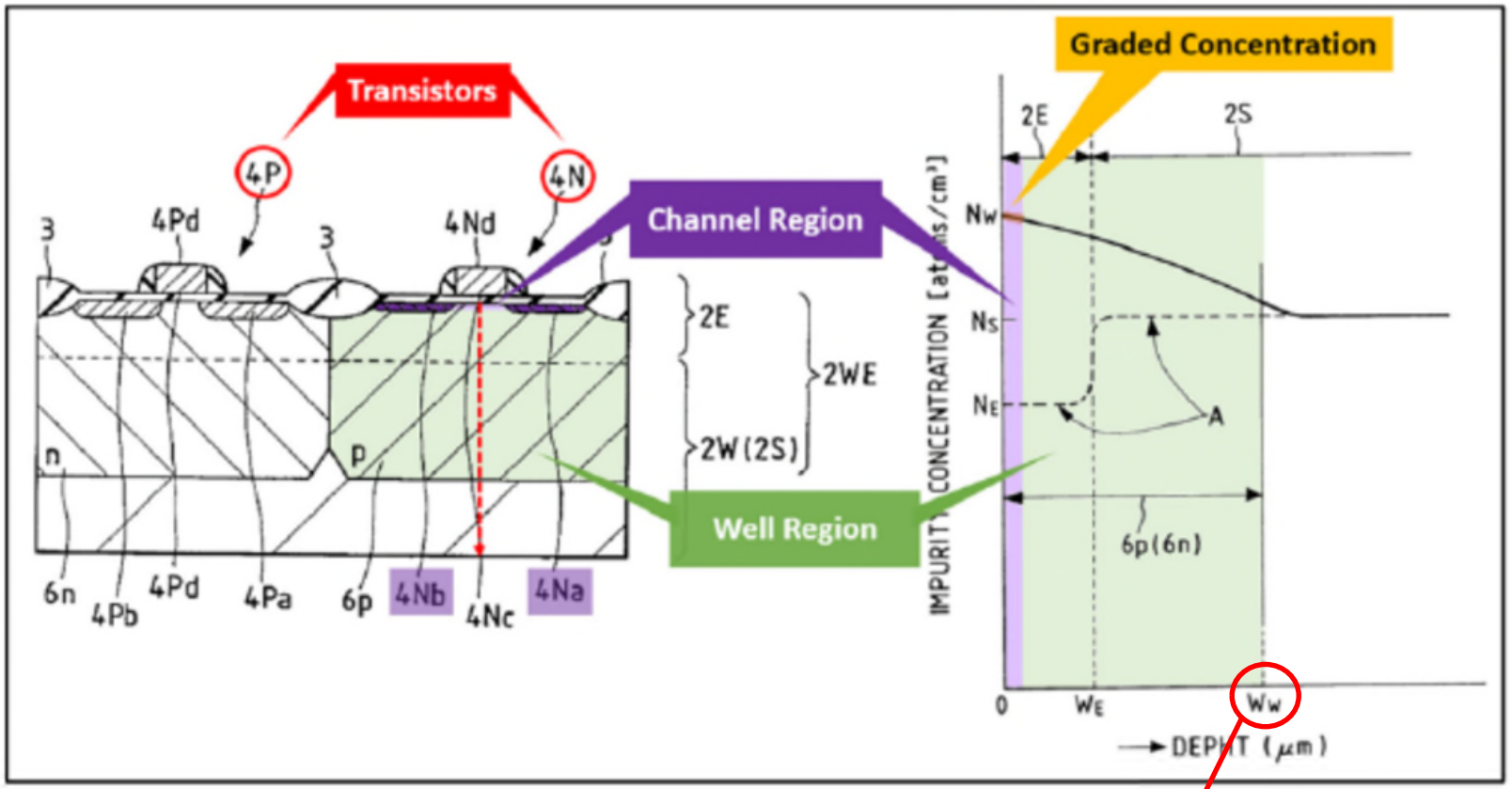


Kawagoe, EX1007, 16:2-11, Figs. 17, 23

PO Preliminary Sur-Reply, Paper 18 (-00263), 6;
PO Preliminary Sur-Reply, Paper 18 (-00264), 6;
PO Preliminary Sur-Reply, Paper 19 (-00265), 6;
PO Preliminary Sur-Reply, Paper 18 (-00266), 6.

Reply, Paper 38 (-00263), 10-14;
Reply, Paper 39 (-00264), 10-14;
Reply, Paper 39 (-00265), 10-13;
Reply, Paper 41 (-00266), 10-13.

Kawagoe's graded dopant concentration is in the active region



Kawagoe, EX1007, Figs. 17, 23; 15:26-36

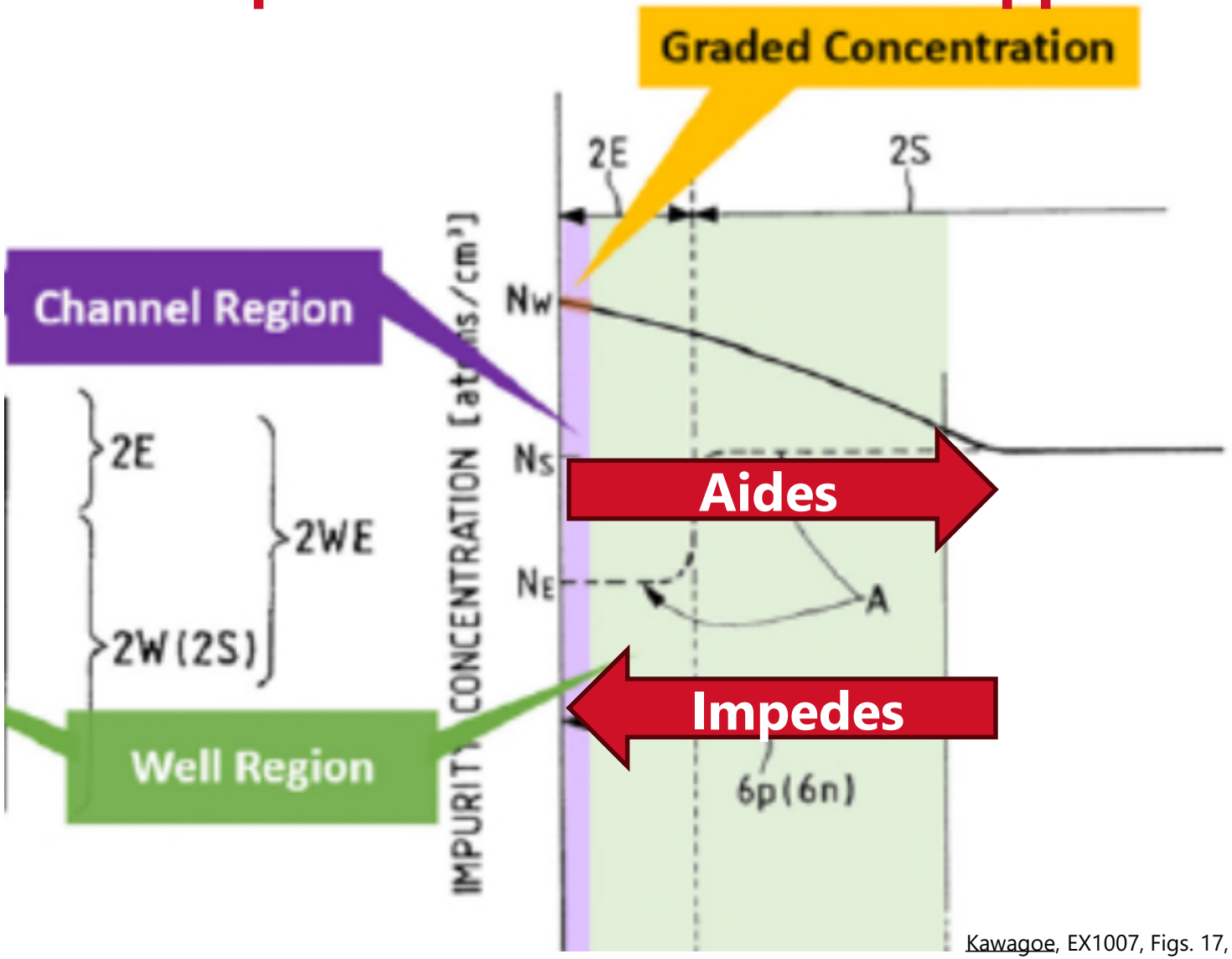
Reply, Paper 38 (-00263), 16;
Reply, Paper 39 (-00264), 16;
Reply, Paper 39 (-00265), 14-15;
Reply, Paper 41 (-00266), 15.

Q. So throughout the depth in Kawagoe from 0 past WW, there is an electric field pushing electrons downward?

A. **Yes**, there's that field shown in Figure 17.

EX1056 (-00263, -00264)/
EX1063 (-00265)/
EX1054 (-00266),
113:12-16

The electric field both aides electron movement one direction and impedes movement in the opposite direction



Kawagoe, EX1007, Figs. 17, 23

A. I'm not sure, beyond that, what there is to say, you know. **The field -- the force of the electric field and its direction provide -- aids movement in the direction of the field**.

Q. And it impedes movement in the opposite direction?

A. Yeah, **in -- the 180 degree opposite direction, yes, it will repel, and it pushes it away**.

EX1056 (-00263, -00264)/ EX1063 (-00265)/ EX1054 (-00266), 109:6-14

Reply, Paper 38 (-00263), 14-16; Reply, Paper 39 (-00264), 14-16; Reply, Paper 39 (-00265), 13-15; Reply, Paper 41 (-00266), 13-15.

Nishizawa disproves PO's argument about whether alpha ray strikes create electrons in the active region

EX1056 (-00263, -00264)/
EX1063 (-00265)/
EX1054 (-00266),
125:5-19

Q. Okay. So would you agree with me that the n+ regions 12 and 13 in Figure 35 correspond to an active region?

[…] A. I would say, generally, these look to be part of an active region, yes.

Q. And if you look at column 19, line 41, 42, this is just after the discussion you cited in your report, right?

A. Same column, same paragraph, I think, yes.

Q. And there's a sentence at line 41 that says, "In other words, **several ten thousand electrons will flow into the n+ type region 13**"[?]

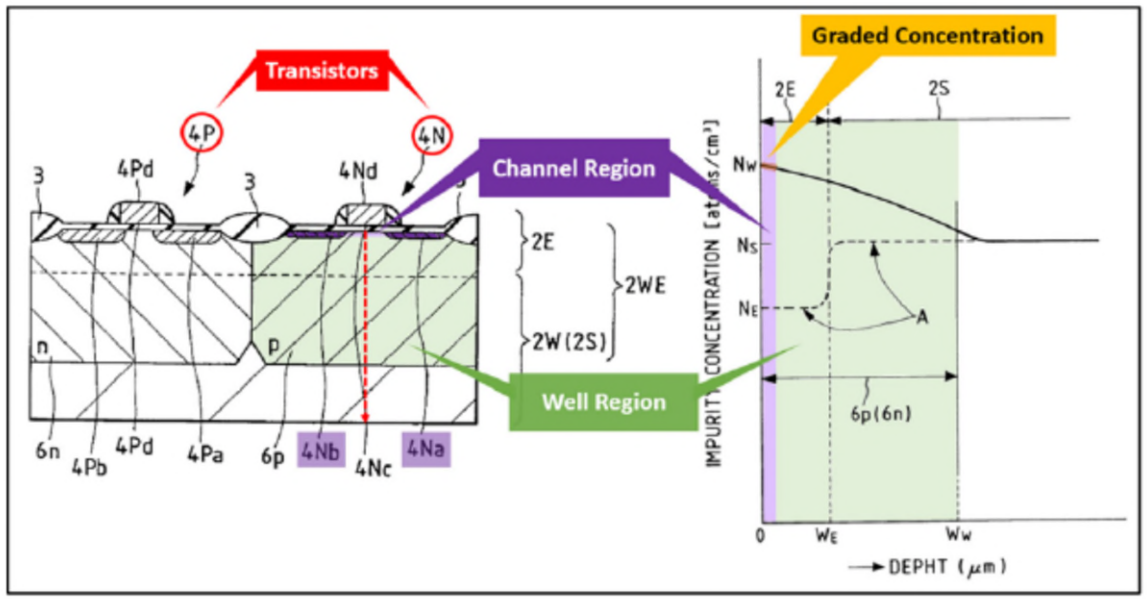
A. Yes.

Reply, Paper 38 (-00263), 12-14;
Reply, Paper 39 (-00264), 13-14;
Reply, Paper 39 (-00265), 12-13;
Reply, Paper 41 (-00266), 12-13.

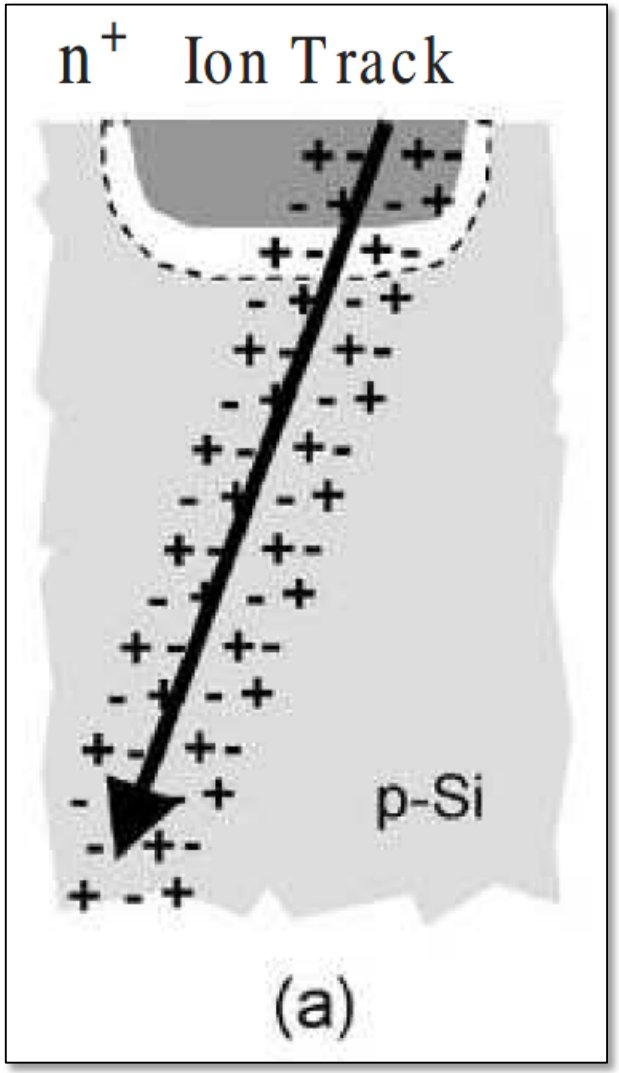
Nishizawa, EX2066, 19:41-42, Figs. 34-36;
EX1056 (-00263, -00264)/
EX1063 (-00265)/
EX1054 (-00266), 123:17-128:11

Petitioner is not proposing to modify Kawagoe in view of Wang

Petition (-00263) at 28: "Indeed, as discussed in Wang and as was well understood in the art, an α-ray generates a stream of millions of carriers (*e.g.*, electrons) that can cause single-event upset (SEU) soft errors."



Kawagoe, EX1007, 16:2-11, Figs. 17, 23



Wang, EX1009 (-00263, -00264), EX1013 (-00265, -00266), 431, Fig. 2(a)

Reply, Paper 38 (-00263), 13-14;
Reply, Paper 39 (-00264), 13-14;
Reply, Paper 39 (-00265), 12-13;
Reply, Paper 41 (-00266), 13.

GRADED DOPANT CONCENTRATIONS ACT ON MINORITY CARRIER

BAKER BOTTS

Petitioner's expert explained that the graded dopant concentrations push minority carriers downward

Petitioner's Expert
(-00265) EX1003, ¶¶ 109-110
(-00266) EX1003, ¶¶ 105-106

109. The figures of this declaration depict electric fields in N-wells, *e.g.*, Payne's nested N-wells 15/18 or Sakai's nested N-wells 3/5. §§ X.A.1.g, X.B.1.f-g, X.B.2, X.D.1. The electric fields would be pointing in the opposite direction in Payne's and Sakai's nested P-wells.

110. In both cases, these electric fields result from the downward-sloping graded concentrations in Payne's and Sakai's N-wells and P-wells and aid the movement of minority carriers (holes in N-wells, electrons in P-wells) downward to the substrate. §§ X.A.1.g, X.B.1.f-g, X.B.2, X.D.1.

Petition, Paper 1 (-00265), 32
Petition, Paper 1 (-00266), 31-32

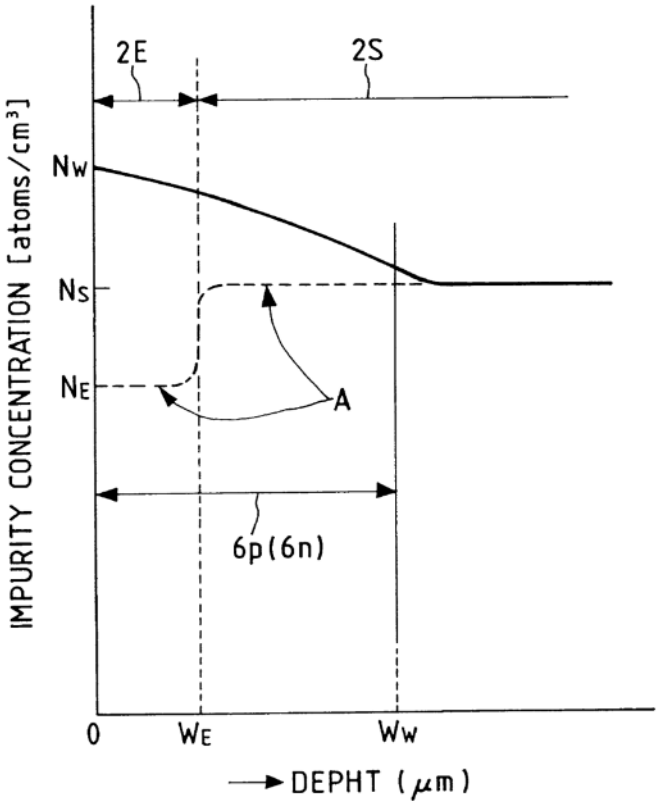
Patent Owner's expert identified electrons as the minority species in Kawagoe's Figure 17

EX1056 (-00263, -00264)/
EX1063 (-00265)/
EX1054 (-00266),
120:11-17.

Q. For the device shown in Figure 17 of Kawagoe, along the depth 0 to WW, is there any region where there would not be electrons?

[...] [A]: This is a p-well, so it is substantially holes. **There are electrons as minority species.**

FIG. 17



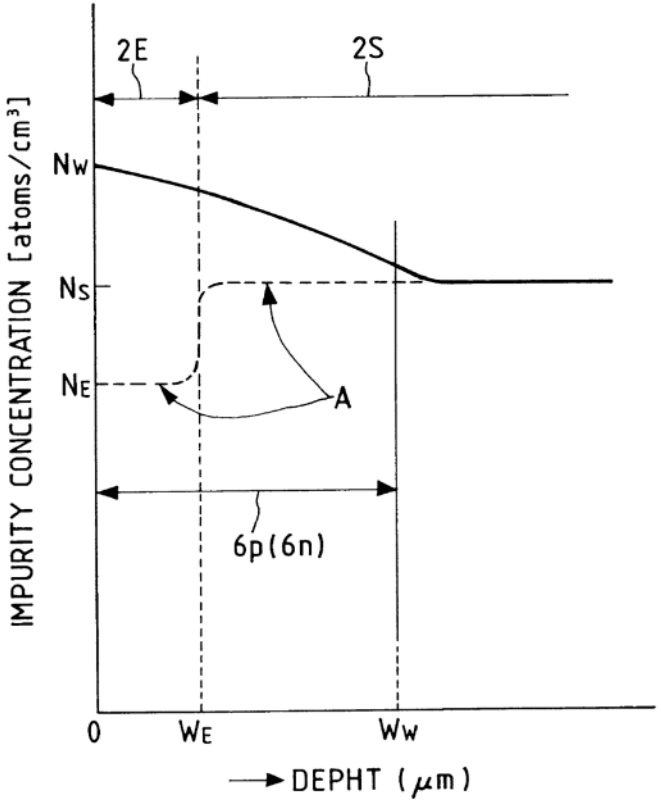
Kawagoe, EX1007, Fig. 17
Petition, Paper 1 (-00265), 53-70;
Petition, Paper 1 (-00266), 65-74;
PO Sur-Reply, Paper 44 (-00265), 15-19;
Paper 45 (-00266), 15-19.

Patent Owner's expert identified electrons as the minority species in Kawagoe's Figure 17

EX2064 (-00265, -00266), ¶55.

"…The SEU event is described as creating **electrons, which are the minority carriers in a p-well, but not in an n-well**…."

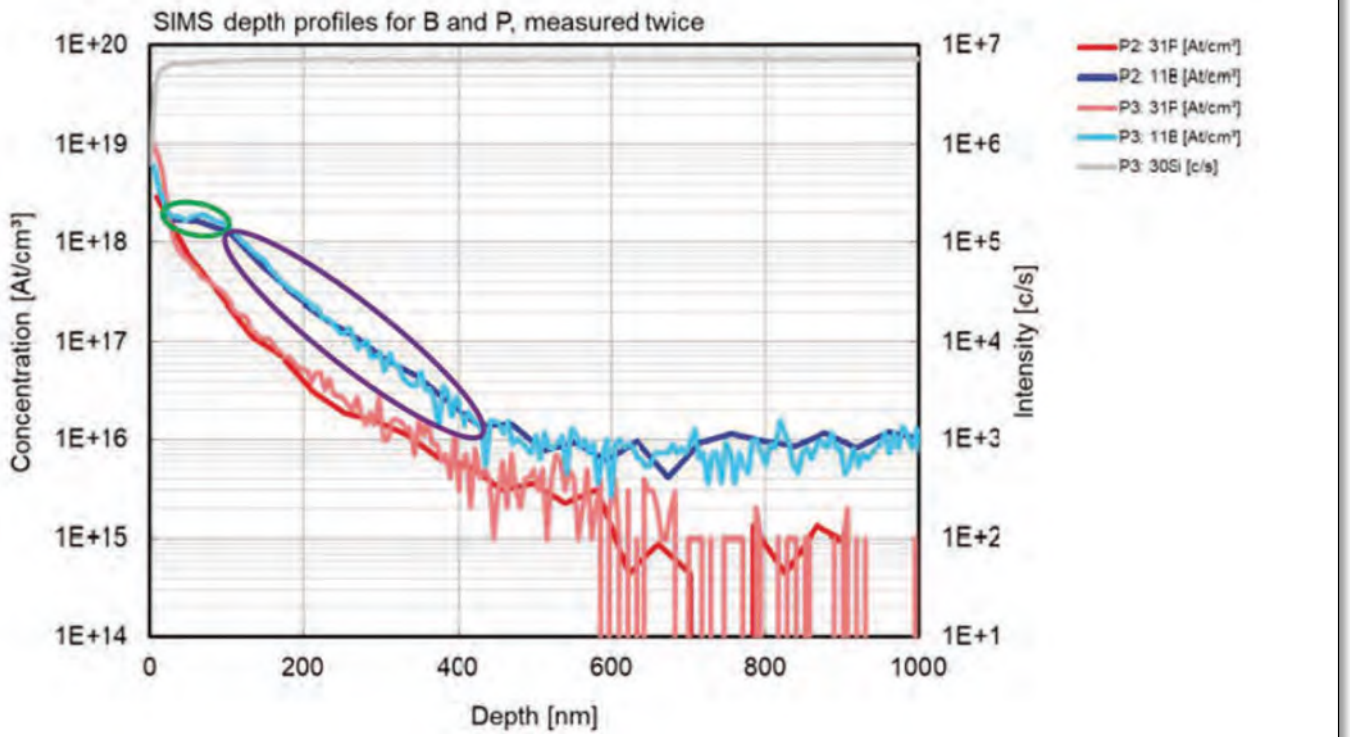
FIG. 17



Kawagoe, EX1007, Fig. 17
Petition, Paper 1 (-00265), 53-70;
Petition, Paper 1 (-00266), 65-74;
PO Sur-Reply, Paper 44 (-00265), 15-19;
Paper 45 (-00266), 15-19.

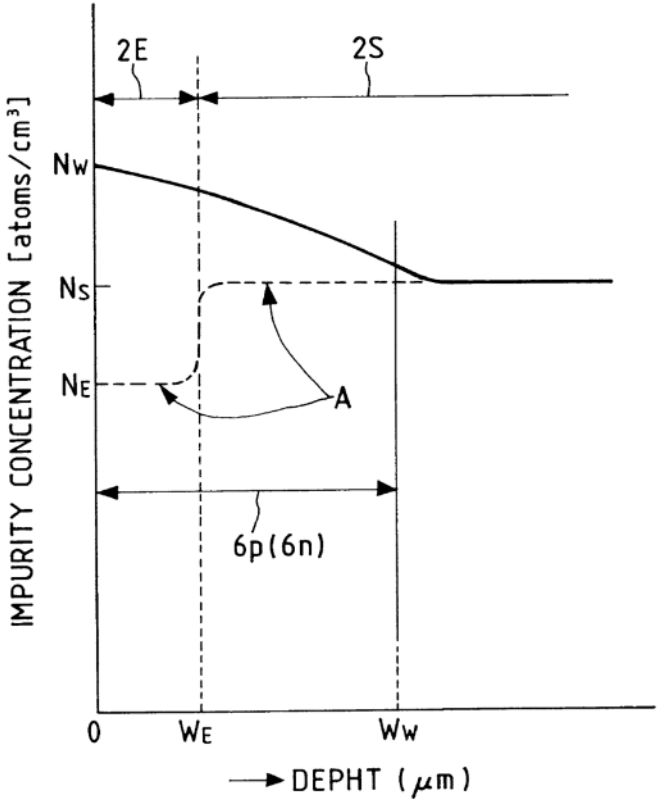
Patent Owner itself argued decreasing dopant concentrations in a p-well aids movement of minority carriers, just like Kawagoe

regions at the surface layer are p-wells, upon information and belief. The p-wells have a depth of at least 139 nm, upon information and belief and based on the SEM image. This reflects one measurement in the SEM figure, but the well extends deeper, as shown by the light regions extending downward beyond 139 nm. As annotated by the green oval in the SIMS graph below (*see* Exhibit A-1, Claim 1, Elements 1-2 for details regarding the SIMS analysis), the well region has a graded concentration of dopants (e.g., boron-11), which is different than the graded concentration of dopants shown with a purple oval below.



EX2048 (-00265, -00266), p.101; *see also* 102 ('195 patent claim 1), 105-106 ('502 patent claim 7).

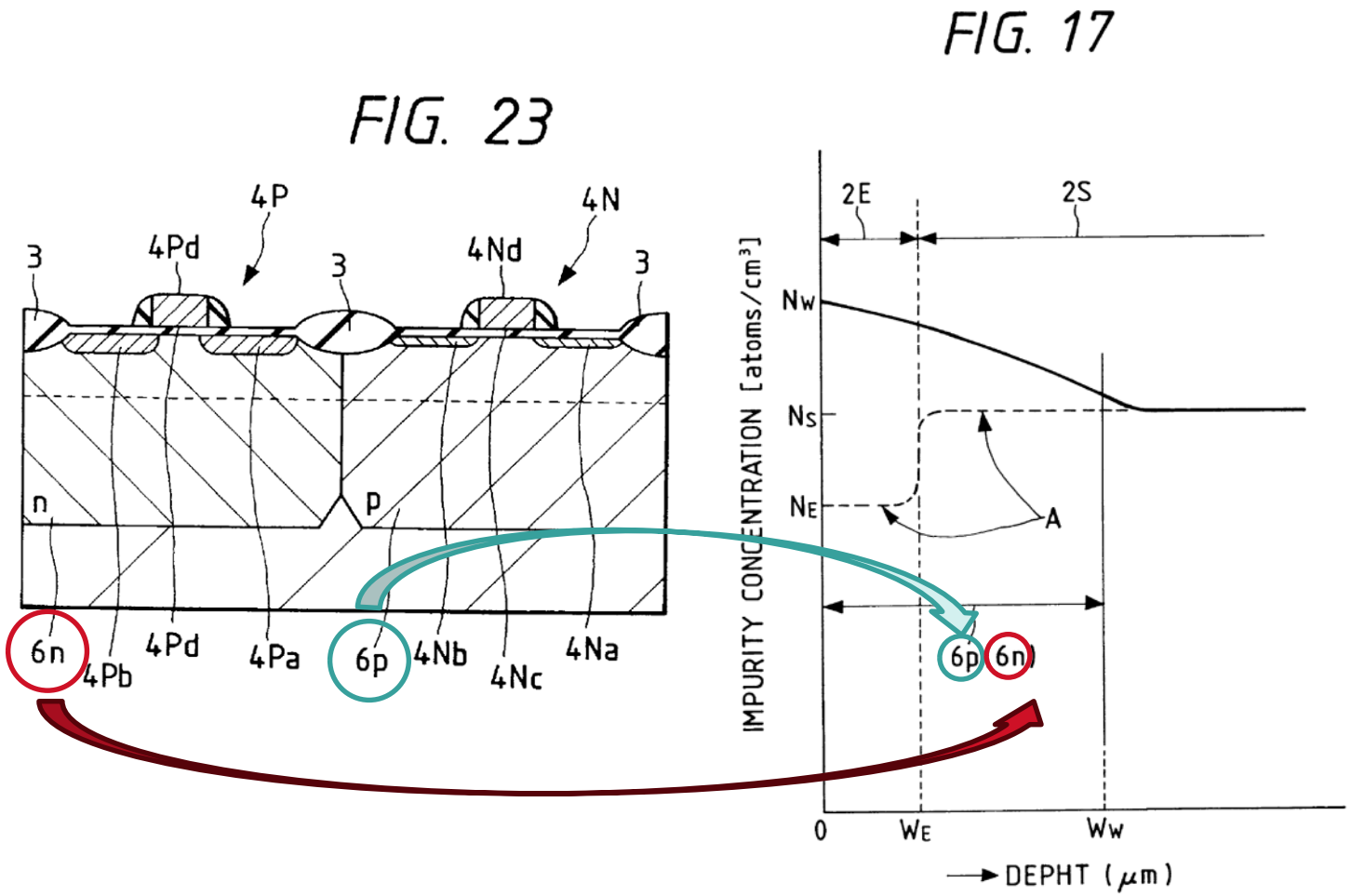
FIG. 17



Kawagoe, EX1007, Fig. 17

Petition, Paper 1 (-00265), 53-70;
Petition, Paper 1 (-00266), 65-74;
PO Sur-Reply, Paper 44 (-00265), 15-19;
Paper 45 (-00266), 15-19.

Kawagoe's Figure 17 applies to the graded dopant concentrations of both the p-well and n-well



Kawagoe, EX1007, Figs. 17, 23 (annotated)

"Incidentally, in the present embodiment 4, the aforementioned p-well 6*p* and n-well 6*n* are formed to extend from the surface of the epitaxial layer 2E to the upper portion of the semiconductor substrate body 2S, as shown in FIGS. 16 and 17, and the p-well 6*p* and n-well 6*n* 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"

Kawagoe, EX1007, 15:62-16:2

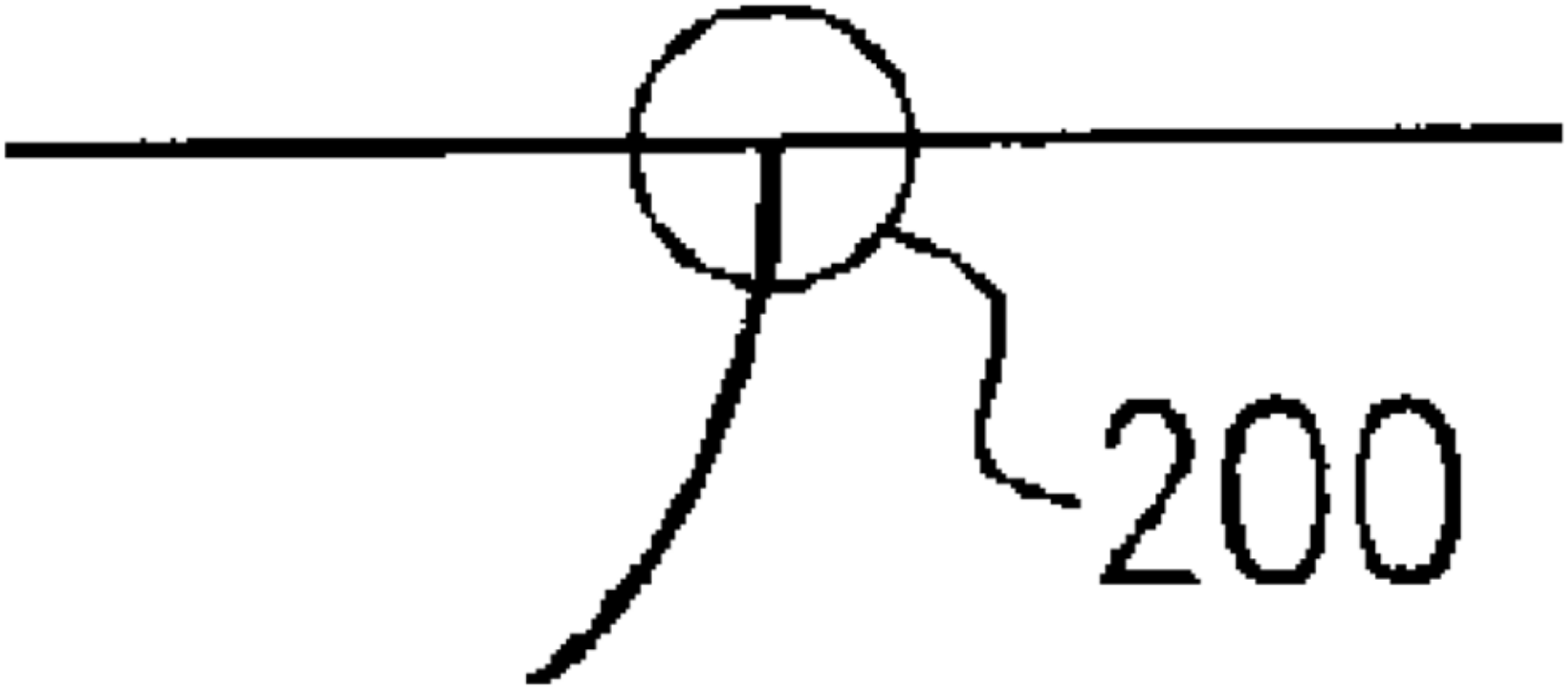
Petition, Paper 1 (-00265), 53-70;
Petition, Paper 1 (-00266), 65-74;
PO Sur-Reply, Paper 44 (-00265), 15-19;
Paper 45 (-00266), 15-19.

WIECZOREK'S ACTIVE REGION HAS A GRADED DOPANT CONCENTRATION

BAKER BOTTS

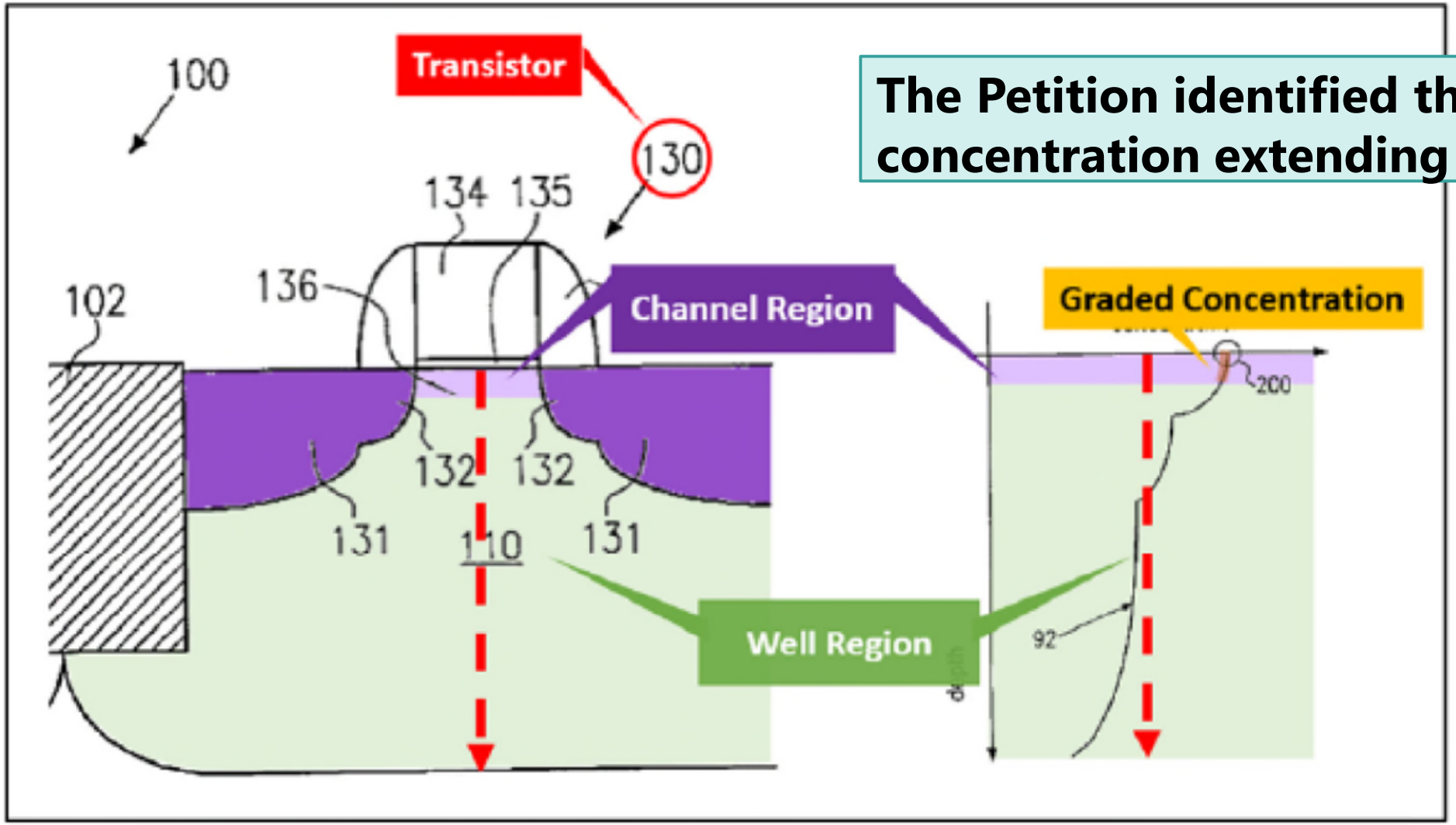
Wieczorek's graded dopant concentration is in the active region

Region 200 is not uniform



Reply, Paper 38 (-00263), 20
Reply, Paper 39 (-00264), 20.

Wieczorek's graded dopant concentration is in the active region



The Petition identified the graded dopant concentration extending beyond 200

Reply, Paper 38 (-00263), 20-21;
Reply, Paper 39 (-00264), 20-21;
Petition, Paper 1 (-00263), 51-53;
Petition, Paper 1 (-00264), 51-53.

Wieczorek's graded dopant concentration is in the active region

The positions of the source/drain (141), and elements 124 and 123 demonstrate the relative positions of the active region in 2

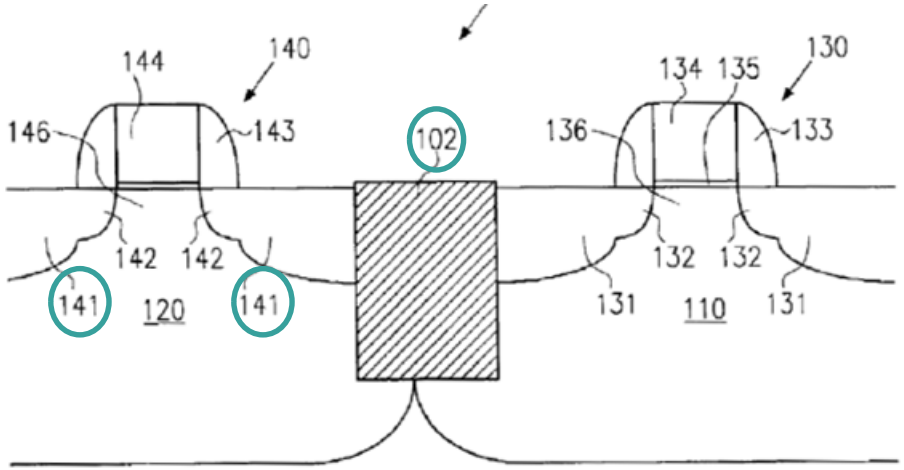


FIG.1b
(Prior Art)

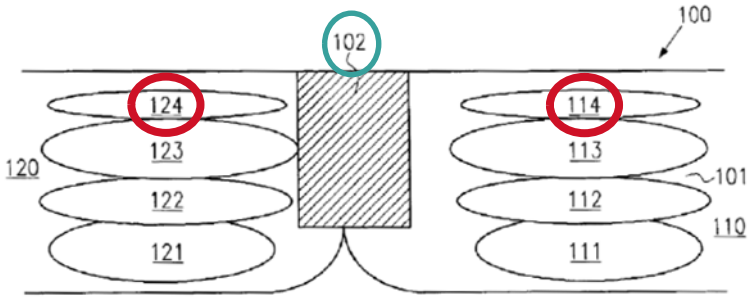


FIG.1a
(Prior Art)

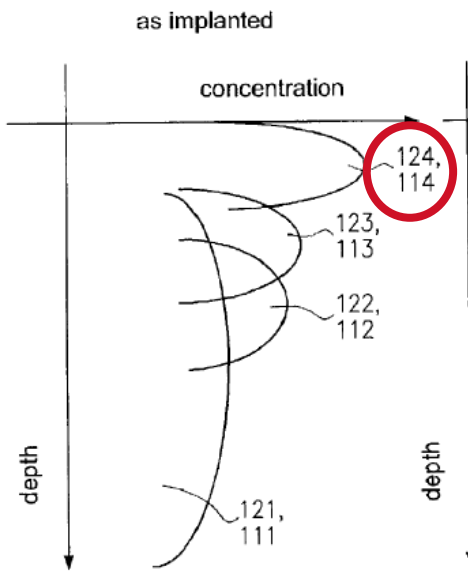


FIG.2a
(Prior Art)

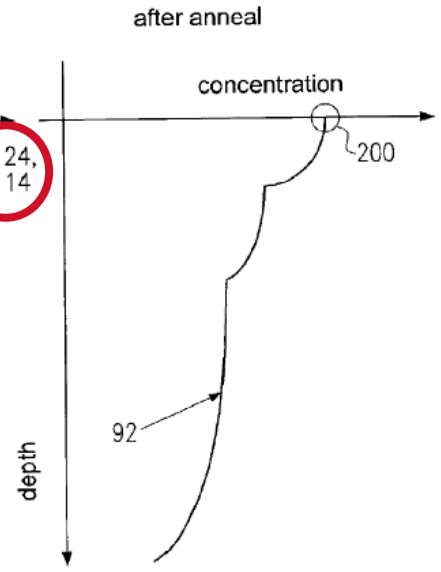


FIG.2b
(Prior Art)

Reply, Paper 38 (-00263), 20-21;
Reply, Paper 39 (-00264), 20-21;
Petition, Paper 1 (-00263), 51-53;
Petition, Paper 1 (-00264), 51-53.

THE "OPPOSITE IN CONDUCTIVITY" LIMITATIONS ARE OBVIOUS

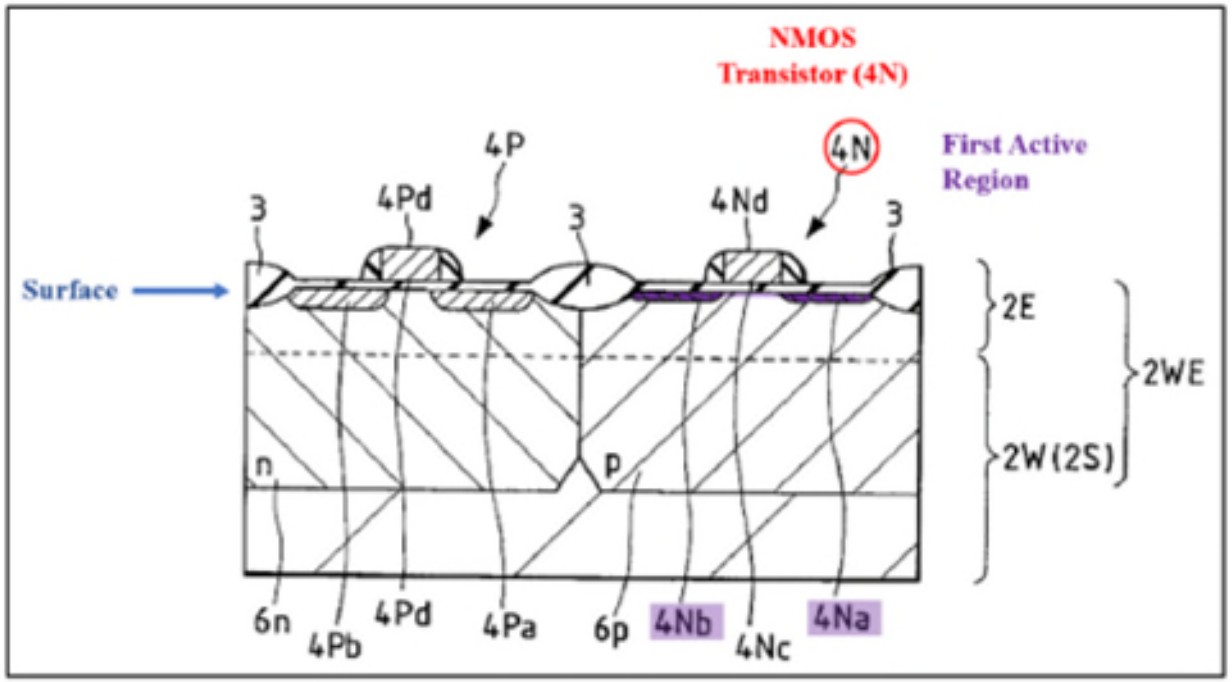
05

BAKER BOTTS

NMOS active region is opposite in conductivity to P-type substrate

[1.3]	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;

See also limitations [21.3] ('014 patent); limitations [1.2], [20.2] ('481 patent).



Petition, Paper 1 (-00263), 13-16, 46-49;
Petition, Paper 1 (-00264), 13-17, 46-49.
Reply, Paper 38 (-00263), 22-25;
Reply, Paper 39 (-00264), 22-25.

"The element forming region, as enclosed by the field insulating film 3, is formed, for example, **with an n-channel MOS.FET (as will be shortly referred to as 'nMOS') 4N** and a p-channel MOS.FET (as will be shortly referred to as 50 'pMOS') 4P, and these nMOS 4N and pMOS 4P constitute a CMOS (i.e., Complementary Metal Oxide Semiconductor) circuit."

* * *

"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 $1x10^{15}$ atoms/cm^2."

Kawagoe, EX1007, 8:46-9:3;
see also 14:46-55, 15:26-40;
EX1003 (-00263), ¶81;
EX1003 (-00264), ¶78.

Figures in ’014/’481 patents show NMOS and P substrate

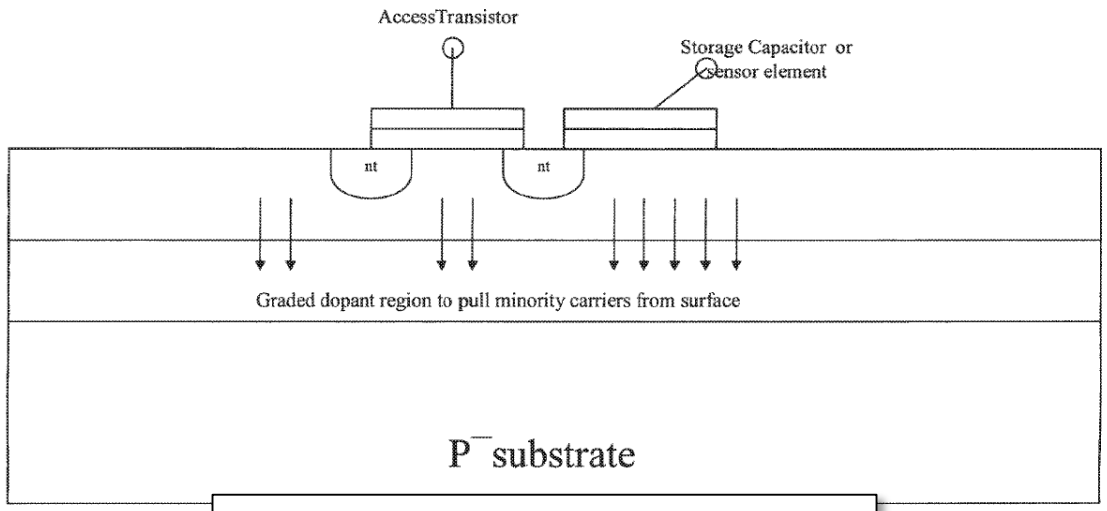


Fig 5B – NMOS & P substrate

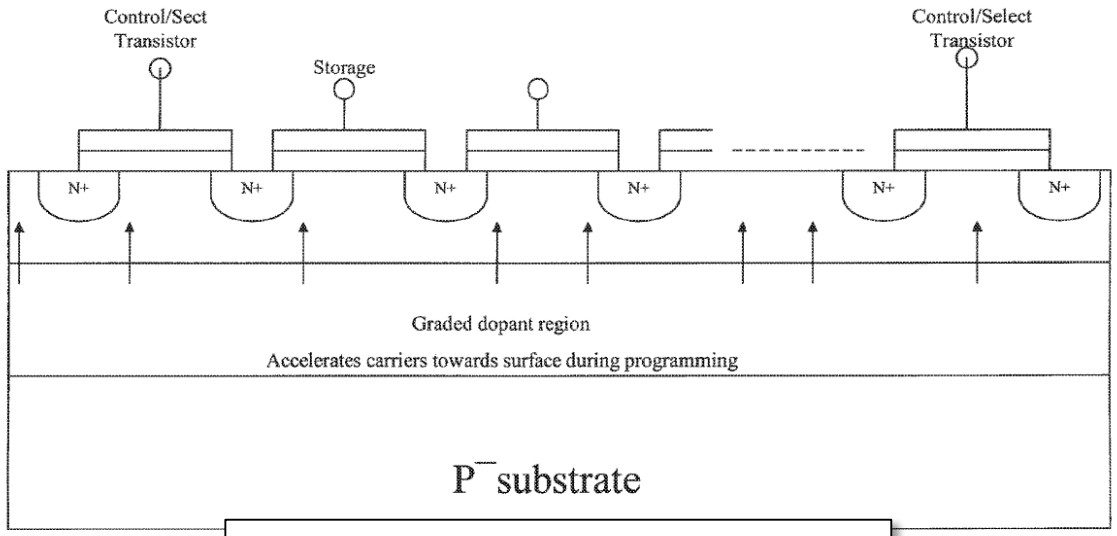
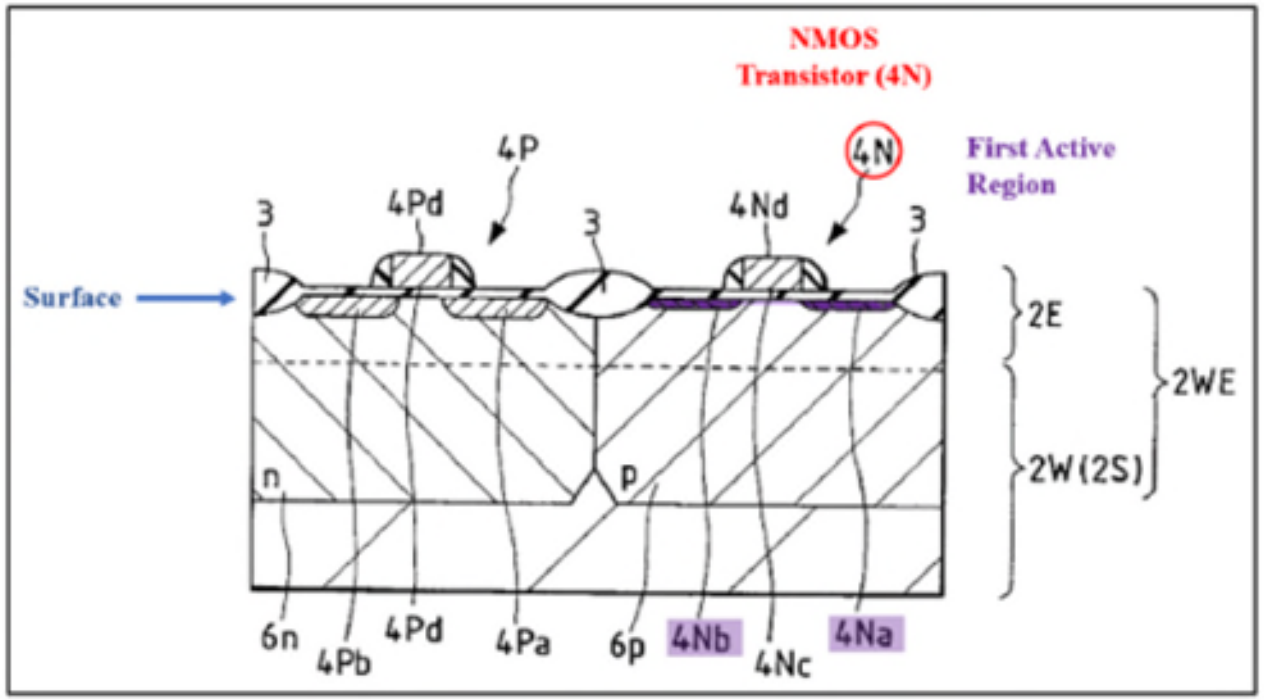


Fig 5C – NMOS & P substrate

Reply, Paper 38 (-00263), 22-25;
Reply, Paper 39 (-00264), 22-25.

The "doping type" of active region is not limited to well/channel

EX1056 (-00263, -00264)/
EX1063 (-00265)/
EX1054 (-00266),
137:1-14



Kawagoe, EX1007, 8:46-9:3;
see also 14:46-55, 15:26-40;
EX1003 (-00263), ¶81;
EX1003 (-00264), ¶78.

Q. The n-type source and drain for the NMOS on the right-hand side of Kawagoe, an n-type source and drain is opposite in conductivity type to a p-type substrate, right?

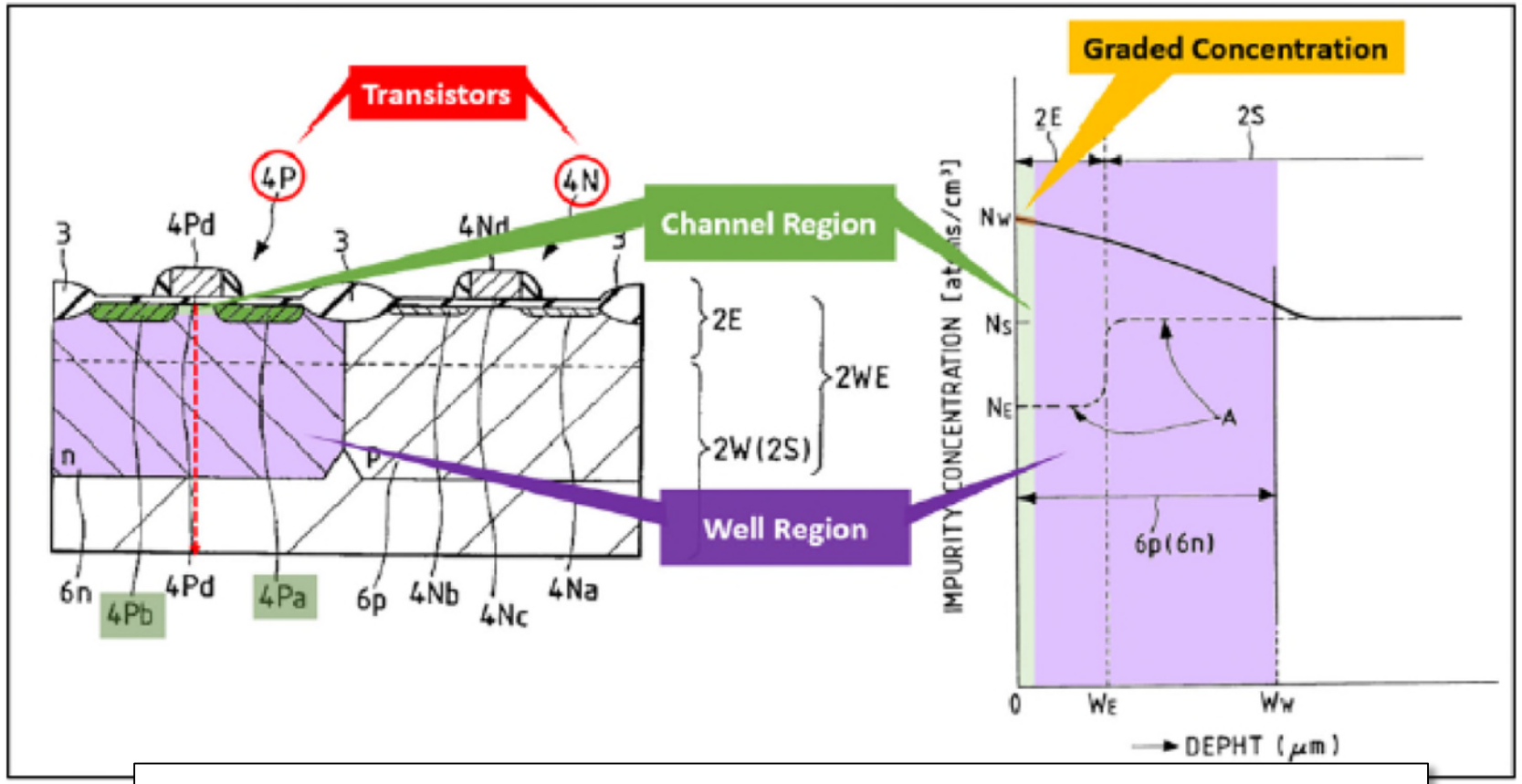
[…]A. **An n-type source and drain is n-type. A p-type substrate is a p-type, so they would be opposite, yes**.

Q. Would you say that the source and drain are part of the active region?

[…]A. **Sources and drains are part of the active region, yes**.

Reply, Paper 38 (-00263), 22-25;
Reply, Paper 39 (-00264), 22-25.

Kawagoe satisfies Patent Owner's narrow construction for "doping type" of active region



Kawagoe shows a CMOS, it has both types
Petition explains how p-type transistor alternatively meets claims

Q. And you told me that you believed that Figure 5B did have an active region conductivity type that was opposite to the p-type substrate?

Q. Yes, you view Figure 5B along with, of course, 5A, and the description that says **it's a CMOS substrate, it has both types**.

EX1056 (-00263, -00264)/EX1063 (-00265)/EX1054 (-00266), 135:3-9; *see also* 22:7-28:24, 71:12-75:23, 132:24-137:14

Kawagoe, EX1007, 9:40-54, 15:62-16:2, 17:50-54, 18:15-23, 21:55-61, Figs. 17, 23 (annotated)

Petition, Paper 1 (-00263), 20; Petition, Paper 1 (-00263), 21
Reply, Paper 38 (-00263), 22-25; Reply, Paper 39 (-00264), 22-25.

THE ISOLATION REGION CLAIMS ARE OBVIOUS

06

Claims 6 and 27 ('014 patent); Claims 6 and 26 ('481 patent)

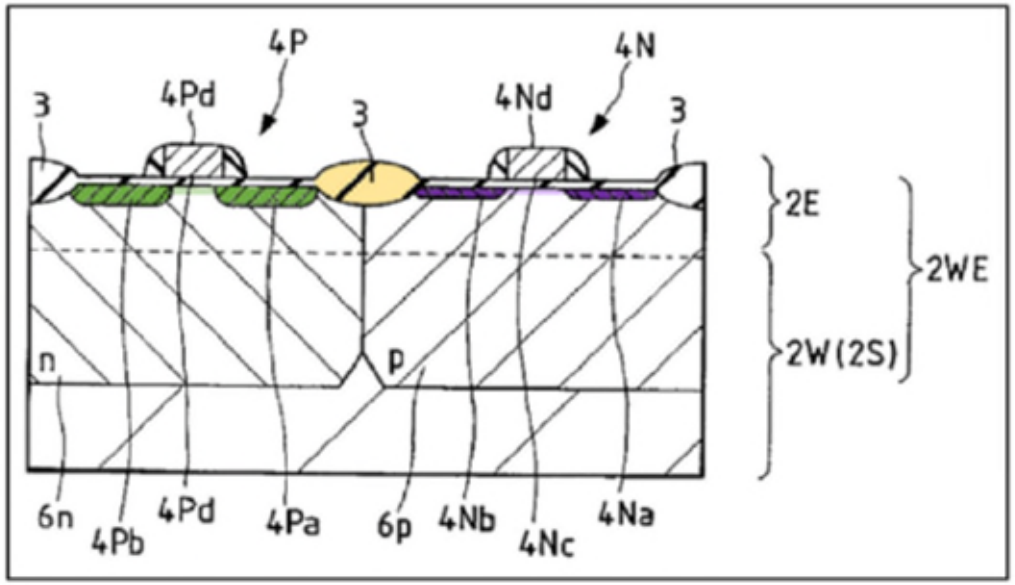
6	The system of claim 1, wherein the first active region and second active region of the at least one semiconductor device are each **separated by at least one isolation region**.
27	The system of claim 21, wherein the first active region and second active region of the at least one semiconductor device are each **separated by at least one isolation region.**
6	The semiconductor device of claim 1, wherein the first active region and second active region are each **separated by at least one isolation region.**
26	The semiconductor device of claim 20, wherein the first active region and second active region are each **separated by at least one isolation region.**

Claims do not say **how much** separation is required

Petition, Paper 1 (-00263), 31-32, 61;
Petition, Paper 1 (-00264), 31-32, 59-60.
Reply, Paper 38 (-00263), 25-27;
Reply, Paper 39 (-00264), 25-27.

Kawagoe alone or in view of Gupta satisfies claims 6 and 27 of the ’014 patent and claims 6 and 26 of the ’481 patent

<u>Kawagoe</u>: insulating film 3 separates at least the surface portions of the first and second active regions

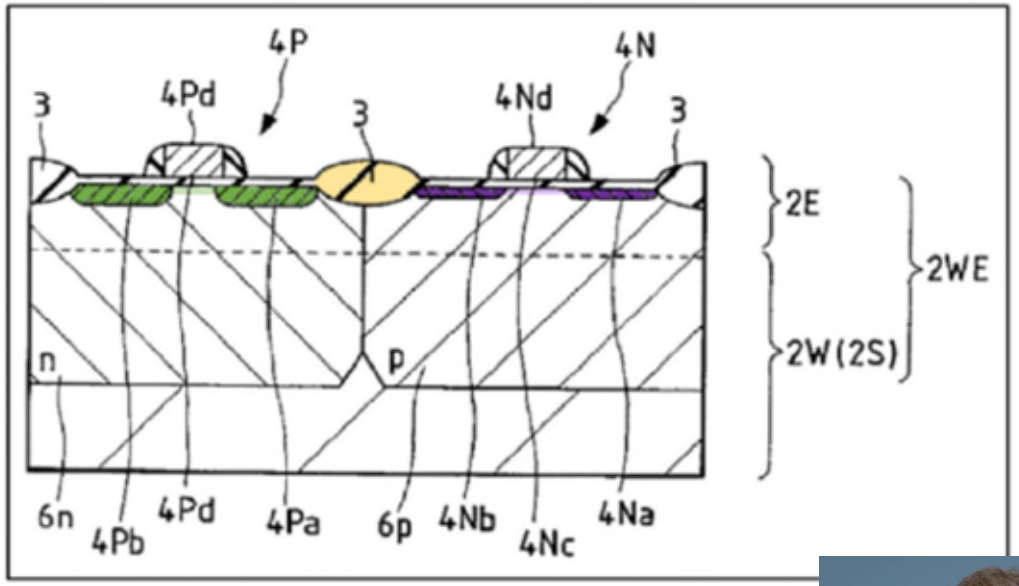


Petition, Paper 1 (-00263), 31-32, 61;
Petition, Paper 1 (-00264), 31-32, 59-60.
Reply, Paper 38 (-00263), 25-27;
Reply, Paper 39 (-00264), 25-27.

Kawagoe contemplates active regions “formed in the range of the thickness of epitaxial layer 2E” (as alleged by Patent Owner), but ***also*** teaches active regions having a depth (e.g., 0.5 μm) that is significantly less than epitaxial layer 2E (e.g., 5 μm)

<u>Kawagoe</u>, EX1007, 8:40-52, 15:37-40, 17:62-18:8, 8:36-40, 9:3-6, 9:47-53, 17:22-25;
<u>Wolf</u>, EX1008A, 818-20, FIG. 16-11(f);
EX1003 (-00263), ¶116;
EX1003 (-00264), ¶111

Kawagoe alone or in view of Gupta satisfies claims 6 and 27 of the ’014 patent and claims 6 and 26 of the ’481 patent



Kawagoe: “Next, as shown in FIG. 6, the field insulating film 3 made of SiO_2 or the like is formed over the principal surface of the epitaxial layer 2E **by the LOCOS method or the like**.”

Kawagoe, EX1007, 8:40-52, 15:37-40, 17:62-18:8, 8:36-40, 9:3-6, 9:47-53, 17:22-25; Wolf, EX1008A, 818-20, FIG. 16-11(f); EX1003 (-00263), ¶116; EX1003 (-00264), ¶111

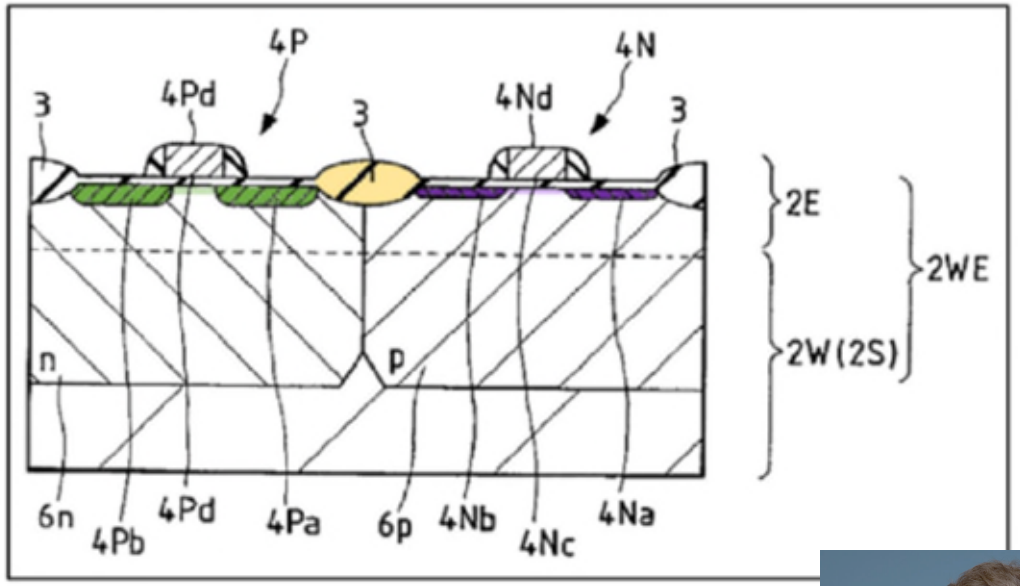
Q. Do you know how LOCOS works?

A. It's a usually either steam or ozone -- high-temperature oxygen oxidation of a silicon -- areas of a silicon substrate… **it consumes a portion of the silicon and works its way downward**.

EX1056 (-00263, -00264), 139:2-142:2

Petition, Paper 1 (-00263), 31-32, 61;
Petition, Paper 1 (-00264), 31-32, 59-60.
Reply, Paper 38 (-00263), 25-27;
Reply, Paper 39 (-00264), 25-27.

Kawagoe still teaches an "isolation region" under Patent Owner's interpretation



"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, EX1007, 8:40-45

A. Essentially, [a channel stopper region's] 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.

EX1056 (-00263, -00264), 142:24-143:6

Petition, Paper 1 (-00263), 31-32, 61;
Petition, Paper 1 (-00264), 31-32, 59-60.
Reply, Paper 38 (-00263), 25-27;
Reply, Paper 39 (-00264), 25-27.

PATENT OWNER'S AGREEMENTS DO NOT SHOW NON-OBVIOUSNESS

07

Evidence of nexus is required for license agreements

"[A]ffirmative evidence of nexus [is required][…] 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) (internal quotation marks omitted)

"'[O]n its face [PO's license] does not refer to the claimed feature of using a graded dopant that PO asserts as 'part and parcel' of all of the licensed patents, nor does it refer to any technical merits of the challenged claims."

"Further, Patent Owner offers no evidence that any licensee mentioned the challenged [] patent or the claimed feature of using a graded dopant during negotiation of the RPX license, and no information relating to [the licensee's] consideration of the potential exposure of their products."

IPR2023-01243, Paper 82, 17-18 (Parallel IPR based on near identical arguments)

Reply, Paper 38 (-00263), 27-28;
Reply, Paper 39 (-00264), 27-28;
Reply, Paper 39 (-00265), 19-20;
Reply, Paper 41 (-00266), 19-20.

RPX's involvement shows licenses motivated by litigation cost

RPX
RATIONAL PATENT®

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.

EX1057 (-00263, -0264)/EX1064 (-00265)/EX1055 (-00266), 2

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.

EX1057 (-00263, -0264)/EX1064 (-00265)/EX1055 (-00266), 1

IPR2023-01243, Paper 82, 17-18 (Parallel IPR based on near identical arguments)

Reply, Paper 38 (-00263), 27-28;
Reply, Paper 39 (-00264), 27-28;
Reply, Paper 39 (-00265), 19-20;
Reply, Paper 41 (-00266), 19-20.

THE PETITION IS TIMELY 08

Patent Owner's arguments have already been rejected by the Board and during Director Review

- Petitioner onsemi filed this IPR in response to Patent Owner's lawsuit

- Arms-length customer/supplier agreements do not create privity

  See, e.g., *WesternGeco*, 889 F.3d at 1319-1322; *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 prior litigant is in privity with Petitioner

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

- No evidence that Petitioner manufactured accused products from prior litigations

Reply, Paper 38 (-00263), 28-31;
Reply, Paper 39 (-00264), 28-31;
Reply, Paper 39 (-00265), 20-22;
Reply, Paper 41 (-00266), 20-22.

Patent Owner's arguments have already been rejected by the Board and during Director Review

It would be fundamentally unfair to allow Patent Owner to manufacture privity between Petitioner and a prior litigant

- Patent Owner's privity arguments rest on idea that ***PO's*** agreement with RPX created a time bar for Petitioner
- Petitioner was a stranger to the RPX agreement and a stranger to the prior litigations

➢ **Petitioner should not be denied its day in court because of PO's conduct**

Reply, Paper 38 (-00263), 28-31;
Reply, Paper 39 (-00264), 28-31;
Reply, Paper 39 (-00265), 20-22;
Reply, Paper 41 (-00266), 20-22.

IPRS ARE CONSTITUTIONAL 09

IPRs are constitutional

The Supreme Court has already upheld the constitutionality of IPRs. *Oil States Energy Servs., LLC v. Greene's Energy Grp., LLC*, 584 U.S. 325, 344–45, (2018).

The present IPRs did not foreclose Patent Owner from litigating its patents in an Article III court.

- The district court stay was not imposed by the institution of IPRs.
- The Article III court heard and resolved Patent Owner's arguments about staying the case.

PO Opp. To Mot. to Stay, EX1060 (-00263, -00264), EX1067 (-00265), EX1058 (-00266).

Reply, Paper 38 (-00263), 31;
Reply, Paper 39 (-00264), 31;
Reply, Paper 39 (-00265), 23;
Reply, Paper 41 (-00266), 23.

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