UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

GREENTHREAD, LLC, a Texas limited liability company, Plaintiff, v. SAMSUNG ELECTRONICS CO., LTD., a Korean business entity, SAMSUNG SEMICONDUCTOR, INC., a California corporation, SAMSUNG ELECTRONICS AMERICA, INC., a New York corporation, and SAMSUNG AUSTIN SEMICONDUCTOR, LLC, a Delaware limited liability company. Defendants.	Civil Action No. _____ JURY TRIAL DEMANDED

COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff Greenthread, LLC ("Plaintiff" or "Greenthread"), by its attorneys, hereby alleges patent infringement against Defendants Samsung Electronics Co., Ltd. ("SEC"), and its U.S. subsidiaries and related entities Samsung Electronics America, Inc. ("SEA"), Samsung Semiconductor, Inc. ("SSI"), and Samsung Austin Semiconductor, LLC ("SAS") (individually or collectively "Defendants" or "Samsung") as follows:

INTRODUCTION

1. This is an action for patent infringement under the Patent Laws of the

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United States, 35 U.S.C. § 1 *et seq.* Greenthread alleges that Samsung has infringed and continues to infringe, directly and/or indirectly, four Greenthread patents: U.S. Patent Nos. 8,421,195 ("Rao '195" or "'195 patent"), 9,190,502 ("Rao '502" or "'502 patent"), 8,106,481 ("Rao '481" or "'481 patent"), and 9,647,070 ("Rao '070" or "'070 patent") (collectively, the "Greenthread Patents"), copies of which are attached hereto as Exhibits 1-4, respectively.

2. The Greenthread Patents cover foundational semiconductor technologies in the design and manufacture of integrated circuits such as memory, including but not limited to DRAM and NAND flash, and image sensors. Specifically, the Greenthread Patents describe semiconductor devices that employ graded dopants and well regions for, *e.g.*, creating electric fields for aiding and/or retarding the movement of carriers to and/or from the semiconductor surface to/from the semiconductor substrate.

3. Samsung has infringed and continues to infringe the Greenthread Patents, directly and indirectly, by making, using, selling, offering for sale, and/or importing into the United States, semiconductor products with infringing graded dopant regions and/or electronics products containing the same; and, at least from the date of this Complaint, by inducing third parties to use, sell, offer for sale, and/or import into the United States, Samsung semiconductor products with infringing graded dopant regions and/or to make, use, offer for sale, sell in the United States, and/or import into the United States electronics products containing the same, with knowledge of the Greenthread Patents and of the third parties' infringement resulting therefrom.

4. Greenthread seeks damages and other relief for Samsung's infringement of

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the Greenthread Patents.

THE PARTIES

5. Plaintiff Greenthread, LLC, is a limited liability company organized and existing under the laws of the State of Texas, having its principal place of business at 6307 Bandera Avenue, Apt. B, Dallas, Texas 75225.

6. Defendant SEC is a corporation organized and existing under the laws of the Republic of Korea that lists its global headquarters as 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, Republic of Korea.

7. Defendant SEA is a corporation organized and existing under the laws of the state of New York, with corporate offices in the Eastern District of Texas at 1301 E. Lookout Drive, Richardson, Texas 75082, and 2800 Technology Drive, Suite 200, Plano, Texas 75074. Defendant SEA has publicly indicated that in early 2019, it will be centralizing multiple offices in a new location in the Eastern District of Texas at the Legacy Central office campus,[1] located at 6550 Chase Oaks Blvd., Plano, Texas 75023. Defendant SEA may be served with process through its registered agent C T Corporation System, 1999 Bryan St., Suite 900, Dallas, Texas 75201-3136.

8. Defendant SSI is a corporation organized and existing under the laws of the State of California, with its principal address at 3655 North First Street, San Jose, California 95134. Defendant SSI may be served with process through its registered agent National Registered Agents, Inc., 1999 Bryan St., Suite 900, Dallas, Texas 75201-3136.

[1] https://news.samsung.com/us/samsung-electronics-america-open-flagship-north-texas-campus/, last accessed Apr. 29, 2019.

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9. Defendant SAS is a limited liability company organized and existing under the laws of the State of Delaware, with its principal address at 12100 Samsung Boulevard, Austin, Texas 78754. Defendant SAS may be served with process through its registered agent C T Corporation System, 1999 Bryan St., Suite 900, Dallas, Texas 75201-3136.

10. Upon information and belief, Defendant SAS is a wholly-owned subsidiary of Defendant SSI, which is a wholly-owned subsidiary of SEA, which is a wholly-owned subsidiary of SEC.

11. Defendants have authorized sellers and sales representatives that offer and sell products pertinent to this Complaint throughout the State of Texas, including in this District and to consumers throughout this District, such as: Best Buy, 422 W TX-281 Loop, Suite 100, Longview, Texas 75605; AT&T Store, 1712 E. Grand Avenue, Marshall, Texas 75670; Verizon authorized retailers, including Russell Cellular, 111 E. Grand Avenue, Marshall, Texas 75670, and Victra, 1006 East End Boulevard, Marshall, Texas 75670; and Amazon.com.

JURISDICTION AND VENUE

12. This is an action for patent infringement under the patent laws of the United States, 35 U.S.C. § 101 *et seq.*

13. This Court has subject matter jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338(a).

14. This Court has specific and personal jurisdiction over each of the Defendants consistent with the requirements of the Due Process Clause of the United

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States Constitution and the Texas Long Arm Statute. Upon information and belief, each Defendant has sufficient minimum contacts with the forum because each Defendant transacts substantial business in the State of Texas and in this District. Further, each Defendant has, directly or through subsidiaries or intermediaries, committed and continues to commit acts of patent infringement in the State of Texas and in this District as alleged in this Complaint, as alleged more particularly below.

15. Venue is proper in this District pursuant to 28 U.S.C. §§ 1400(b) and 1391 (b) and (c) because each Defendant is subject to personal jurisdiction in this District, has committed acts of patent infringement in this District, and has a regular and established place of business in this District. Each Defendant, through its own acts and/or through the acts of each other Defendant, makes, uses, sells, and/or offers to sell infringing products within this District, regularly does and solicits business in this District, and has the requisite minimum contacts with the District such that this venue is a fair and reasonable one. Further, upon information and belief, the Defendants have admitted or not contested proper venue in this District in other patent infringement actions.

FACTUAL BACKGROUND

I. The Greenthread Patents

16. Plaintiff Greenthread solely owns all rights, titles, and interests in and to the Greenthread Patents, including the exclusive rights to bring suit with respect to any past, present, and future infringement thereof.

17. The Rao ’195 patent, entitled “Semiconductor Devices with Graded Dopant Regions,” was duly and legally issued on April 16, 2013, from a patent application filed

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January 12, 2007, with G.R. Mohan Rao as the named inventor. The Rao '195 patent claims priority from U.S. Patent Application No. 10/934,915 (Pub. No. US 2006/0049464 A1), filed on September 3, 2004.

18. The Rao '502 patent, entitled "Semiconductor Devices with Graded Dopant Regions," was duly and legally issued on November 17, 2015, from a patent application filed October 16, 2014, with G.R. Mohan Rao as the named inventor. The Rao '502 patent claims priority from U.S. Patent Application No. 10/934,915 (Pub. No. US 2006/0049464 A1), filed on September 3, 2004.

19. The Rao '481 patent, entitled "Semiconductor Devices with Graded Dopant Regions," was duly and legally issued on January 31, 2012, from a patent application filed August 27, 2009, with G.R. Mohan Rao as the named inventor. The Rao '481 patent claims priority from U.S. Patent Application No. 10/934,915 (Pub. No. US 2006/0049464 A1), filed on September 3, 2004.

20. The Rao '070 patent, entitled "Semiconductor Devices with Graded Dopant Regions," was duly and legally issued on May 9, 2017, from a patent application filed November 3, 2015, with G.R. Mohan Rao as the named inventor. The Rao '070 patent claims priority from U.S. Patent Application No. 10/934,915 (Pub. No. US 2006/0049464 A1), filed on September 3, 2004.

21. Each of the Greenthread Patents is valid and enforceable.

22. Defendants are not authorized to practice the Greenthread Patents.

23. The inventions recited in the Greenthread Patents enable Samsung to offer superior semiconductor products, including faster, more efficient, and more reliable

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DRAM and NAND flash, and image sensors. The Greenthread Patents also enable Samsung to continue scaling down the feature size of its semiconductor products to keep pace in the highly competitive semiconductor market.

II. The Inventor

24. G.R. Mohan Rao is the sole inventor on the Greenthread Patents.

25. Dr. Rao is the inventor of approximately 111 U.S. Patents and the author of at least 15 technical publications spanning several decades.

26. Dr. Rao has been an innovator in the semiconductor industry since the 1960s. After receiving his Ph.D. in physics with a specialization in electronics in September 1968 from Andhra University in Waltair, India, near the village where he grew up, Dr. Rao traveled to the United States to attend a graduate program in physics at the University of Cincinnati, fulfilling his lifelong dream to study in the United States.

27. Shortly after beginning his studies at the University of Cincinnati, Dr. Rao found a bulletin indicating that Prof. William Carr of Southern Methodist University (SMU) was looking for a graduate assistant for his work on MOS transistors. Dr. Rao called Prof. Carr about the opportunity, and by December 1968, after completing the fall semester at the University of Cincinnati, Dr. Rao had received the assistantship with Prof. Carr, moved to Dallas, Texas, and enrolled in a Ph.D. program at SMU in electrical engineering.

28. At the laboratory at SMU, Dr. Rao was able to build MOS devices from scratch. In the 1969-1970 timespan, while attending SMU, Dr. Rao also worked in the SMU laboratory with Jack Kilby of Texas Instruments, a pioneering electrical engineer

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who would later receive a Nobel Prize for his work. In early 1972, Mr. Kilby set up an interview for Dr. Rao at Texas Instruments' Houston facility, then the home of Texas Instruments' MOS-related work.

29. Dr. Rao began working for Texas Instruments in June 1972. He would go on to work for the company for 22 years, until 1994. Dr. Rao rose through the ranks at Texas Instruments, starting in an Engineer position and ascending to the position of Senior Fellow—one of 12 out of approximately 20,000 engineers at the company at the time. He then moved into a management position, starting as a Vice President in 1983 and becoming a Senior Vice President in 1985.

30. Dr. Rao received his first patent while working in a process and product engineering capacity to solve a production problem with Texas Instruments' 4-kilobit RAM product. From the late 1970s through the mid-1980s, he worked on and/or managed Texas Instruments': (1) 64Kb RAM, in a project management capacity as a Senior Member of Technical Staff; (2) 256Kb RAM, in a project management capacity as a Fellow; (3) 1Mb RAM, in a management capacity as a Senior Fellow, overseeing several projects; and (4) 4Mb RAM, in a management capacity as a Senior Fellow, overseeing several projects. At Texas Instruments, Dr. Rao also worked on projects involving EEPROM, SRAM, and microcontrollers. In total, Dr. Rao received approximately 35 U.S. patents during his time at Texas Instruments.

31. Some of Dr. Rao's work for Texas Instruments is featured in the

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Smithsonian Institution, in the Texas Instruments Collection.[2] For example, the Smithsonian Institution has a display of Texas Instruments' experimental 1-megabit CMOS DRAM with one-micron feature size, produced in April 1985 under Dr. Rao's leadership.

32. After his time at Texas Instruments, Dr. Rao joined Cirrus Logic in 1994. Although Cirrus Logic was a California company, Dr. Rao coordinated a team in the Dallas area. His work focused on a major project involving integration of a graphics controller and memory. During his time at Cirrus Logic, Dr. Rao received approximately 22 U.S. patents relating to his work on integrated graphics controllers and memory. Dr. Rao left Cirrus Logic in the summer of 1996.

33. Later in 1996, Dr. Rao started a company called Silicon Aquarius. Through a relationship between Silicon Aquarius and Matsushita, Dr. Rao led a design team in working on a 256Mb DRAM chip.

34. After Silicon Aquarius ceased operations, Dr. Rao did consulting work for a number of different companies and devoted much of his free time to thinking about various challenges and problems with which the semiconductor industry had struggled for years.

35. A focal point of Dr. Rao's research was poor refresh time and the related problem of how to deal with and control the movement of both wanted and unwanted carriers in semiconductor devices, including memory and logic devices. Dr. Rao realized

[2] http://smithsonianchips.si.edu/texas/t_360.htm, last accessed Apr. 29, 2019; http://smithsonianchips.si.edu/texas/wafer.htm, last accessed Apr. 29, 2019.

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that graded dopants could be used to create a "drift layer" to facilitate the movement—in an upward or downward direction, as appropriate—of carriers from the semiconductor surface down into the substrate and vice versa. It was Dr. Rao's work on this problem that culminated in the Greenthread Patents.

III. Samsung

36. Samsung is a global leader in the electronics market, which includes computer memory and consumer electronics products such as smartphones, tablet computers, and televisions. Samsung is one of the largest semiconductor manufacturers in the world, and a world leader in DRAM, mobile DRAM, graphics DRAM, NAND flash, and solid-state drives (SSDs). Upon information and belief, Samsung designs, manufacturers, uses, offers for sale, sells, and/or imports into the United States—including into the Eastern District of Texas—billions of dollars of computer memory and consumer electronics every year.

37. Samsung had global revenue of approximately $214 billion across all product lines in 2018. Upon information and belief, approximately 34% of Samsung's global revenue comes from sales in the Americas, and a significant portion of Samsung's sales in the Americas is attributable to sales in the United States.

IV. Samsung's Direct Infringement and the Accused Instrumentalities

38. Defendants have directly infringed, and continue to infringe, one or more claims of each of the Greenthread Patents (as further specified below as to each of the Greenthread Patents, in Counts I-IV) by making, using, offering to sell, selling within the United States, and/or importing into the United States (1) semiconductor products that

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practice the claimed inventions ("Accused Semiconductor Instrumentalities"), and (2) consumer electronics products that incorporate said Accused Semiconductor Instrumentalities ("Accused Consumer Electronics"), including but not limited to Samsung smartphones, tablets, televisions, SSDs, USB flash drives, and memory cards. The Accused Semiconductor Instrumentalities and Accused Consumer Electronics are collectively referred to herein as the "Accused Instrumentalities."

39. The Accused Instrumentalities include Accused Semiconductor Instrumentalities and Accused Consumer Electronics made, used, offered for sale, sold within the United States, and/or imported into the United States within the last six years.

40. The Accused Semiconductor Instrumentalities include semiconductor devices manufactured to include the claimed inventions, including but not limited to:

- Samsung DRAM ("Accused DRAM Instrumentalities"), including but not limited to the exemplary Samsung K4A8G045WB 8 Gb DDR4 SDRAM chip, other Samsung DDR4 memory, and other categories of DRAM that are manufactured and/or operate in the same or substantially the same fashion relative to the Greenthread Patents, including DDR3, high-bandwidth memory (HBM), graphics DRAM (including GDDR6 and GDDR5), mobile/low-power DRAM (including LPDDR4X, LPDDR4, and LPDDR3), and memory modules containing such categories of DRAM;
- Samsung NAND flash ("Accused NAND Instrumentalities"), including but not limited to the exemplary Samsung K9DUGB8S7M V-NAND Flash chip, other Samsung V-NAND flash, and other categories of NAND flash,

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including planar NAND flash, that are manufactured and/or operate in the same or substantially the same fashion relative to the Greenthread Patents, and MMCs and memory modules containing such categories of NAND flash; and

- Samsung CMOS image sensor chips ("Accused Image Sensor Instrumentalities"), including but not limited to the exemplary Samsung S5K2X7SP CMOS image sensor and other categories of image sensors that are manufactured and/or operate in the same or substantially the same fashion relative to the Greenthread Patents.

41. The Accused Consumer Electronics include consumer electronics products that incorporate Accused Semiconductor Instrumentalities, including but not limited to any Samsung consumer electronic devices that contain Accused DRAM Instrumentalities; the Portable T3 SSD, which contains the exemplary K9DUGB8S7M V-NAND Flash, and other Samsung consumer electronic devices containing Accused NAND Instrumentalities, including but not limited to the Portable SSD X5 (MU-PB2T0B/AM, MU-PB1T0B/AM, MU-PB500B/AM), Portable SSD T5 (MU-PA2T0B/AM, MU-PA1T0B/AM, MU-PA500B/AM, MU-PA250B/AM), SSD 860 QVO 2.5" SATA III (MZ-76Q4T0B/AM, MZ-76Q2T0B/AM, MZ-76Q1T0B/AM), SSD 860 PRO 2.5" SATA III (MZ-76P4T0BW, MZ-76P2T0BW, MZ-76P1T0BW, MZ-76P512BW, MZ-76P256BW), SSD 860 EVO 2.5" SATA III (MZ-76E4T0B/AM, MZ-76E2T0B/AM, MZ-76E1T0B/AM, MZ-76E500B/AM, MZ-76E250B/AM), SSD 970 PRO NVM3 M.2 (MZ-V7P1T0BW, MZ-V7P512BW), SSD 970 EVO NVMe M.2 (MZ-

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V7E2T0BW, MZ-V7E1T0BW, MZ-V7E500BW, MZ-V7E250BW), SSD 860 EVO M.2 SATA (MZ-N6E2T0BW, MZ-N6E1T0BW, MZ-N6E500BW, MZ-N6E250BW), SSD 860 EVO mSATA (MZ-M6E1T0BW, MZ-M6E500BW, MZ-M6E250BW), SSD 960 EVO NVMe M.2 (MZ-V6E1T0BW), SSD 970 EVO Plus NVMe M.2 (MZ-V7S1T0B/AM, MZ-V7S500B/AM, MZ-V7S250B/AM), USB 3.1 Flash Drive DUO Plus (MUF-256DB/AM, MUF-128DB/AM, MUF-64DB/AM, MUF-32DB/AM), USB 3.1 Flash Drive FIT Plus (MUF-256AB/AM, MUF-128AB/AM, MUF-64AB/AM, MUF-32AB/AM), USB 3.1 Flash Drive BAR Plus (MUF-256BE4/AM, MUF-128BE4/AM, MUF-64BE4/AM, MUF-32BE4/AM, MUF-256BE3/AM, MUF-128BE3/AM, MUF-64BE3/AM, MUF-32BE3/AM), MicroSDXC EVO Plus Memory Card w/Adapter (MB-MC32GA/AM, MB-MC64GA/AM, MB-MC128GA/AM, MB-MC256GA/AM, MB-MC512GA/AM), MicroSDXC PRO Endurance Memory Card w/Adapter (MB-MJ32GA/AM, MB-MJ64GA/AM, MB-MJ128GA/AM), MicroSDXC EVO Memory Card w/Adapter (MB-MP32GA/AM, MB-MP64GA/AM, MB-MP128GA/AM, MB-MP256GA/AM), MicroSDXC EVO Select Memory Card w/Adapter (MB-ME32GA/AM, MB-ME64GA/AM, MB-ME128GA/AM, MB-ME256GA/AM, MB-ME512GA/AM); and any Samsung consumer electronic devices that contain Accused Image Sensor Instrumentalities.

42. Defendants have actual notice of all of the Greenthread Patents and the infringement alleged herein at least upon filing of this Complaint, if not earlier, pursuant to 35 U.S.C. § 287(a).

43. The above-described acts of direct infringement committed by Defendants

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have caused injury and damage to Plaintiff Greenthread, and will cause additional severe and irreparable injury and damages in the future.

V. Samsung's Indirect Infringement

44. Defendants indirectly infringe the Greenthread Patents by inducing infringement by others, such as OEMs, manufacturers, importers, resellers, customers, and end-users under 35 U.S.C. § 271(b) in this District and elsewhere in the United States and the State of Texas.

45. Specifically, Defendants indirectly infringe the Greenthread Patents by pursuing third-party customers for its products who then directly infringe by making, having made, using, offering to sell, selling within the United States, or importing into the United States products that infringe.

46. The Accused Semiconductor Instrumentalities are designed such that, as incorporated into the products of third parties, the third-party products infringe one or more claims of the Greenthread Patents if made, used, sold, offered for sale in, or imported into the United States.

47. Upon information and belief, Defendants are aware that many of their customers make, have made, use, sell, offer to sell in, or import into the United States, many products that incorporate Samsung semiconductor products, including the Accused Semiconductor Instrumentalities, including, among many others, SSDs, server hardware, and mobile devices.

48. Upon information and belief, Defendants also provide OEMs and manufacturers with instructions and technical specifications describing how to

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incorporate their semiconductor products, including the Accused Semiconductor Instrumentalities, into electronic devices and other products that are made, used, sold, offered for sale in and/or imported into the United States. When such OEMs and manufacturers follow such instructions and technical specifications and embed the Accused Semiconductor Instrumentalities in end-products they make, have made, use, offer to sell, sell within the United States, or import into the United States, they directly infringe one or more claims of the Greenthread Patents. Defendants know that by providing such instructions and technical specifications, OEMs and manufacturers follow these instructions and technical specifications, and directly infringe one or more claims of the Greenthread Patents. Defendants thus know, at least as of the filing of this Complaint, that their actions actively induce infringement.

49. Upon information and belief, the targets for Defendants' marketing efforts are OEMs or other manufacturers who then incorporate Samsung's semiconductor products, including the Accused Semiconductor Instrumentalities, into electronic devices and other products that are made, used, sold, offered for sale in and/or imported into the United States. These marketing efforts demonstrate Defendants' attempts to induce infringement.

50. Defendants derive significant revenue by selling semiconductor products, including the Accused Semiconductor Instrumentalities, to third parties who directly infringe one or more claims of the Greenthread Patents. Samsung derived worldwide sales of approximately $65.8 billion for semiconductor products in 2018.

51. The above-described acts of indirect infringement committed by

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Defendants have caused injury and damage to Plaintiff Greenthread, and will cause additional severe and irreparable injury and damages in the future.

COUNT I: INFRINGEMENT OF U.S. PATENT NO. 8,421,195

52. The allegations set forth in paragraphs 1 through 51 of this Complaint are incorporated by reference as though fully set forth herein.

53. Pursuant to 35 U.S.C. § 282, the Rao '195 patent is presumed valid.

54. Defendants have directly infringed and continue to infringe one or more claims of the Rao '195 patent in violation of 35 U.S.C. § 271. The infringing products include Accused DRAM Instrumentalities, Accused NAND Instrumentalities, and Accused Consumer Electronics that contain one or more of the Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities.

55. Upon information and belief, the Accused DRAM Instrumentalities, Accused NAND Instrumentalities, and Accused Consumer Electronics containing Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities directly infringe at least claim 1 of the Rao '195 patent at least in the manner described in paragraphs 56-69 below. Plaintiff's allegations of infringement are not limited to claim 1, and additional infringed claims will be identified and disclosed through discovery and infringement contentions.

56. Paragraphs 58-62 detail the manner in which the Accused DRAM Instrumentalities infringe claim 1 of the Rao '195 patent, by way of the exemplary Samsung K4A8G045WB DDR4 chip. The images and SRP (spreading resistance profiling) analyses of the K4A8G045WB chip, set forth below, are derived from the

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TechInsights teardown report for that chip.

57. Upon information and belief, the Accused DRAM Instrumentalities are in relevant part substantially similar to the exemplary K4A8G045WB DDR4 chip, in particular with regard to the manner in which the Accused DRAM Instrumentalities include and utilize regions with graded dopant concentrations. Upon information and belief, Samsung fabricates the Accused DRAM Instrumentalities according to a limited number of processes, many or all of which utilize substantially similar process steps, including process steps for creating regions with graded dopant concentrations. Paragraphs 58-62 are thus illustrative of the manner in which each of the Accused DRAM Instrumentalities infringes.

58. The Accused DRAM Instrumentalities are CMOS semiconductor devices.

59. The Accused DRAM Instrumentalities comprise a surface layer and a substrate:

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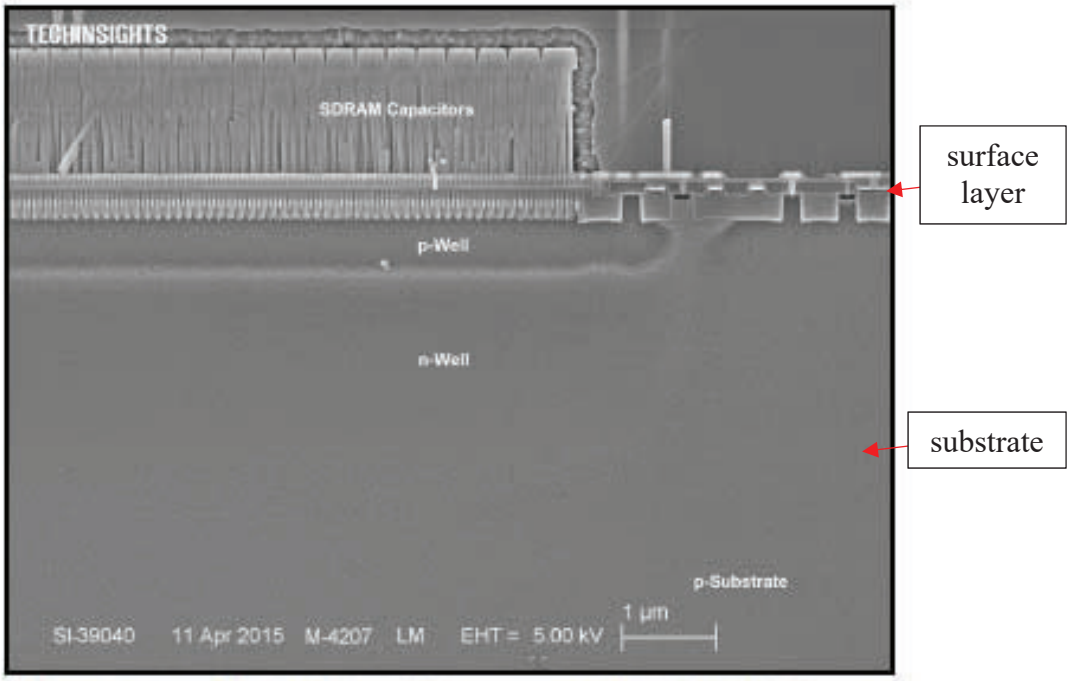


Figure 2.1.3: SDRAM array well structure, SEM cross-section through edges of SDRAM array in bitline direction, silicon etch.

60. The Accused DRAM Instrumentalities comprise an active region including a source and a drain, disposed on one surface of said surface layer, including, *e.g.*:

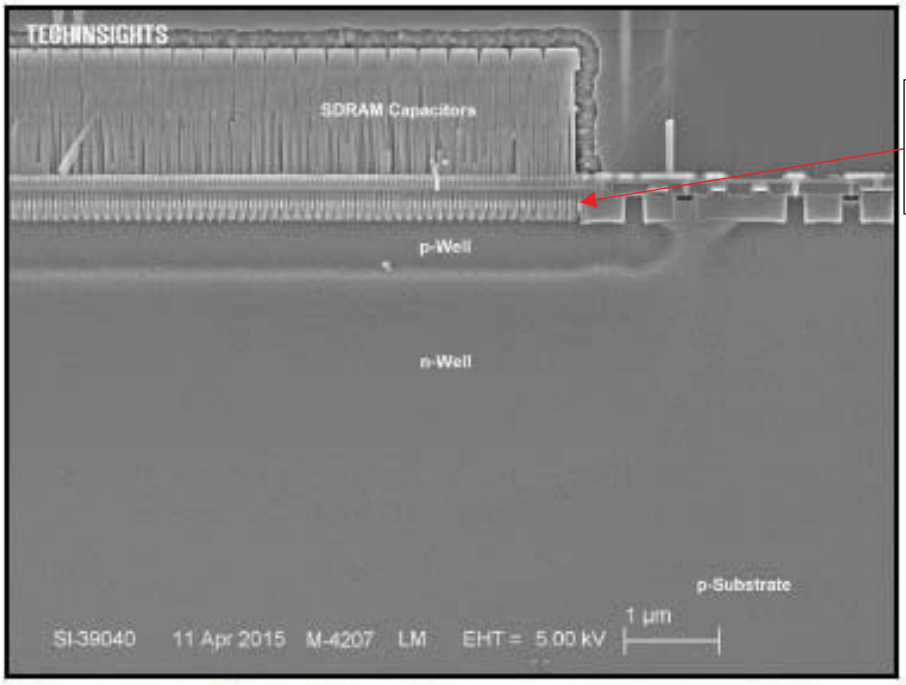


Figure 2.1.3: SDRAM array well structure, SEM cross-section through edges of SDRAM array in bitline direction, silicon etch.

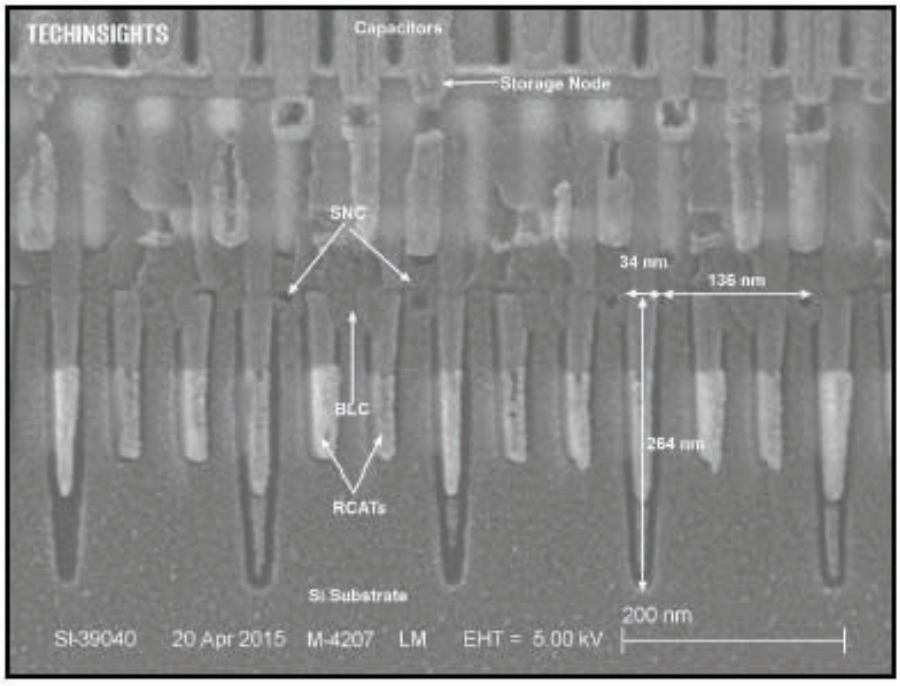


Figure 3.2.6: Recessed channel access transistors, bitline contacts and storage node contact, SEM cross-section in the direction 20 degree to bitline (parallel to active).

61. As shown in the SRP analysis below, the Accused DRAM Instrumentalities

comprise 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:

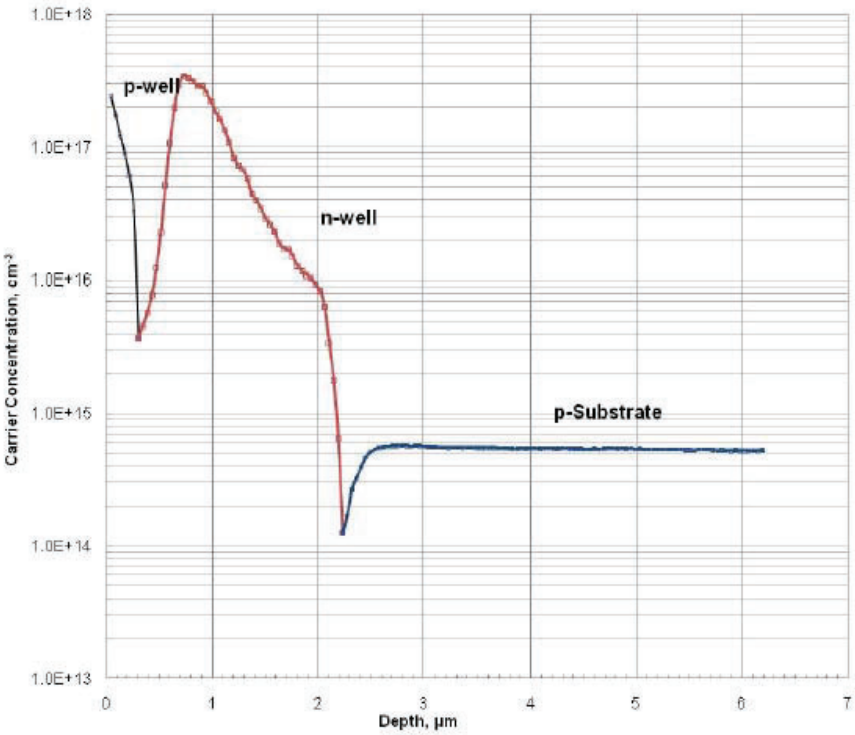


Figure 2.1.2: Spreading resistance profile of an p-well in embedded n-well in SDRAM array.

Table 2.1.1: Summary of SRP measurements.

Feature	Well Depth [µm]	Peak Concentration [cm^{-1}]	Peak Concentration Depth (µm)
p-Substrate	—	5.2×10^{14}	—
Embedded P-well, SDRAM cell array	0.26	2.4×10^{17}	0.1
Deep N-well in array	2.2	3.4×10^{17}	0.73
P-well in periphery	1.0	2.23×10^{17}	0.1

62. The Accused DRAM Instrumentalities comprise 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:

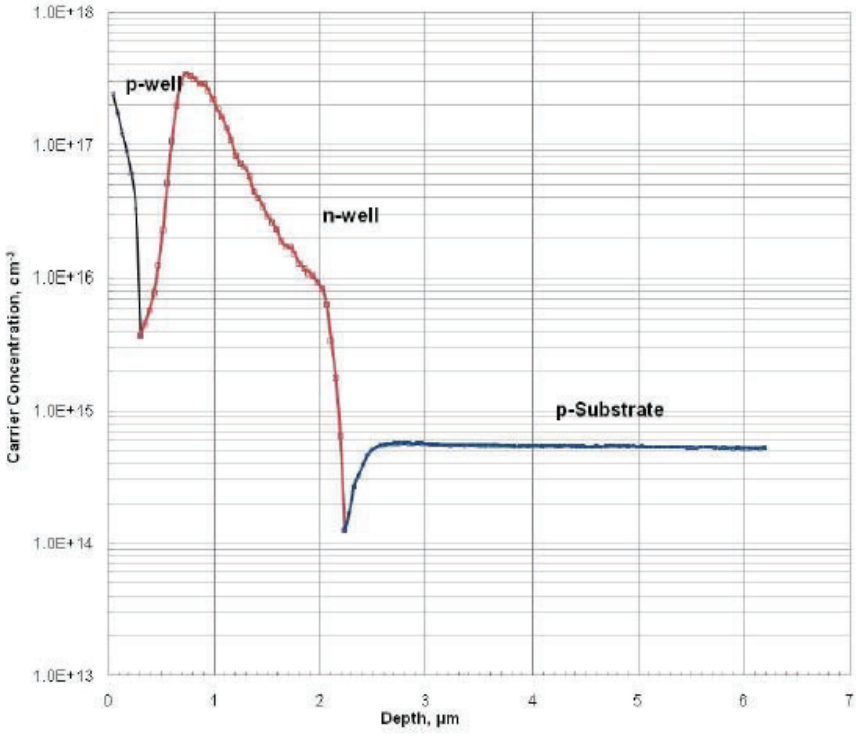


Figure 2.1.2: Spreading resistance profile of an p-well in embedded n-well in SDRAM array.

63. Paragraphs 65-69 detail the manner in which the Accused NAND Instrumentalities infringe claim 1 of the Rao '195 patent, by way of the exemplary Samsung K9DUGB8S7M V-NAND Flash chip. The images and SRP (spreading resistance profiling) analyses of the K9DUGB8S7M chip, set forth below, are derived from the TechInsights teardown report for that chip.

64. Upon information and belief, the Accused NAND Instrumentalities are in relevant part substantially similar to the exemplary K9DUGB8S7M V-NAND Flash chip,

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in particular with regard to the manner in which the Accused NAND Instrumentalities include and utilize regions with graded dopant concentrations. Upon information and belief, Samsung fabricates the Accused NAND Instrumentalities according to a limited number of processes, many or all of which utilize substantially similar process steps, including process steps for creating regions with graded dopant concentrations. Paragraphs 65-69 are thus illustrative of the manner in which each of the Accused NAND Instrumentalities infringes.

65. The Accused NAND Instrumentalities are CMOS semiconductor devices.

66. The Accused NAND Instrumentalities comprise a surface layer and a substrate:

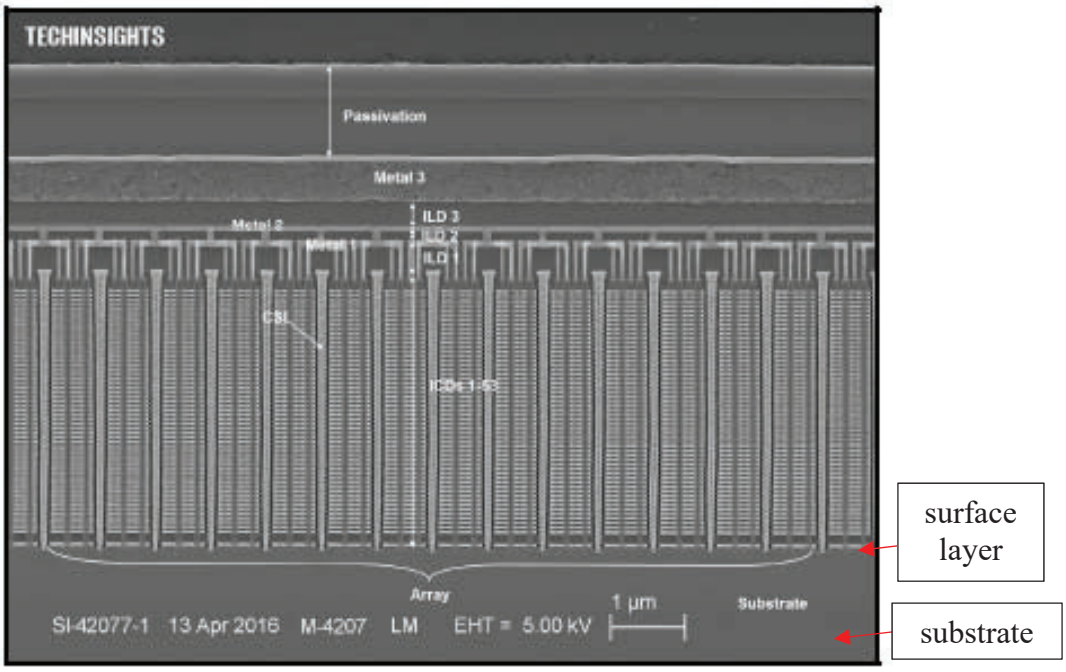


Figure 2.0.2: Process overview, array circuitry (SEM)

67. The Accused NAND Instrumentalities comprise an active region including a source and a drain, disposed on one surface of said surface layer:

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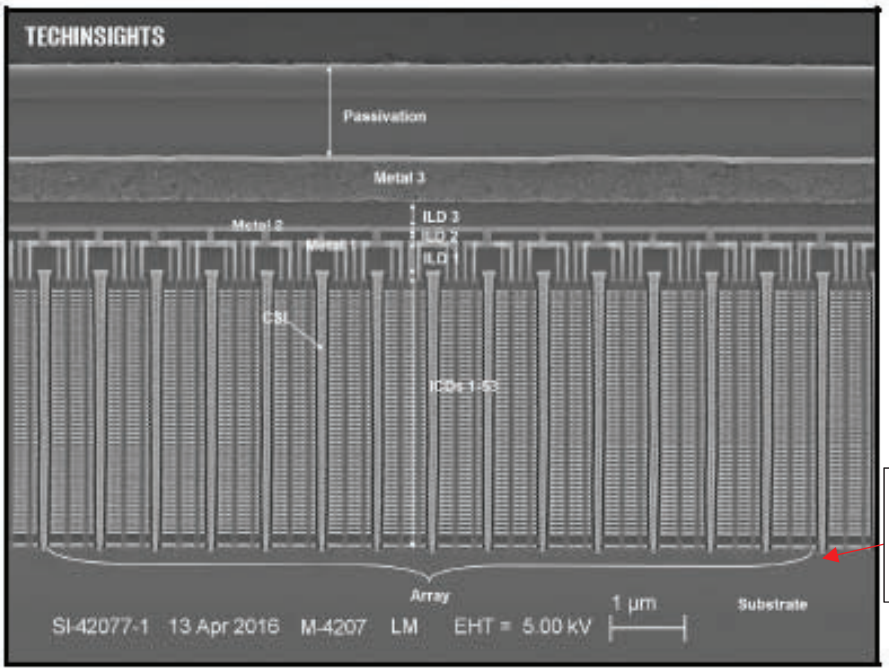


Figure 2.0.2: Process overview, array circuitry (SEM)

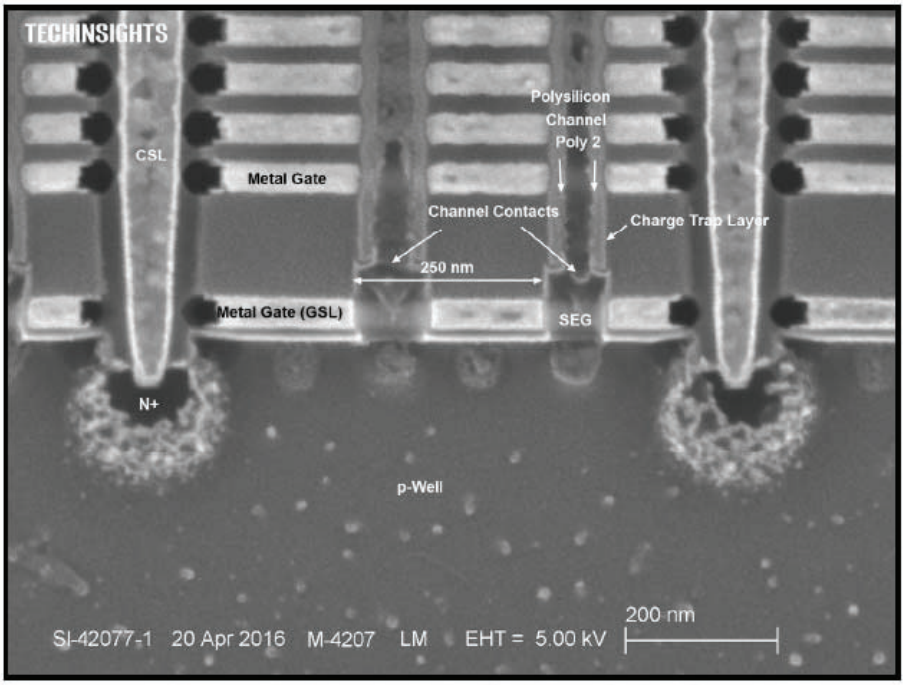


Figure 4.2.2: Source contact at bottom of V-NAND string, Si implants delineated (SEM)

68. As shown in the SRP analysis below, the Accused NAND Instrumentalities comprise 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:

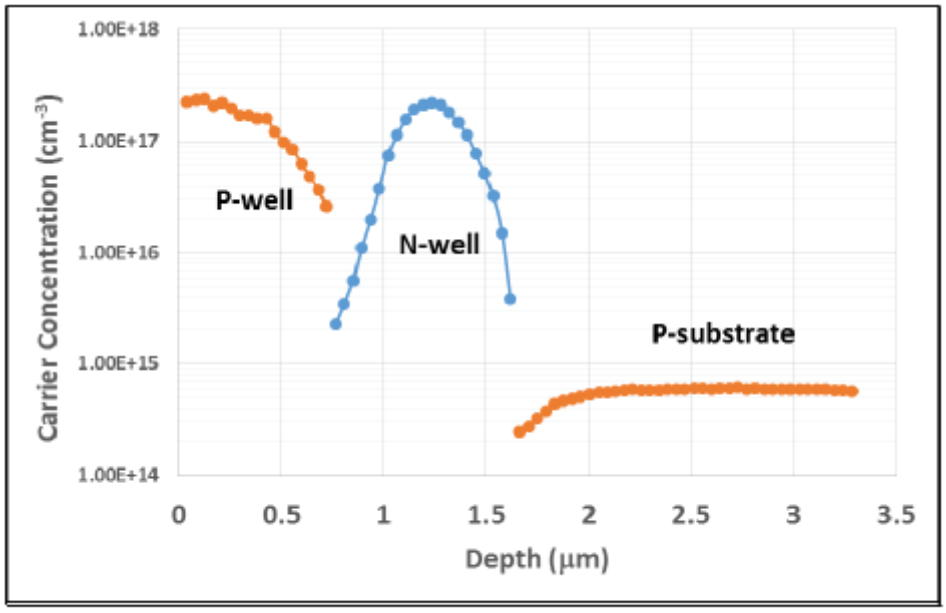


Figure 2.1.2: SRP profile of embedded p-well in NAND array

Table 2.1.1: Substrate and Well Doping

Feature	Depth (µm)	Peak Concentration (cm^{-3})
p-type Si substrate		6.0×10^{14}
n-well in periphery	1.82	2.65×10^{17}
Embedded p-well in flash array	0.73	2.40×10^{17}
Deep n-well in flash array	1.62	2.13×10^{17}

69. The Accused NAND Instrumentalities comprise 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:

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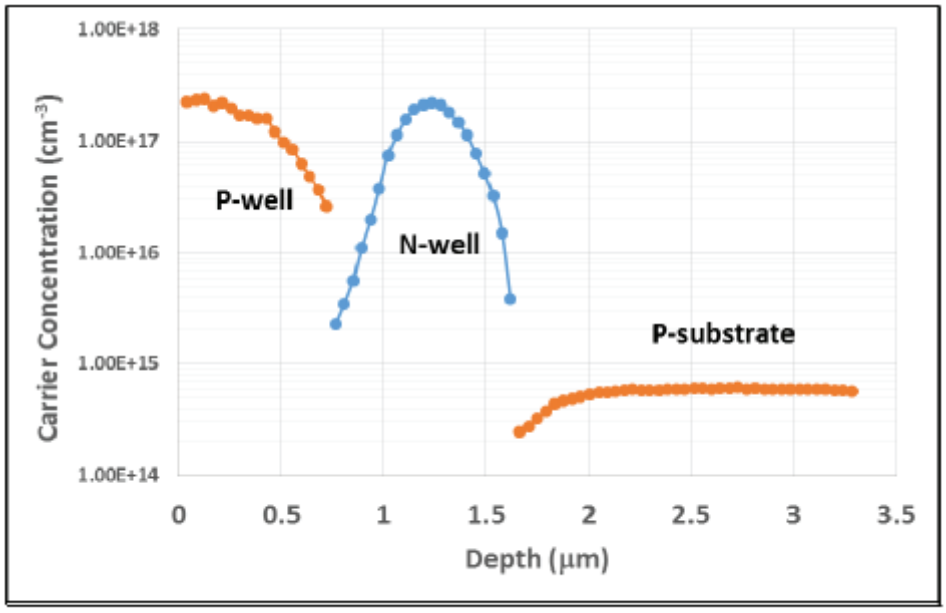


Figure 2.1.2: SRP profile of embedded p-well in NAND array

70. Defendants have actual notice of the Rao '195 patent and the infringement alleged herein at least upon filing of this Complaint, if not earlier, pursuant to 35 U.S.C. § 287(a).

71. Defendants are indirectly infringing the Rao '195 patent by actively inducing the direct infringement of others of the Rao '195 patent, in the United States, the State of Texas, and the Eastern District of Texas.

72. Defendants are inducing, through affirmative acts, their customers and other third parties to directly infringe the Rao '195 patent by making, using, selling in the United States, and/or importing into the United States the Accused DRAM Instrumentalities, Accused NAND Instrumentalities, and/or products that contain one or more of the Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities.

73. The affirmative acts of inducement include, but are not limited to: (1) enabling and encouraging the use, sale, or importation of products that contain one or

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more of the Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities; and (2) advertising or marketing the Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities.

74. At least as of the filing of this Complaint, Defendants knew that the induced conduct would constitute infringement—and intended that infringement at the time of committing the aforementioned affirmative acts, such that the acts and conduct have been and continue to be committed with the specific intent to induce infringement—or deliberately avoided learning of the infringing circumstances at the time of committing these acts so as to be willfully blind to the infringement that was induced.

75. The above-described acts of infringement committed by Defendants have caused injury and damage to Greenthread, and will cause additional severe and irreparable injury and damages in the future.

76. Greenthread is entitled to recover damages sustained as a result of Defendants' wrongful acts in an amount subject to proof at trial, but in no event less than a reasonable royalty.

COUNT II: INFRINGEMENT OF U.S. PATENT NO. 9,190,502

77. The allegations set forth in paragraphs 1 through 51 of this Complaint are incorporated by reference as though fully set forth herein.

78. Pursuant to 35 U.S.C. § 282, the Rao '502 patent is presumed valid.

79. Defendants have directly infringed and continue to infringe one or more claims of the Rao '502 patent in violation of 35 U.S.C. § 271. The infringing products include Accused DRAM Instrumentalities, Accused NAND Instrumentalities, and

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Accused Consumer Electronics that contain one or more of the Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities.

80. Upon information and belief, the Accused DRAM Instrumentalities, Accused NAND Instrumentalities, and Accused Consumer Electronics containing Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities directly infringe at least claim 7 of the Rao '502 patent at least in the manner described in paragraphs 81-94 below. Plaintiff's allegations of infringement are not limited to claim 7, and additional infringed claims will be identified and disclosed through discovery and infringement contentions.

81. Paragraphs 83-87 detail the manner in which the Accused DRAM Instrumentalities infringe claim 7 of the Rao '502 patent, by way of the exemplary Samsung K4A8G045WB DDR4 chip. The images and SRP analyses of the K4A8G045WB chip, set forth below, are derived from the TechInsights teardown report for that chip.

82. Upon information and belief, the Accused DRAM Instrumentalities are in relevant part substantially similar to the exemplary K4A8G045WB DDR4 chip, in particular with regard to the manner in which the Accused DRAM Instrumentalities include and utilize regions with graded dopant concentrations. Upon information and belief, Samsung fabricates the Accused DRAM Instrumentalities according to a limited number of processes, many or all of which utilize substantially similar process steps, including process steps for creating regions with graded dopant concentrations. Paragraphs 83-87 are thus illustrative of the manner in which each of the Accused

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DRAM Instrumentalities infringes.

83. The Accused DRAM Instrumentalities are semiconductor devices.

84. The Accused DRAM Instrumentalities comprise a surface layer and a substrate:

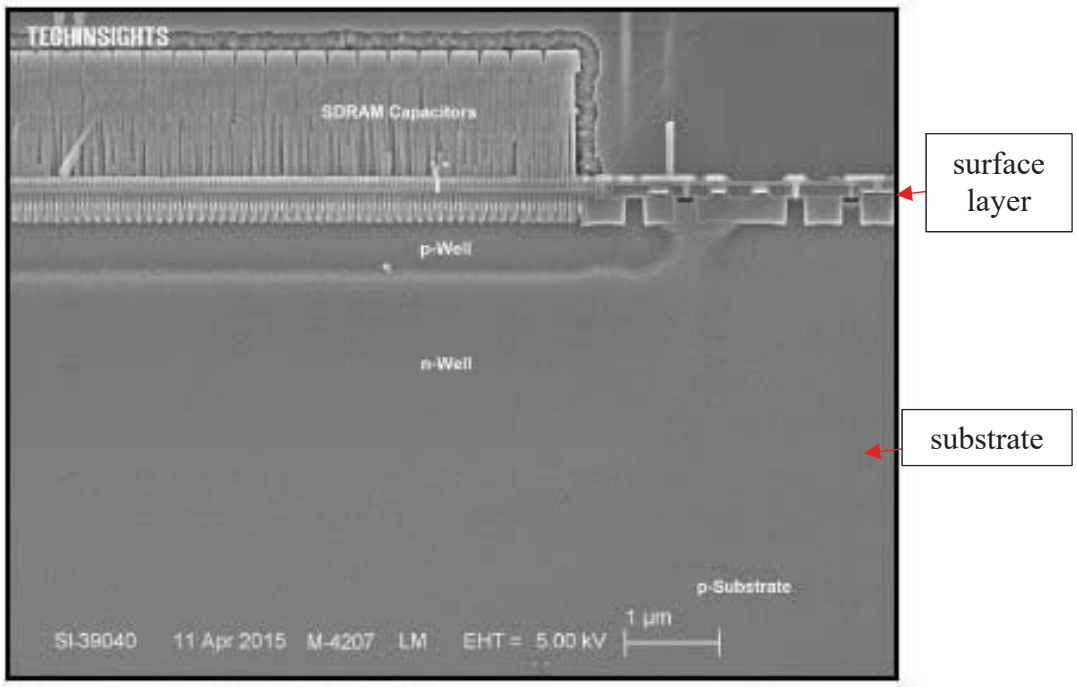


Figure 2.1.3: SDRAM array well structure, SEM cross-section through edges of SDRAM array in bitline direction, silicon etch.

85. The Accused DRAM Instrumentalities comprise an active region including a source and a drain, disposed on one surface of said surface layer:

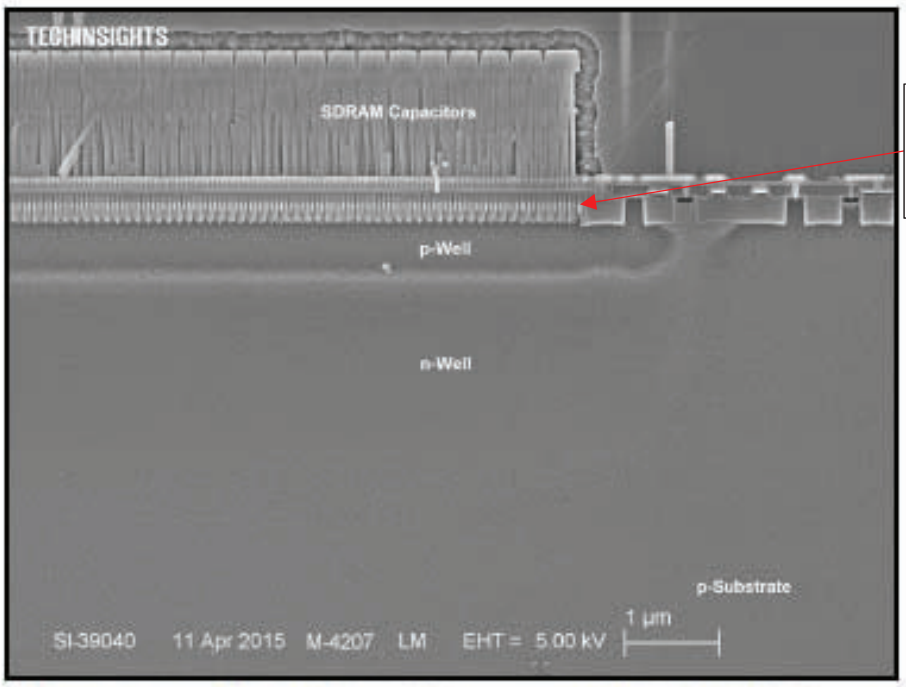


Figure 2.1.3: SDRAM array well structure, SEM cross-section through edges of SDRAM array in bitline direction, silicon etch.

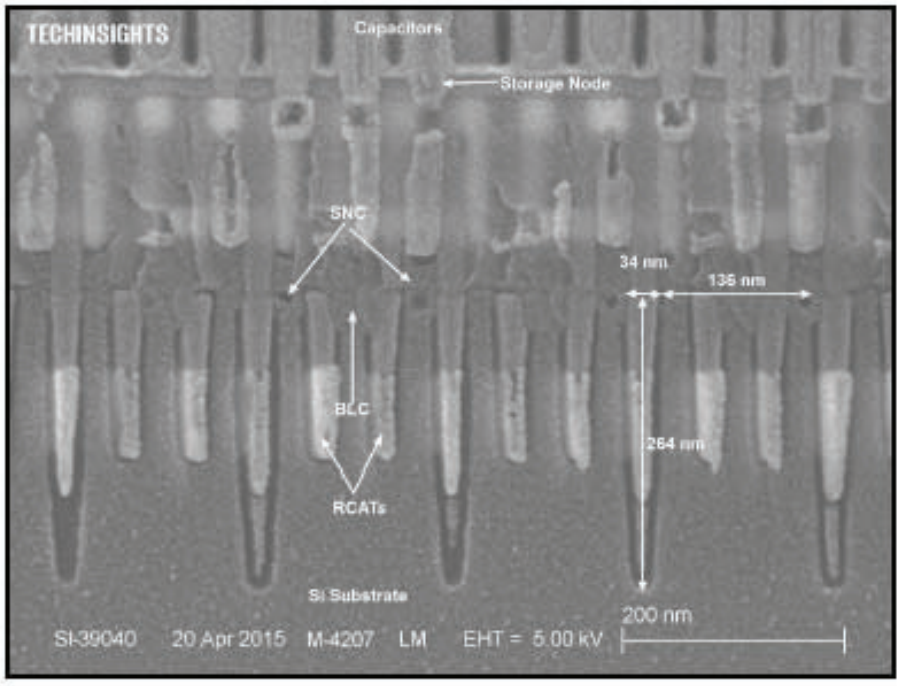


Figure 3.2.6: Recessed channel access transistors, bitline contacts and storage node contact, SEM cross-section in the direction 20 degree to bitline (parallel to active).

86. As shown in the SRP analysis below, the Accused DRAM Instrumentalities

comprise 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:

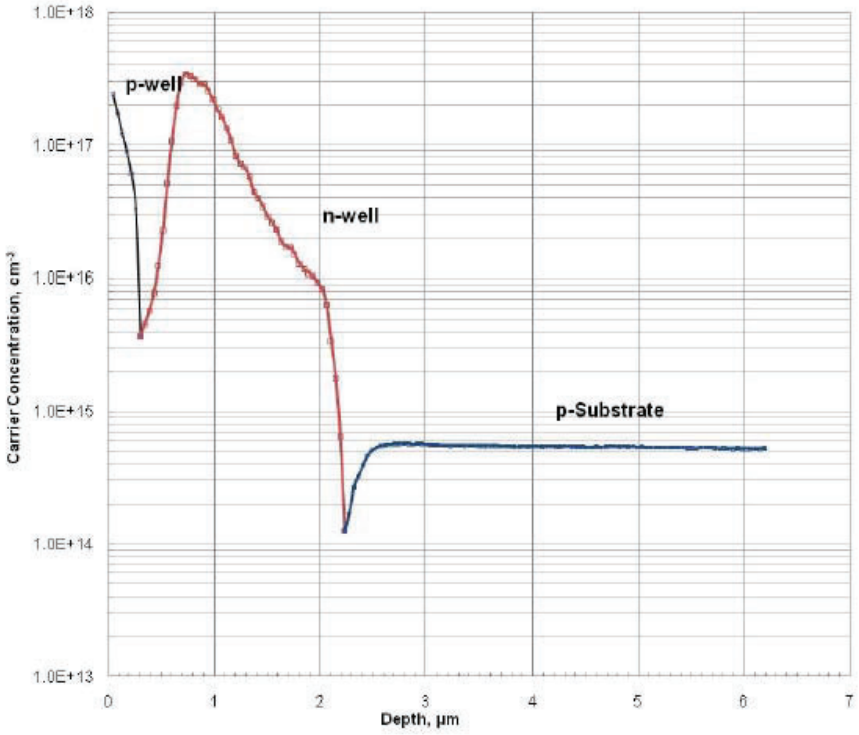


Figure 2.1.2: Spreading resistance profile of an p-well in embedded n-well in SDRAM array.

Table 2.1.1: Summary of SRP measurements.

Feature	Well Depth [µm]	Peak Concentration [cm^{-1}]	Peak Concentration Depth (µm)
p-Substrate	—	5.2×10^{14}	—
Embedded P-well, SDRAM cell array	0.26	2.4×10^{17}	0.1
Deep N-well in array	2.2	3.4×10^{17}	0.73
P-well in periphery	1.0	2.23×10^{17}	0.1

87. The Accused DRAM Instrumentalities comprise 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:

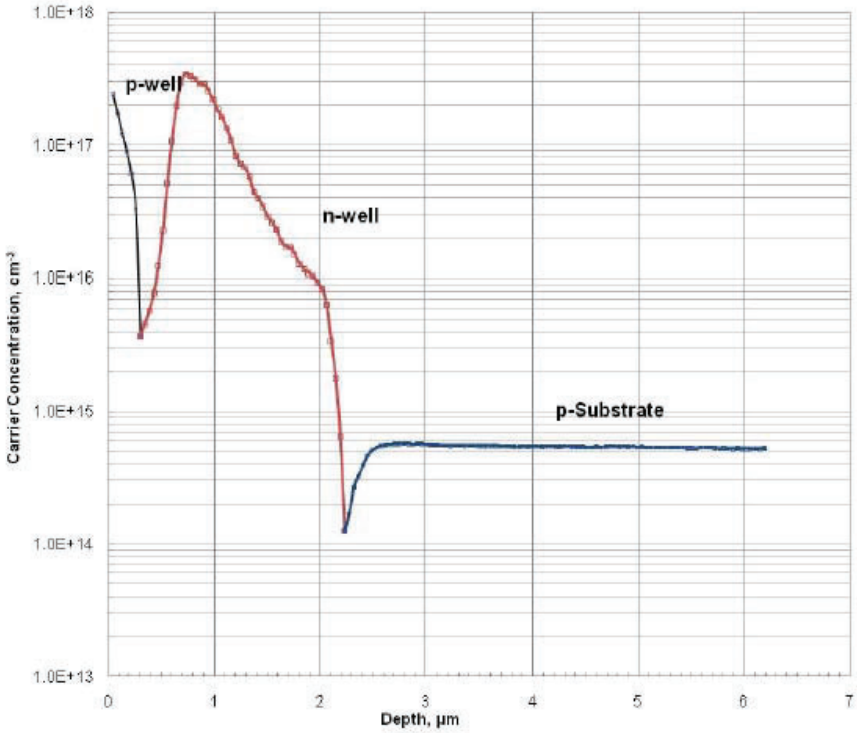


Figure 2.1.2: Spreading resistance profile of an p-well in embedded n-well in SDRAM array.

88. Paragraphs 90-94 detail the manner in which the Accused NAND Instrumentalities infringe claim 7 of the Rao '502 patent, by way of the exemplary Samsung K9DUGB8S7M V-NAND Flash chip. The images and SRP analyses of the K9DUGB8S7M chip, set forth below, are derived from the TechInsights teardown report for that chip.

89. Upon information and belief, the Accused NAND Instrumentalities are in relevant part substantially similar to the exemplary K9DUGB8S7M V-NAND Flash chip, in particular with regard to the manner in which the Accused NAND Instrumentalities

include and utilize regions with graded dopant concentrations. Upon information and belief, Samsung fabricates the Accused NAND Instrumentalities according to a limited number of processes, many or all of which utilize substantially similar process steps, including process steps for creating regions with graded dopant concentrations. Paragraphs 90-94 are thus illustrative of the manner in which each of the Accused NAND Instrumentalities infringes.

90. The Accused NAND Instrumentalities are semiconductor devices.

91. The Accused NAND Instrumentalities comprise a surface layer and a substrate:

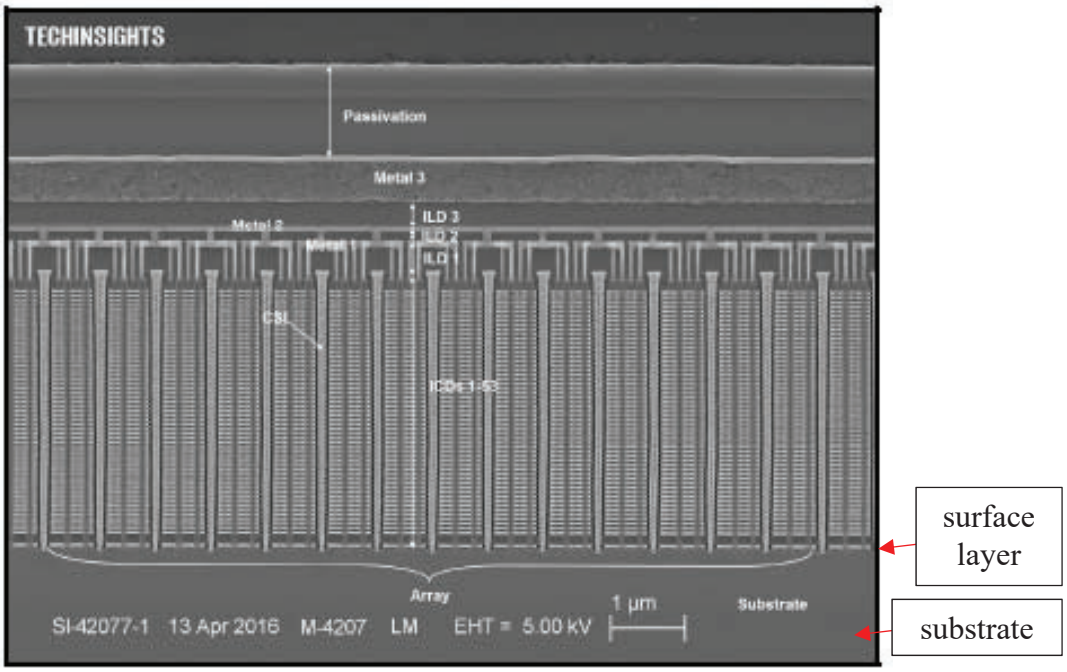


Figure 2.0.2: Process overview, array circuitry (SEM)

92. The Accused NAND Instrumentalities comprise an active region including a source and a drain, disposed on one surface of said surface layer:

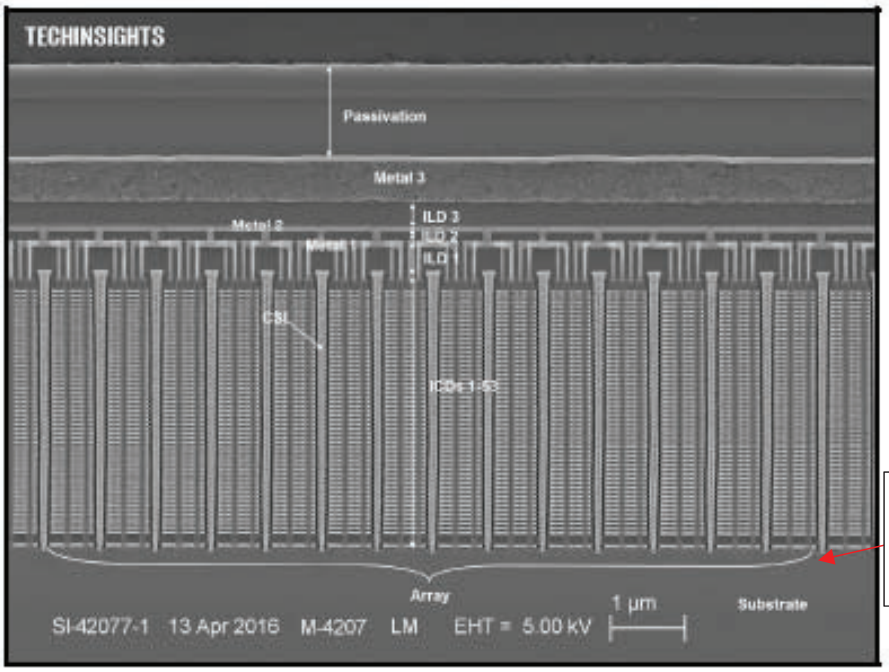


Figure 2.0.2: Process overview, array circuitry (SEM)

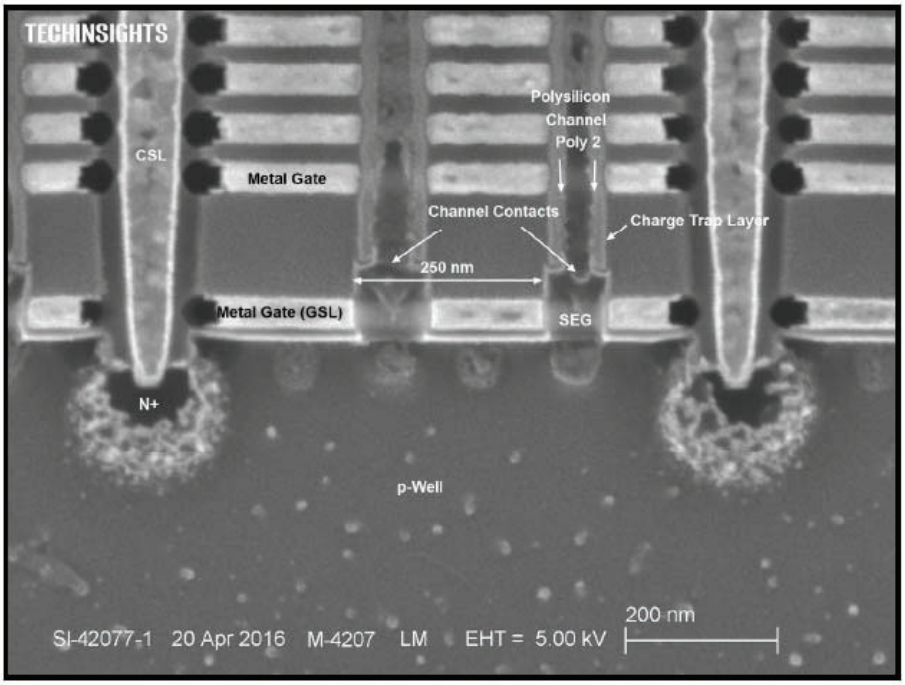


Figure 4.2.2: Source contact at bottom of V-NAND string, Si implants delineated (SEM)

93. As shown in the SRP analysis below, the Accused NAND Instrumentalities comprise 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:

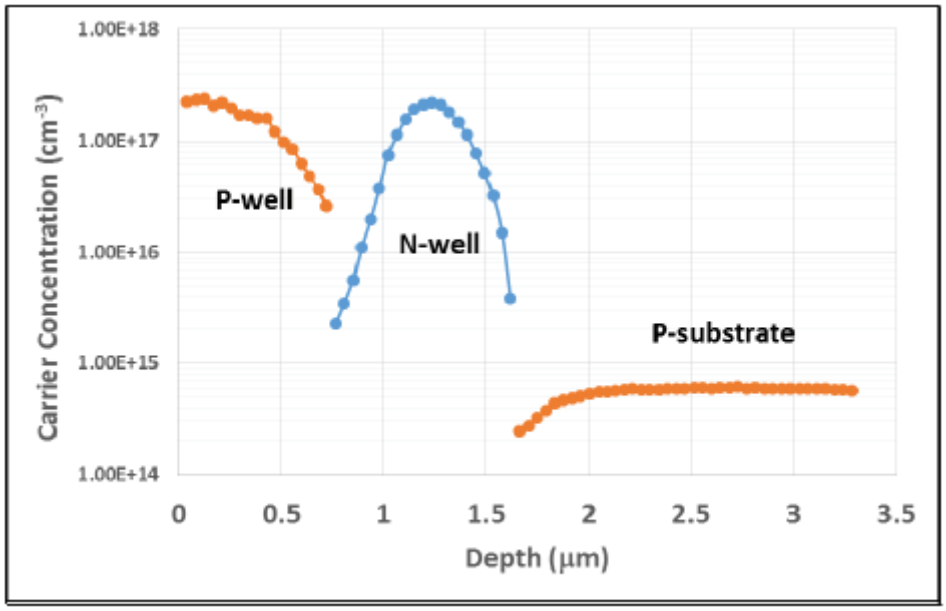


Figure 2.1.2: SRP profile of embedded p-well in NAND array

Table 2.1.1: Substrate and Well Doping

Feature	Depth (µm)	Peak Concentration (cm^{-3})
p-type Si substrate		6.0×10^{14}
n-well in periphery	1.82	2.65×10^{17}
Embedded p-well in flash array	0.73	2.40×10^{17}
Deep n-well in flash array	1.62	2.13×10^{17}

94. The Accused NAND Instrumentalities comprise 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:

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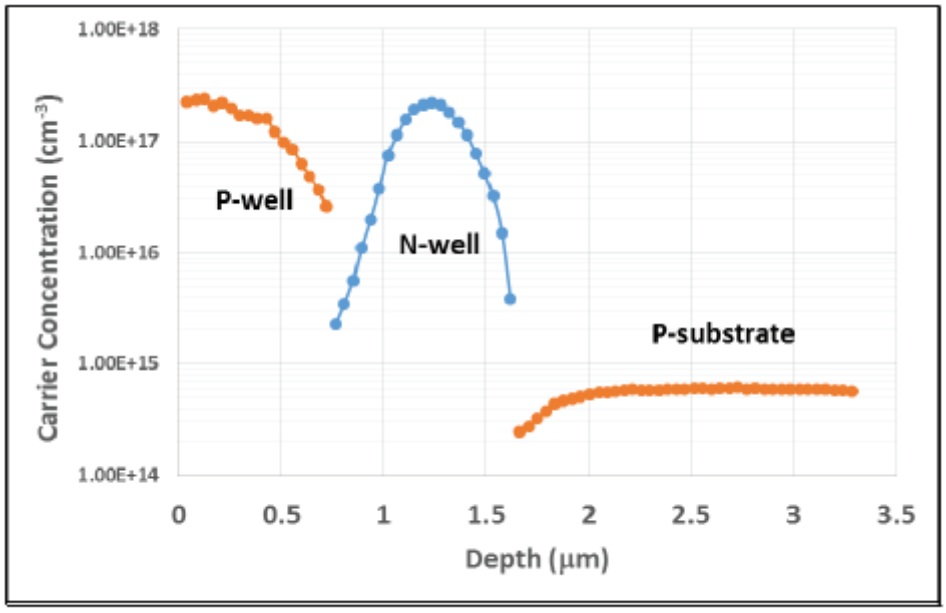


Figure 2.1.2: SRP profile of embedded p-well in NAND array

95. Defendants have actual notice of the Rao '502 patent and the infringement alleged herein at least upon filing of this Complaint, if not earlier, pursuant to 35 U.S.C. § 287(a).

96. Defendants are indirectly infringing the Rao '502 patent by actively inducing the direct infringement of others of the Rao '502 patent, in the United States, the State of Texas, and the Eastern District of Texas.

97. Defendants are inducing, through affirmative acts, their customers and other third parties to directly infringe the Rao '502 patent by making, using, selling in the United States, and/or importing into the United States the Accused DRAM Instrumentalities, Accused NAND Instrumentalities, and/or products that contain one or more of the Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities.

98. The affirmative acts of inducement include, but are not limited to: (1) enabling and encouraging the use, sale, or importation of products that contain one or

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more of the Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities; and (2) advertising or marketing the Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities.

99. At least as of the filing of this Complaint, Defendants knew that the induced conduct would constitute infringement—and intended that infringement at the time of committing the aforementioned affirmative acts, such that the acts and conduct have been and continue to be committed with the specific intent to induce infringement—or deliberately avoided learning of the infringing circumstances at the time of committing these acts so as to be willfully blind to the infringement that was induced.

100. The above-described acts of infringement committed by Defendants have caused injury and damage to Greenthread, and will cause additional severe and irreparable injury and damages in the future.

101. Greenthread is entitled to recover damages sustained as a result of Defendants' wrongful acts in an amount subject to proof at trial, but in no event less than a reasonable royalty.

COUNT III: INFRINGEMENT OF U.S. PATENT NO. 8,106,481

102. The allegations set forth in paragraphs 1 through 51 of this Complaint are incorporated by reference as though fully set forth herein.

103. Pursuant to 35 U.S.C. § 282, the Rao '481 patent is presumed valid.

104. Defendants have directly infringed and continue to infringe one or more claims of the Rao '481 patent in violation of 35 U.S.C. § 271. The infringing products include Accused DRAM Instrumentalities, Accused NAND Instrumentalities, and

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Accused Consumer Electronics that contain one or more of the Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities.

105. Upon information and belief, the Accused DRAM Instrumentalities, the Accused NAND Instrumentalities, and Accused Consumer Electronics containing Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities directly infringe at least claim 1 of the Rao '481 patent at least in the manner described in paragraphs 106-119 below. Plaintiff's allegations of infringement are not limited to claim 1, and additional infringed claims will be identified and disclosed through discovery and infringement contentions.

106. Paragraphs 108-112 detail the manner in which the Accused DRAM Instrumentalities infringe claim 1 of the Rao '481 patent, by way of the exemplary Samsung K4A8G045WB DDR4 chip. The images and SRP analyses of the K4A8G045WB chip, set forth below, are derived from the TechInsights teardown report for that chip.

107. Upon information and belief, the Accused DRAM Instrumentalities are in relevant part substantially similar to the exemplary K4A8G045WB DDR4 chip, in particular with regard to the manner in which the Accused DRAM Instrumentalities include and utilize regions with graded dopant concentrations. Upon information and belief, Samsung fabricates the Accused DRAM Instrumentalities according to a limited number of processes, many or all of which utilize substantially similar process steps, including process steps for creating regions with graded dopant concentrations. Paragraphs 108-112 are thus illustrative of the manner in which each of the Accused

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DRAM Instrumentalities infringes.

108. The Accused DRAM Instrumentalities are CMOS IC devices.

109. The Accused DRAM Instrumentalities comprise a non-epitaxial substrate having a surface area:

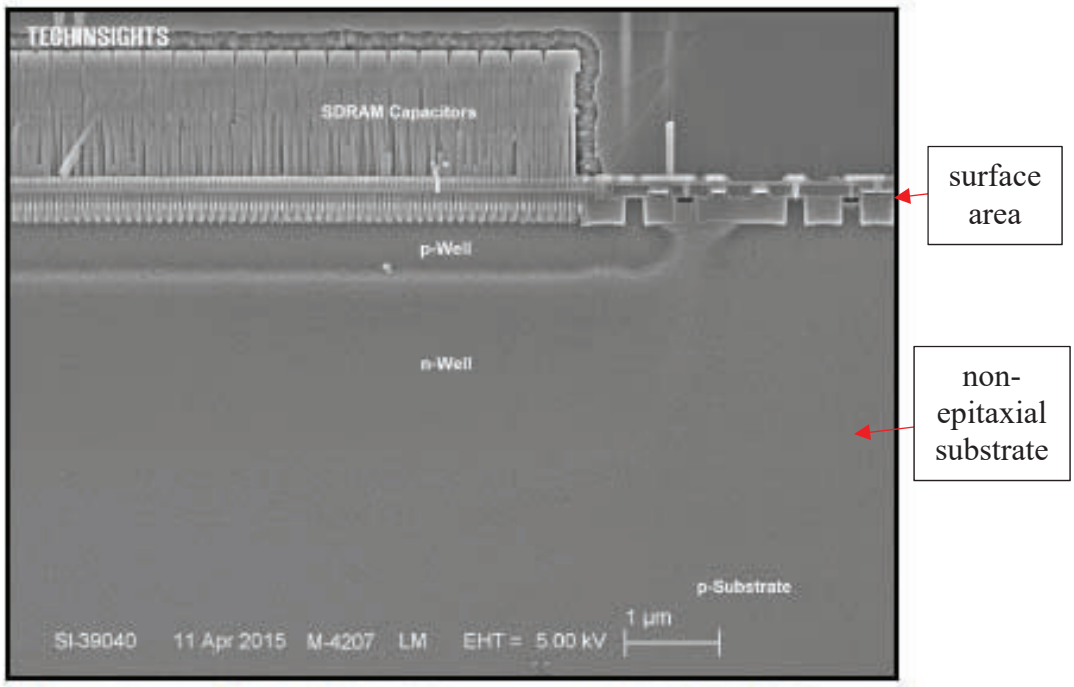


Figure 2.1.3: SDRAM array well structure, SEM cross-section through edges of SDRAM array in bitline direction, silicon etch.

110. The Accused DRAM Instrumentalities comprise a plurality of well regions, *i.e.*, p-wells and n-wells, fabricated on said non-epitaxial substrate and arranged in said surface area, each one of said plurality of well regions comprising 2-way graded dopants disposed therein and at least one of said plurality of well regions further comprising at least one first isolation region disposed therein:

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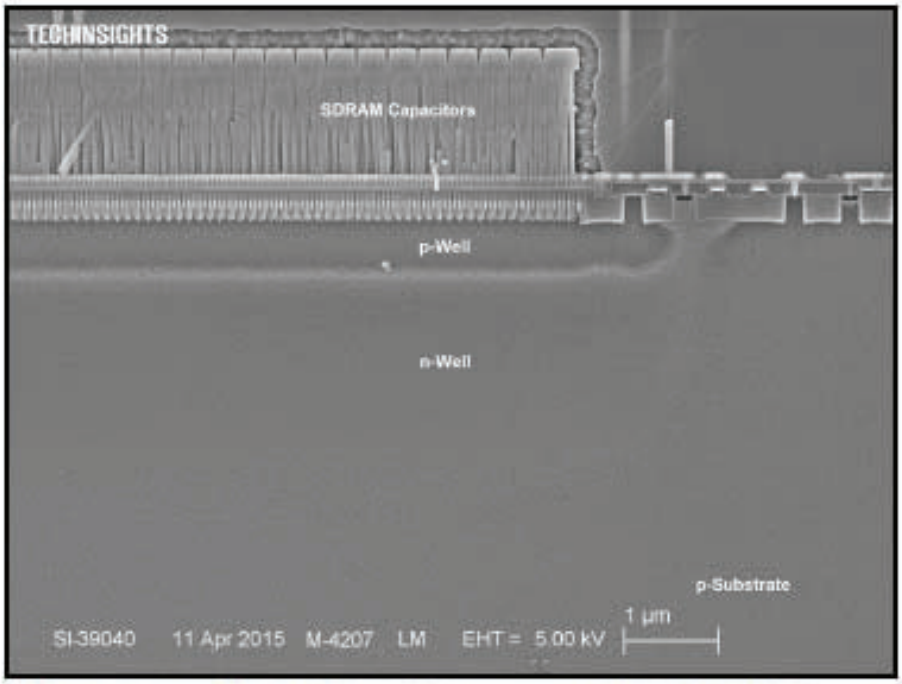


Figure 2.1.3: SDRAM array well structure, SEM cross-section through edges of SDRAM array in bitline direction, silicon etch.

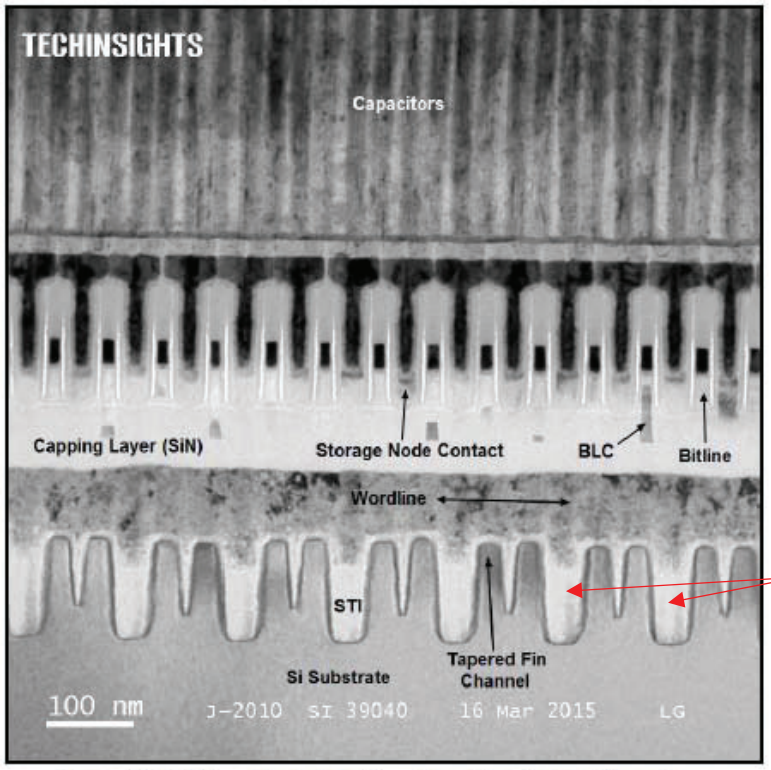


Figure 3.3.6: Bitlines, buried wordline, silicon fin under buried wordline, TEM cross-section along a wordline.

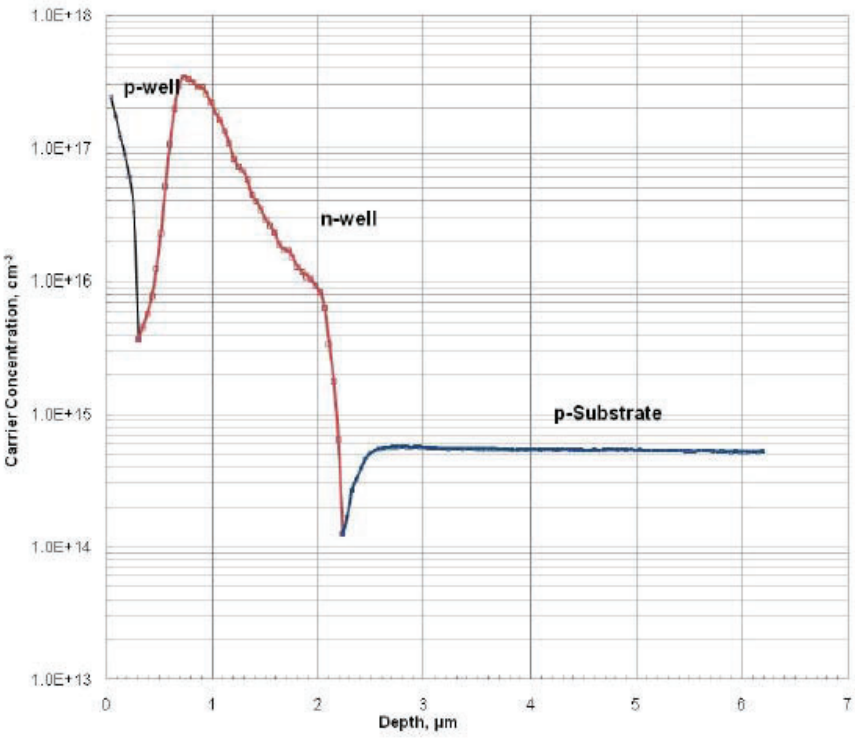


Figure 2.1.2: Spreading resistance profile of an p-well in embedded n-well in SDRAM array.

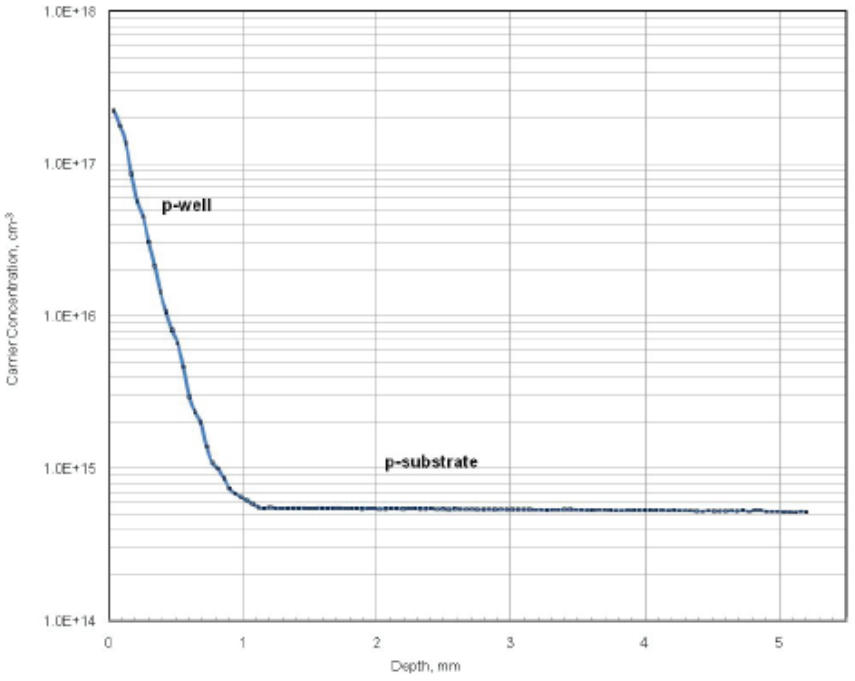


Figure 2.1.1: Spreading resistance profile of a peripheral P-well.

111. The Accused DRAM Instrumentalities comprise at least one second isolation region fabricated on said non-epitaxial substrate separating said plurality of well regions:

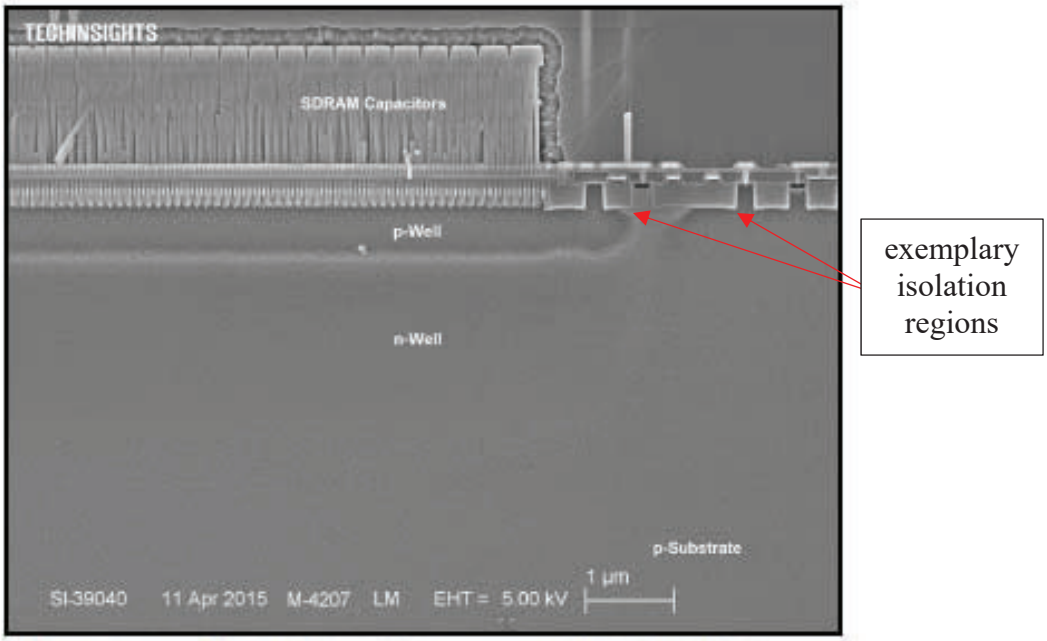


Figure 2.1.3: SDRAM array well structure, SEM cross-section through edges of SDRAM array in bitline direction, silicon etch.

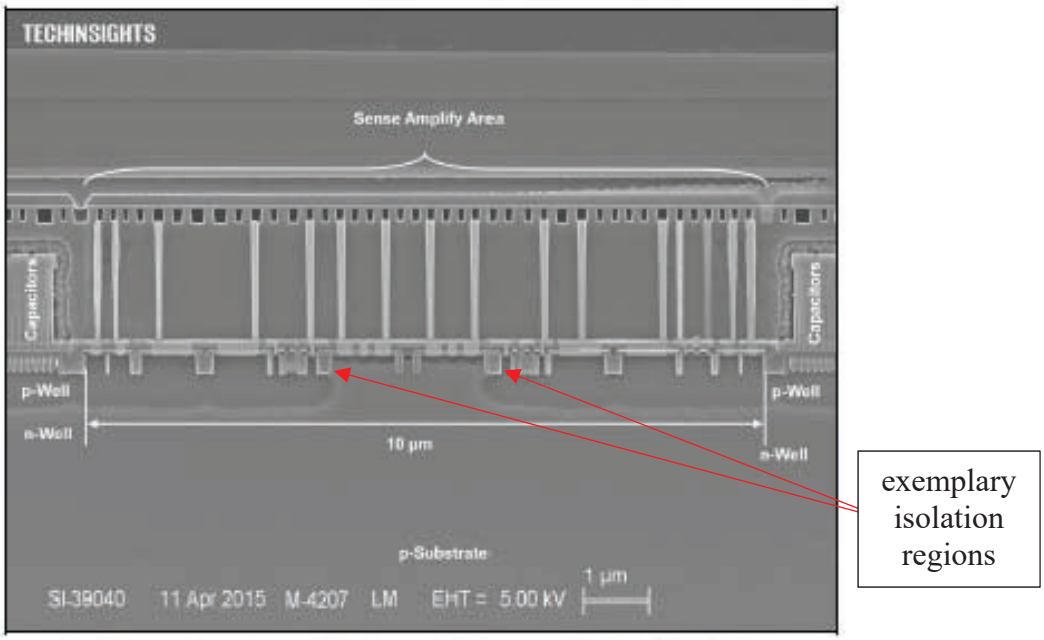


Figure 3.2.1: Sense amplify area between two SDRAM arrays, SEM cross-section in bitline direction with Si etch.

112. As shown in the SRP analysis below, the Accused DRAM Instrumentalities comprise the aforementioned well regions wherein in each one of said plurality of well regions said 2-way graded dopants create a plurality of electric fields for aiding the movement of a first plurality of carriers up toward said surface area and a second plurality of carriers down towards said substrate:

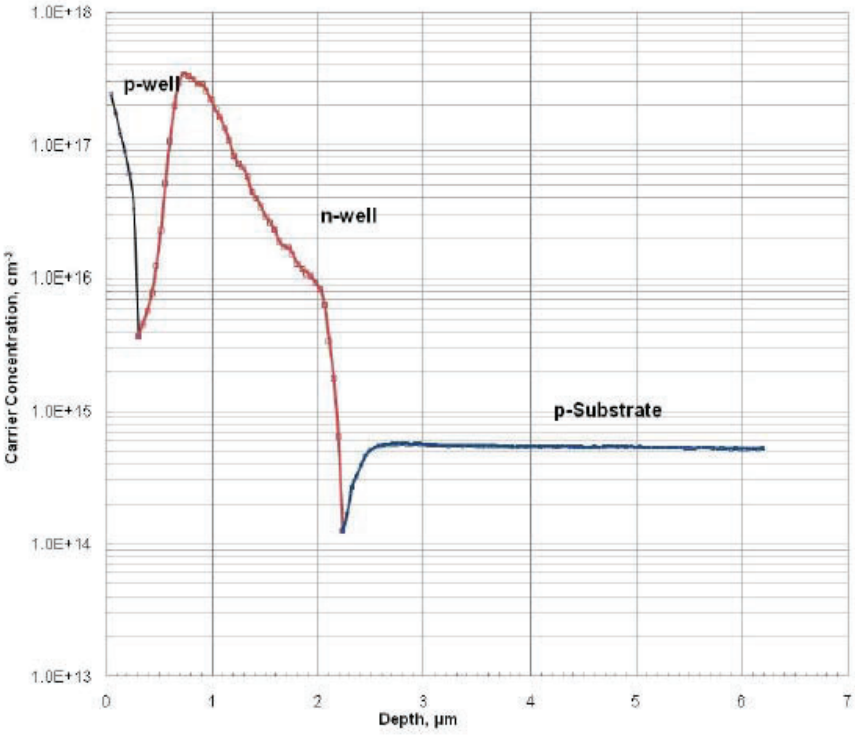


Figure 2.1.2: Spreading resistance profile of an p-well in embedded n-well in SDRAM array.

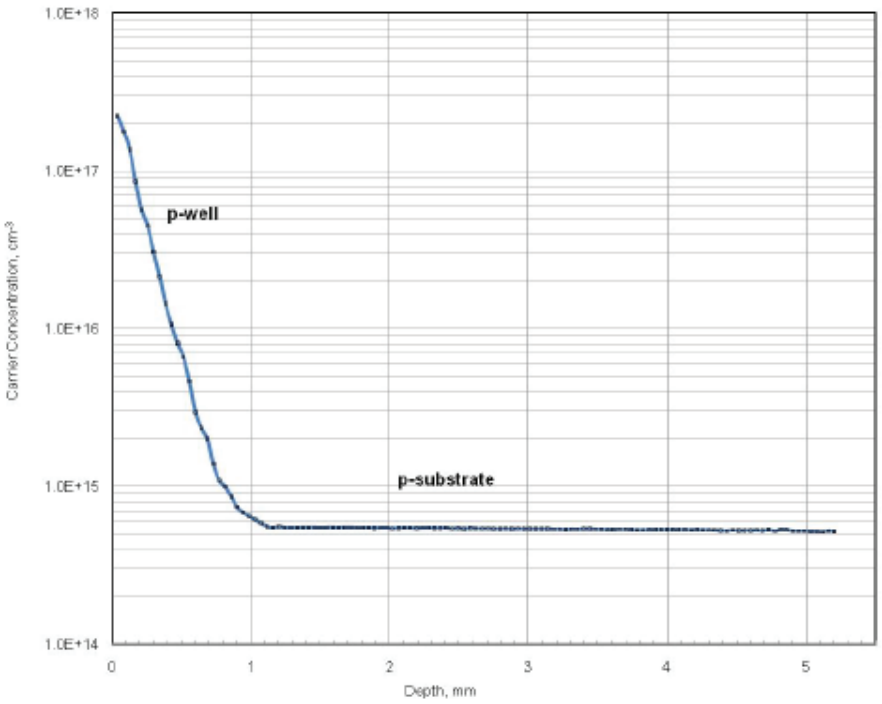


Figure 2.1.1: Spreading resistance profile of a peripheral P-well.

Table 2.1.1: Summary of SRP measurements.

Feature	Well Depth [µm]	Peak Concentration [cm^{-1}]	Peak Concentration Depth (µm)
p-Substrate	—	5.2×10^{14}	—
Embedded P-well, SDRAM cell array	0.26	2.4×10^{17}	0.1
Deep N-well in array	2.2	3.4×10^{17}	0.73
P-well in periphery	1.0	2.23×10^{17}	0.1

113. Paragraphs 115-119 detail the manner in which the Accused NAND Instrumentalities infringe claim 1 of the Rao '481 patent, by way of the exemplary Samsung K9DUGB8S7M V-NAND Flash chip. The images and SRP analyses of the K9DUGB8S7M chip, set forth below, are derived from the TechInsights teardown report for that chip.

114. Upon information and belief, the Accused NAND Instrumentalities are in relevant part substantially similar to the exemplary K9DUGB8S7M V-NAND Flash chip,

in particular with regard to the manner in which the Accused NAND Instrumentalities include and utilize regions with graded dopant concentrations. Upon information and belief, Samsung fabricates the Accused NAND Instrumentalities according to a limited number of processes, many or all of which utilize substantially similar process steps, including process steps for creating regions with graded dopant concentrations. Paragraphs 115-119 are thus illustrative of the manner in which each of the Accused NAND Instrumentalities infringes.

115. The Accused NAND Instrumentalities are CMOS IC devices.

116. The Accused NAND Instrumentalities comprise a non-epitaxial substrate having a surface area:

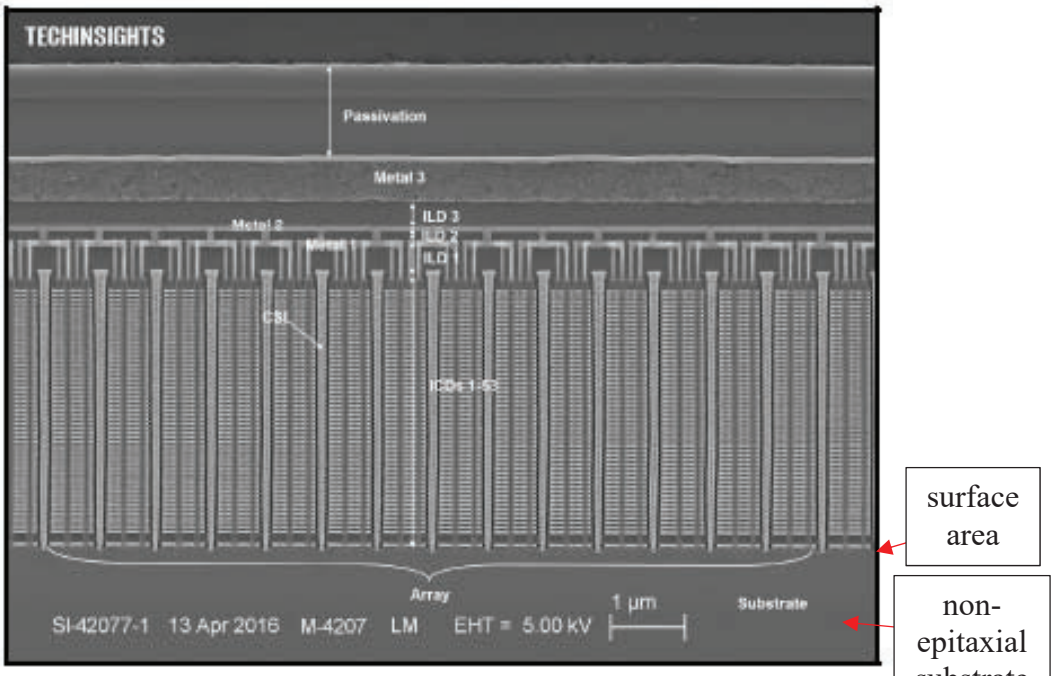


Figure 2.0.2: Process overview, array circuitry (SEM)

117. The Accused NAND Instrumentalities comprise a plurality of well regions, *i.e.*, p-wells and n-wells, fabricated on said non-epitaxial substrate and arranged in said

surface area, each one of said plurality of well regions comprising 2-way graded dopants disposed therein and at least one of said plurality of well regions further comprising at least one first isolation region disposed therein:

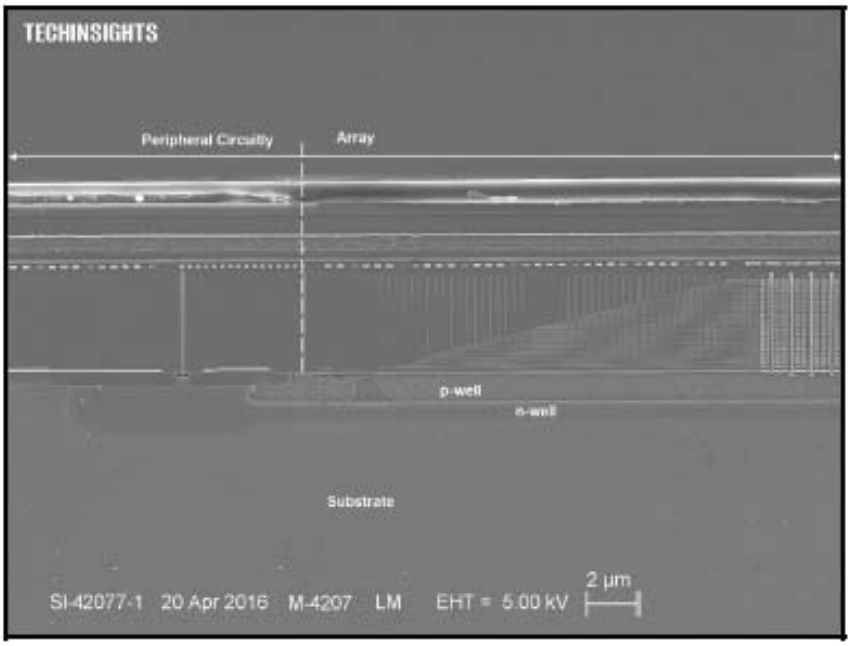


Figure 2.1.1: Flash array edge with well structures delineated (SEM)

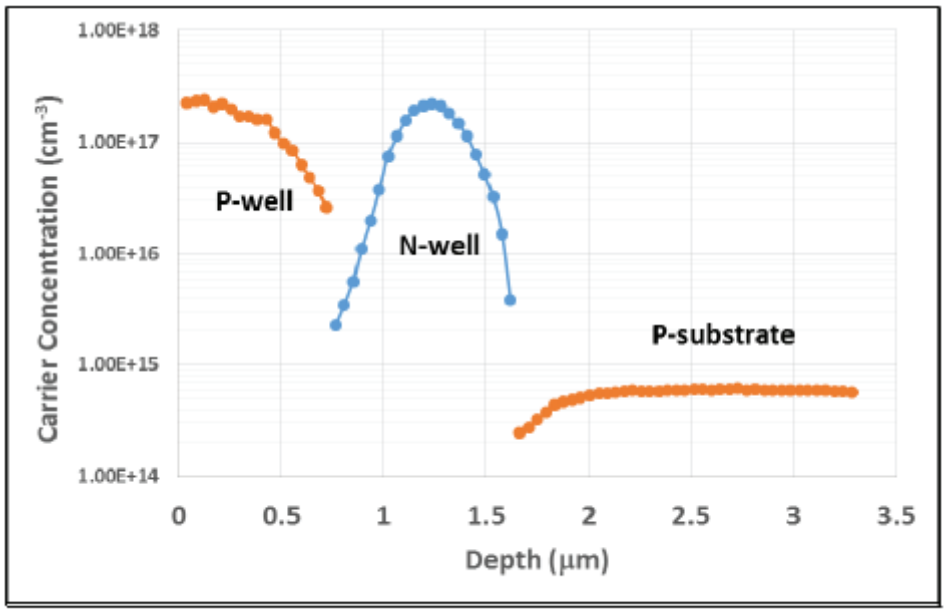


Figure 2.1.2: SRP profile of embedded p-well in NAND array

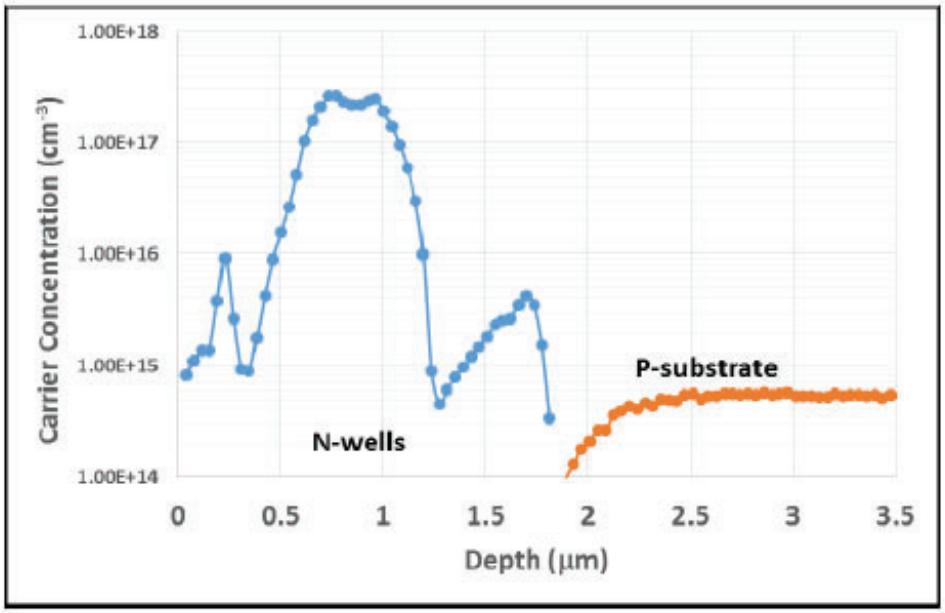


Figure 2.1.3: SRP profile of peripheral n-wells

118. The Accused NAND Instrumentalities comprise at least one second isolation region fabricated on said non-epitaxial substrate separating said plurality of well regions. Upon information and belief, for the device to function properly, the wells under the peripheral circuitry must be isolated from the wells under the array circuitry, and the well regions under the individual blocks within the array must also be isolated from one another.

119. As shown in the SRP analysis below, the Accused NAND Instrumentalities comprise the aforementioned well regions wherein in each one of said plurality of well regions said 2-way graded dopants create a plurality of electric fields for aiding the movement of a first plurality of carriers up toward said surface area and a second plurality of carriers down towards said substrate:

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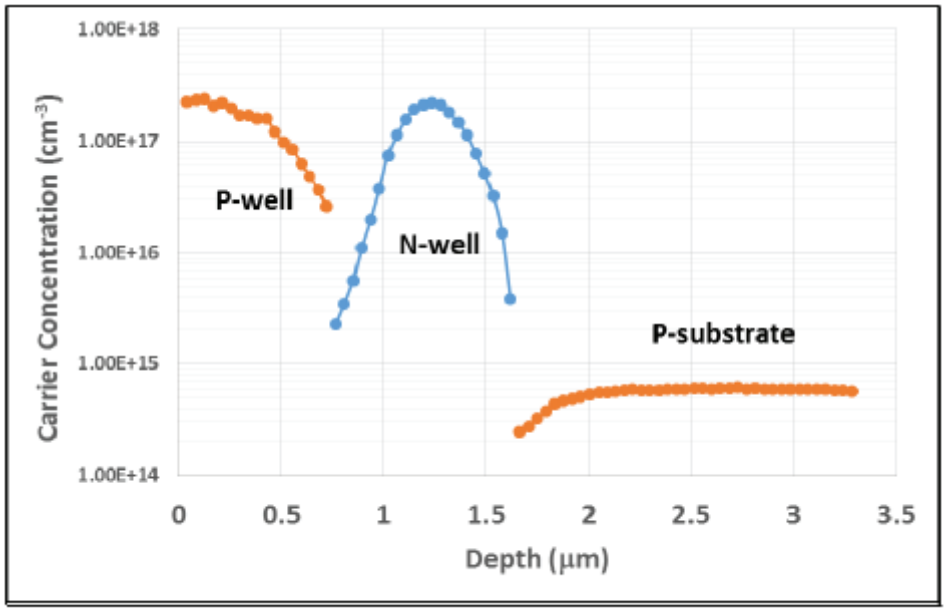


Figure 2.1.2: SRP profile of embedded p-well in NAND array

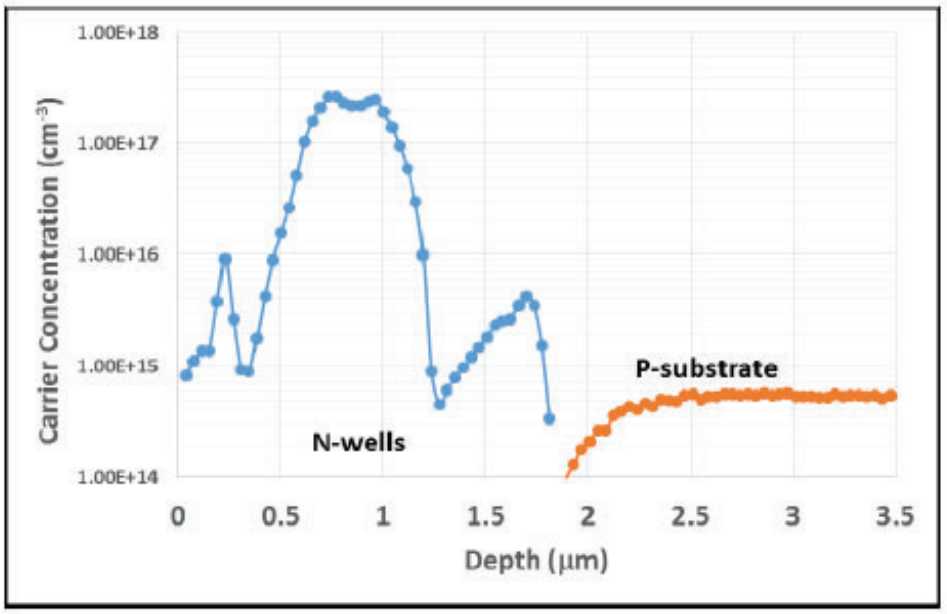


Figure 2.1.3: SRP profile of peripheral n-wells

Table 2.1.1: Substrate and Well Doping

Feature	Depth (µm)	Peak Concentration (cm^{-3})
p-type Si substrate		6.0×10^{14}
n-well in periphery	1.82	2.65×10^{17}
Embedded p-well in flash array	0.73	2.40×10^{17}
Deep n-well in flash array	1.62	2.13×10^{17}

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120. Defendants have actual notice of the Rao '481 patent and the infringement alleged herein at least upon filing of this Complaint, if not earlier, pursuant to 35 U.S.C. § 287(a).

121. Defendants are indirectly infringing the Rao '481 patent by actively inducing the direct infringement of others of the Rao '481 patent, in the United States, the State of Texas, and the Eastern District of Texas.

122. Defendants are inducing, through affirmative acts, their customers and other third parties to directly infringe the Rao '481 patent by making, using, selling in the United States, and/or importing into the United States the Accused DRAM Instrumentalities, Accused NAND Instrumentalities, and/or products that contain one or more of the Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities.

123. The affirmative acts of inducement include, but are not limited to: (1) enabling and encouraging the use, sale, or importation of products that contain one or more of the Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities; and (2) advertising or marketing the Accused DRAM Instrumentalities and/or Accused NAND Instrumentalities.

124. At least as of the filing of this Complaint, Defendants knew that the induced conduct would constitute infringement—and intended that infringement at the time of committing the aforementioned affirmative acts, such that the acts and conduct have been and continue to be committed with the specific intent to induce infringement—or deliberately avoided learning of the infringing circumstances at the time of committing these acts so as to be willfully blind to the infringement that was induced.

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125. The above-described acts of infringement committed by Defendants have caused injury and damage to Greenthread, and will cause additional severe and irreparable injury and damages in the future.

126. Greenthread is entitled to recover damages sustained as a result of Defendants' wrongful acts in an amount subject to proof at trial, but in no event less than a reasonable royalty.

COUNT IV: INFRINGEMENT OF U.S. PATENT NO. 9,647,070

127. The allegations set forth in paragraphs 1 through 51 of this Complaint are incorporated by reference as though fully set forth herein.

128. Pursuant to 35 U.S.C. § 282, the Rao '070 patent is presumed valid.

129. Defendants have directly infringed and continue to infringe one or more claims of the Rao '070 patent in violation of 35 U.S.C. § 271. The infringing products include the Accused Image Sensor Instrumentalities and Accused Consumer Electronics that contain Accused Image Sensor Instrumentalities.

130. Upon information and belief, the Accused Image Sensor Instrumentalities and Accused Consumer Electronics containing Accused Image Sensor Instrumentalities directly infringe at least claim 1 of the Rao '070 patent at least in the manner described in paragraphs 133-137 below. Plaintiff's allegations of infringement are not limited to claim 1, and additional infringed claims will be identified and disclosed through discovery and infringement contentions.

131. Paragraphs 133-137 detail the manner in which the Accused Image Sensor Instrumentalities infringe claim 1 of the Rao '070 patent, by way of the exemplary

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Samsung S5K2X7SP CMOS image sensor. The images and SIMS analyses of the S5K2X7SP chip, set forth below, are derived from the TechInsights teardown report for that chip.

132. Upon information and belief, the Accused Image Sensor Instrumentalities are in relevant part substantially similar to the exemplary S5K2X7SP CMOS image sensor, in particular with regard to the manner in which the Accused Image Sensor Instrumentalities include and utilize regions with graded dopant concentrations. Upon information and belief, Samsung fabricates the Accused Image Sensor Instrumentalities according to processes that utilize substantially similar process steps, including process steps for creating regions with graded dopant concentrations. Paragraphs 133-137 are thus illustrative of the manner in which each of the Accused Image Sensor Instrumentalities infringes.

133. The Accused Image Sensor Instrumentalities are semiconductor devices.

134. The Accused Image Sensor Instrumentalities comprise a substrate of a first doping type, *i.e.*, p-type, at a first doping level having first and second surfaces:

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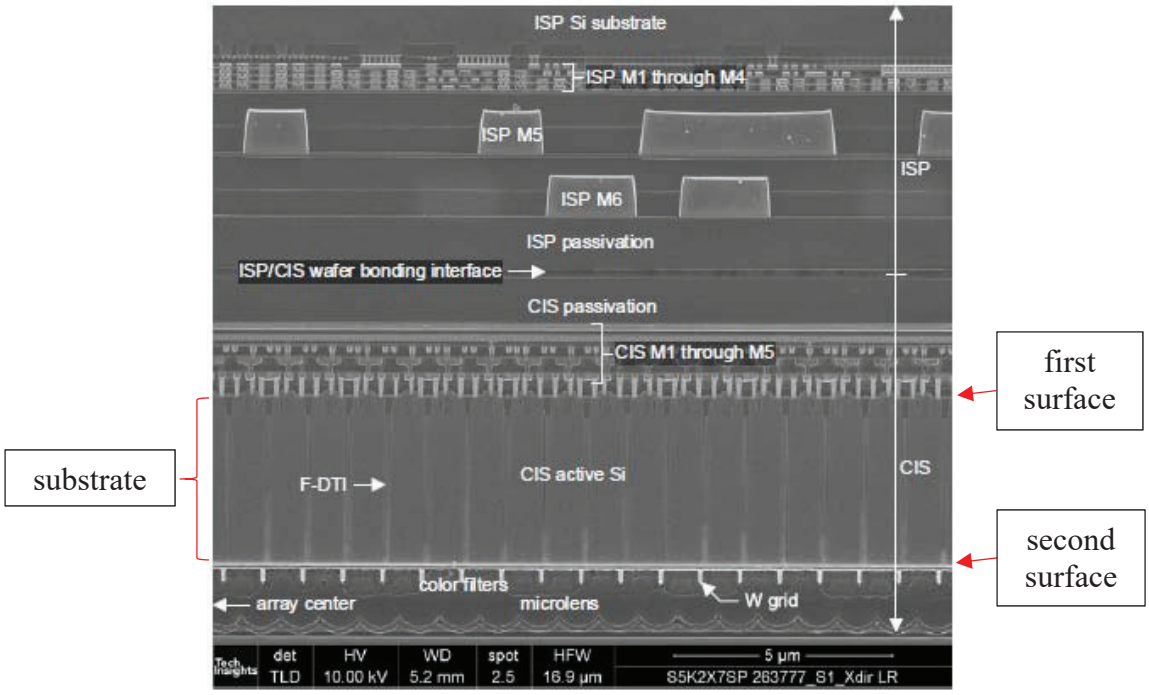


Figure 4.3.10 CIS Pixel Array General Structure – SEM

135. The Accused Image Sensor Instrumentalities comprise an active region disposed adjacent the first surface of the substrate with a second doping type, *i.e.*, n-type, opposite in conductivity to the first doping type:

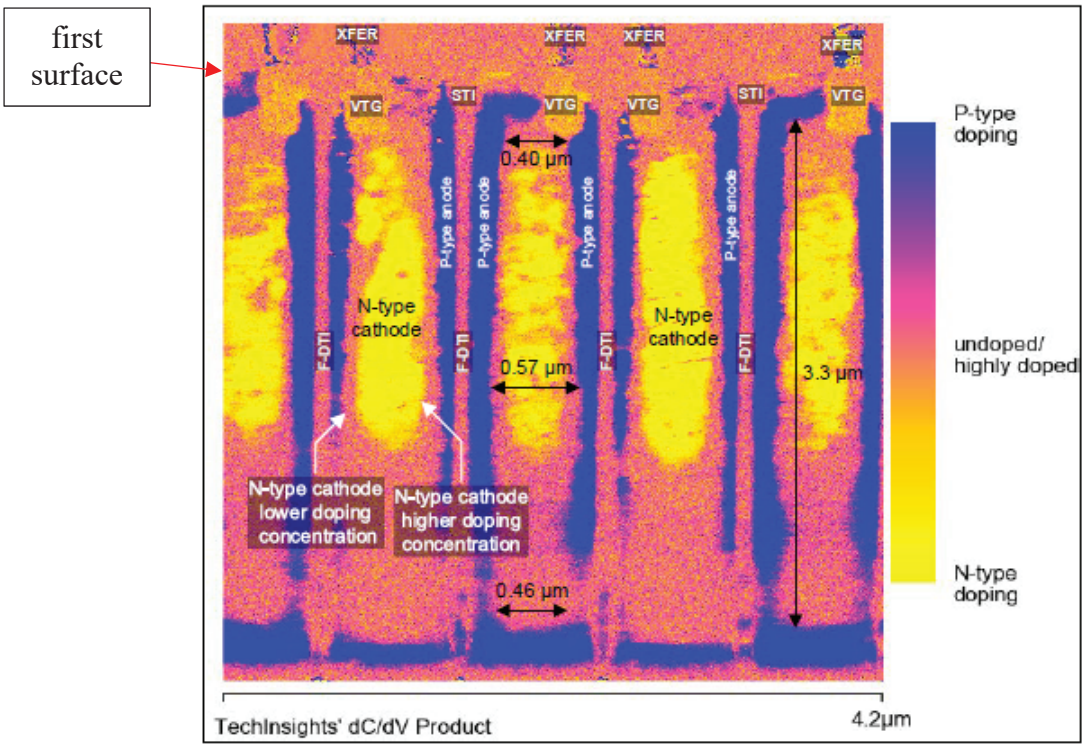


Figure 4.4.4 Pixel Array Photodiode and VTG – SCM

136. The Accused Image Sensor Instrumentalities comprise circuitry formed in a portion of the active region disposed away from the first surface of the substrate and having at least one region of higher conductivity of the second doping type relative to the doping level in the remainder of the active region proximate the at least one region. As a non-limiting example, as shown in the SCM image below, the center region of the n-type photocathode has a higher doping concentration than the peripheral region of the n-type photocathode:

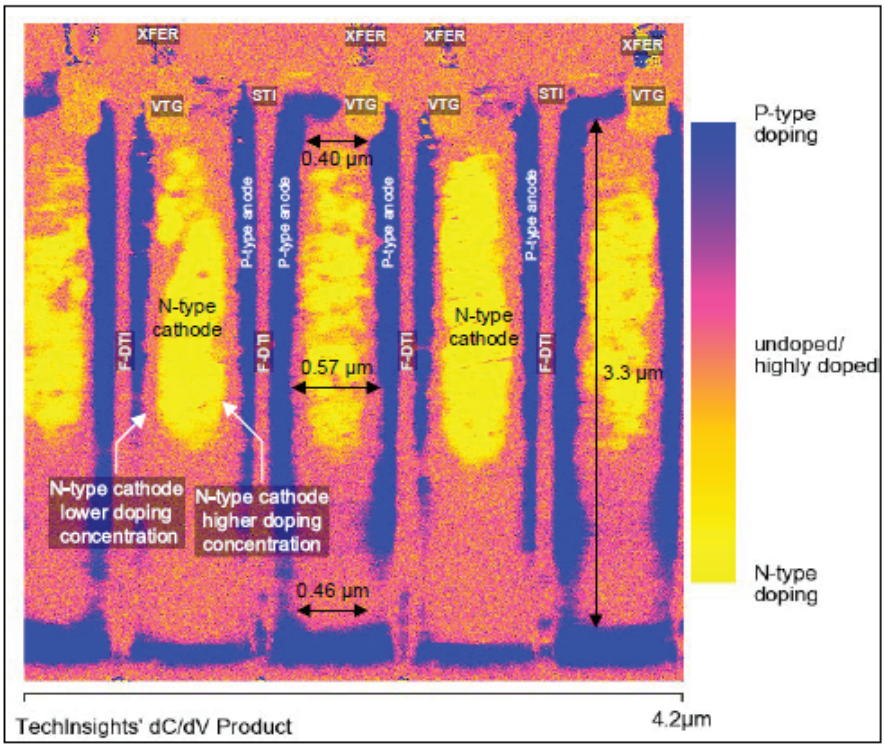


Figure 4.4.4 Pixel Array Photodiode and VTG – SCM

137. As shown in the SIMS analysis below, the Accused Image Sensor Instrumentalities comprise at least a portion of the active region proximate the first surface of the substrate and not containing the at least one region defined with a graded dopant concentration, to aid carrier movement from an emitter in the active region, *e.g.*, the n-type cathode, to a collector in the substrate, *e.g.*, the p-type anode, the graded dopant concentration greater proximate the first surface of the substrate:

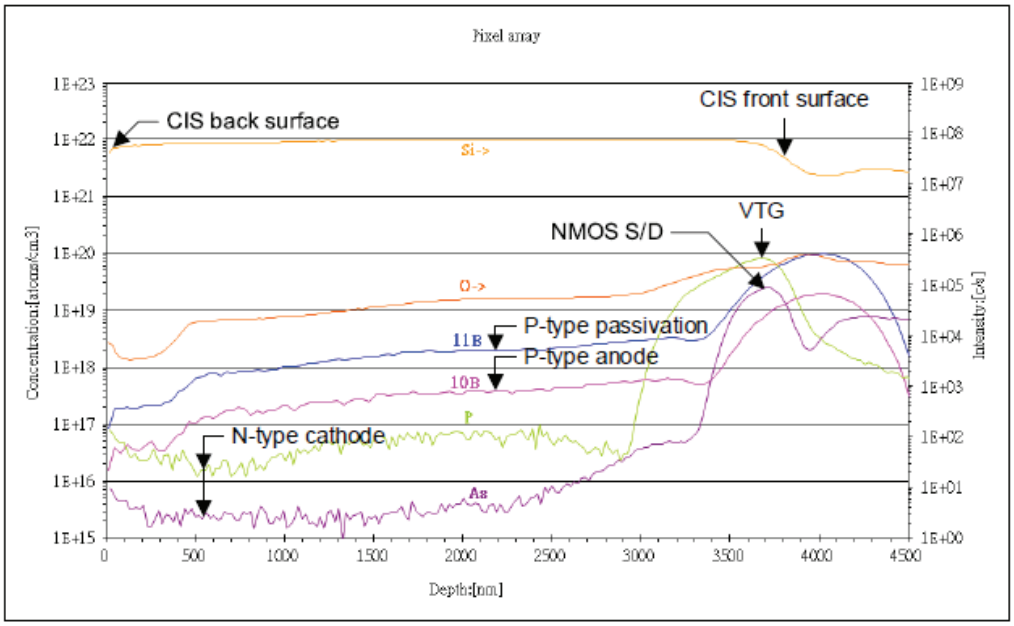


Figure 4.4.10 Pixel Array SIMS Doping Profiles (10B, 11B, P, and As)

138. Defendants have actual notice of the Rao '070 patent and the infringement alleged herein at least upon filing of this Complaint, if not earlier, pursuant to 35 U.S.C. § 287(a).

139. Defendants are indirectly infringing the Rao '070 patent by actively inducing the direct infringement of others of the Rao '070 patent, in the United States, the State of Texas, and the Eastern District of Texas.

140. Defendants are inducing, through affirmative acts, their customers and other third parties to directly infringe the Rao '070 patent by making, using, selling in the United States, and/or importing into the United States the Accused Image Sensor Instrumentalities, and/or products that contain the Accused Image Sensor Instrumentalities.

141. The affirmative acts of inducement include, but are not limited to:

(1) enabling and encouraging the use, sale, or importation of products that contain the Accused Image Sensor Instrumentalities; and (2) advertising or marketing the Accused Image Sensor Instrumentalities.

142. At least as of the filing of this Complaint, Defendants knew that the induced conduct would constitute infringement—and intended that infringement at the time of committing the aforementioned affirmative acts, such that the acts and conduct have been and continue to be committed with the specific intent to induce infringement—or deliberately avoided learning of the infringing circumstances at the time of committing these acts so as to be willfully blind to the infringement that was induced.

143. The above-described acts of infringement committed by Defendants have caused injury and damage to Greenthread, and will cause additional severe and irreparable injury and damages in the future.

144. Greenthread is entitled to recover damages sustained as a result of Defendants' wrongful acts in an amount subject to proof at trial, but in no event less than a reasonable royalty.

JURY TRIAL DEMANDED

Greenthread, LLC, hereby demands a trial by jury on all claims and issues so triable.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff Greenthread respectfully requests that this Court:

A. Enter judgment that each of the Defendants has infringed one or more claims of each of the Greenthread Patents and continues to infringe those claims;

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B. Enter an order, pursuant to 35 U.S.C. § 284, awarding to Plaintiff Greenthread monetary relief in an amount adequate to compensate for Defendants' infringement of the Greenthread Patents, in an amount to be determined at trial, but not less than a reasonable royalty, as well as pre- and post-judgment interest and costs;

C. Enter an order that Defendants pay to Plaintiff Greenthread ongoing royalties in an amount to be determined for any infringement occurring after the date that judgment is entered;

D. Enter an order, pursuant to 35 U.S.C. § 285, declaring this to be an exceptional case and thereby awarding to Plaintiff Greenthread its reasonable attorneys' fees; and

E. Enter an order awarding to Plaintiff Greenthread such other and further relief, whether at law or in equity, that this Court seems just, equitable, and proper.

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Dated: April 30, 2019

Respectfully submitted,

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