IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MASSACHUSETTS

PRESIDENT AND FELLOWS OF HARVARD COLLEGE Plaintiff, v. GLOBALFOUNDRIES U.S., INC. Defendant.	)	COMPLAINT Civil Action No. ___________ **JURY TRIAL DEMANDED**

COMPLAINT

Plaintiff, President and Fellows of Harvard College ("Harvard"), by and through its counsel, Pepper Hamilton LLP, for its Complaint against Defendant GlobalFoundries U.S., Inc. ("GlobalFoundries"), alleges as follows:

THE PARTIES

1. Plaintiff Harvard is an educational institution and charitable corporation organized under the laws of the Commonwealth of Massachusetts with its principal place of business at Massachusetts Hall, Cambridge, MA 02138.

2. Upon information and belief, Defendant GlobalFoundries is a Delaware corporation with its principal place of business at 2600 Great America Way, Santa Clara, CA 95054.

JURISDICTION AND VENUE

3. This is an action for patent infringement arising under the Patent Laws of the United States, 35 U.S.C. § *1 et. seq*. This Court has jurisdiction over the subject matter of this action pursuant to 28 U.S.C. §§ 1331 and 1338(a).

4. This Court has personal jurisdiction over GlobalFoundries based, at least, upon GlobalFoundries' contacts with the forum and the nature of the infringing activity alleged herein. Upon information and belief, GlobalFoundries regularly does or solicits business, engages in other persistent courses of conduct, and/or derives substantial revenue from products and/or services provided to individuals in the Commonwealth of Massachusetts. Upon information and belief, GlobalFoundries has committed acts of patent infringement within the Commonwealth of Massachusetts by, *inter alia*, selling, offering for sale, and/or importing products manufactured by processes, and/or using materials that infringe one or more claims of the patents asserted herein. Further, the exercise of personal jurisdiction comports with Due Process under the United States Constitution.

5. Venue is proper in this district pursuant to 28 U.S.C. §§ 1391(b) and 1400.

BACKGROUND

6. Established in 1636, Harvard is the nation's oldest institution of higher learning and is recognized as one of the world's leading academic institutions. The range of research activities at Harvard is broad and deep. Harvard scholars conduct research in almost every field of knowledge and constantly seek to expand human knowledge through analysis, innovation, and insight. Research at Harvard is supported by more than $800 million of sponsored research funds each year. Researchers include faculty members, visiting scholars, post-doctoral fellows, and graduate and undergraduate students. These researchers collaborate with colleagues across Harvard, at Harvard-affiliated institutions, at other research institutions, and with private corporations throughout the world.

7. Harvard has had a long history of benefiting the public through its research programs. Harvard recognizes that the public benefits from new products and processes that result from discoveries and inventions made by individuals connected with Harvard in the course

of their scholarly and research activities. Harvard protects and manages the intellectual property resulting from the efforts of its researchers, to the benefit of, among others, the researchers, Harvard, and the public.

8. Professor Roy G. Gordon has worked and performed research in Harvard’s Department of Chemistry for over 50 years. Professor Gordon has served as Chairman of the Department of Chemistry and is the Thomas D. Cabot Professor of Chemistry. The Department of Chemistry at Harvard, through its faculty, students, postdoctoral fellows, and other research scholars, work in first-class facilities on individual investigator-led research projects and in collaboration with others in a broad spectrum of chemistry topics.

9. Professor Gordon’s research has spanned a wide range of subjects including applied mathematics, quantum mechanics, spectroscopy, intermolecular forces, solid state, and materials science. His theoretical work has led to a better understanding of bonding in molecules and solids, and to predictions of new solid phases and phase transitions. Currently, the chemical kinetics of crystal growth from vapor systems are being studied both theoretically and experimentally in his laboratory. His discoveries of new materials and vapor deposition processes are widely used commercially for making thin films in solar cells, energy-conserving window coatings, display devices, and semiconductor electronics.

10. Professor Gordon, along with Drs. Jill Becker, Dennis Hausmann, and Seigi Suh are named inventors on U.S. Patent Nos. 6,969,539 (“the ’539 Patent”), 7,507,848 (“the ’848 Patent”), and 8,334,016 (“the ’016 Patent”) (collectively, “the Asserted Patents”). Harvard is the assignee of each of the Asserted Patents and owns all right, title, and interest in the Asserted Patents.

11. The inventions claimed by the Asserted Patents include novel processes and materials for deposition of thin films that contain metal oxides, silicates, metal phosphates or silicon dioxide. Such films are essential to key components of numerous products such as computers and cell phones.

12. Some of the claimed inventions include atomic layer deposition ("ALD"). ALD is a process by which thin films for microelectronics are produced. The ALD process requires a number of steps, one of which is the use of a chemical precursor with appropriate reactive properties, *e.g.*, to form a dielectric layer. However, problems can occur with the use of ALD for the fabrication of small sized semiconductors. For example, problems can occur in forming dielectric materials in deep trench structures, such as those found in dynamic random access memory ("DRAM") devices. Not only must the capacitance values remain at a certain level despite the small size, but the precursor must also be delivered deep into the trenches without causing a premature reaction that precludes uniform coverage within the entire deep trench structure.

13. The ALD processes and materials claimed in the Asserted Patents solve some of the problems associated with the production of semiconductors at smaller sizes. The inventions claimed in the Asserted Patents provide a viable solution for the semiconductor industry, including a solution to forming dielectric materials in deep-trench structures, such as those found in DRAM devices.

14. GlobalFoundries is a member of the semiconductor industry, advertising that it is the world's first full-service semiconductor foundry. Additionally, GlobalFoundries advertises that it is based in Silicon Valley and operates three foundries within the United States, each of which manufactures semiconductor devices.

15. Upon information and belief, GlobalFoundries' facilities in the United States manufacture products using ALD processes and materials. Upon information and belief, GlobalFoundries' manufacturing facilities in the United States manufacture certain products using ALD processes and materials that infringe one or more claims of each of the Asserted Patents. For example, upon information and belief, GlobalFoundries' manufacturing facilities in the United States manufacture processors using the ALD processes and materials claimed by the Asserted Patents.

16. Upon information and belief, on or around July 1, 2015, GlobalFoundries acquired IBM's microelectronics business. As part of that acquisition, GlobalFoundries acquired IBM's semiconductor manufacturing foundries. Upon information and belief, as part of its acquisition of IBM's microelectronics business, GlobalFoundries became IBM's exclusive semi-conductor processor technology provider for the next 10 years. Upon information and belief, all IBM processors from the date of the acquisition are to be provided by GlobalFoundries, including at least the Power7+ and Power8 processors.

17. Upon information and belief, the foundries acquired by GlobalFoundries manufacture certain products using ALD processes and materials that infringe one or more claims of each of the Asserted Patents, including Power8 processors, within the United States.

18. GlobalFoundries manufactures processors for information technology products, which are available worldwide, including throughout the United States and within the Commonwealth of Massachusetts. For example, processors such as the Power8 manufactured by GlobalFoundries, can be purchased in Tyan servers. Tyan is a brand owned by Mitac Computing Technology Corporation.[1] These Tyan servers are advertised for sale and sold throughout the

[1] Seamus Quinn, *GlobalFoundries gets $1.5 billion to make Power chips*, PowerWireeu (Oct. 20 2014), http://powerwire.eu/globalfoundries-gets-1-5-billion-to-make-power-chips.

United States, including the Commonwealth of Massachusetts.[2] For example, Tyan servers that include a Power8 processor are available for sale and shipment to customers in the Commonwealth of Massachusetts. A copy of a quotation by one of Tyan's authorized resellers, as listed on Tyan's website, for sale and shipment to Boston, Massachusetts of a Tyan server including a Power8 processor, is attached as Exhibit D to this Complaint.

19. Upon information and belief, certain GlobalFoundries products are manufactured using the ALD processes and materials claimed by the Asserted Patents and are advertised for sale and sold throughout the United States, including the Commonwealth of Massachusetts. For example, GlobalFoundries Power8 processors are semiconductor devices that are advertised for sale and sold throughout the United States, including the Commonwealth of Massachusetts.

20. Upon information and belief, GlobalFoundries has infringed and continues to infringe the Asserted Patents by manufacturing products using the ALD processes and materials claimed by the Asserted Patents. Additionally, GlobalFoundries has infringed and continues to infringe the Asserted Patents by, directly or through its agents, using, offering for sale, and selling infringing products throughout the United States, including within the Commonwealth of Massachusetts.

21. GlobalFoundries has been aware of its infringing activities at least as of the filing of this Complaint.

COUNT I
(INFRINGEMENT OF U.S. PATENT NO. 6,969,539)

22. Harvard hereby re-alleges and incorporates by reference the foregoing paragraphs of the Complaint as if fully set forth herein.

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[2] *See* Tyan, USA Resellers List, http://www.tyan.com/wtb_usa.aspx.

23. On November 29, 2005, the United States Patent and Trademark Office ("USPTO") duly and legally issued the '539 Patent, entitled "Vapor Deposition of Metal Oxides, Silicates and Phosphates, and Silicon Dioxide," to inventors Roy G. Gordon, Jill Becker, Dennis Hausmann, and Seigi Suh. A true and correct copy of the '539 Patent is attached as Exhibit A to this Complaint.

24. Upon information and belief, in violation of 35 U.S.C. § 271, GlobalFoundries and its subsidiaries have directly infringed and continue to directly infringe, both literally and under the doctrine of equivalents, one or more claims of the '539 Patent, by, without limitation, making products using the process claimed by one or more claims of the '539 Patent. Additionally, GlobalFoundries and its subsidiaries have infringed and continue to infringe the '539 Patent, either literally or under the doctrine of equivalents, by, without limitation, using, offering for sale and/or selling, those products within the United States.

25. Upon information and belief, at least certain GlobalFoundries processors are made using a process that includes all of the limitations of one or more of the claims of the '539 Patent. Upon further information and belief, GlobalFoundries makes these processors in the United States. Upon information and belief, GlobalFoundries directly or indirectly, uses, sells, and/or offers for sale these processors within the United States.

26. GlobalFoundries further violates 35 U.S.C. § 271(g) to the extent GlobalFoundries makes products, including at least Power7+ processors, using a process that includes all of the limitations of one or more of the claims of the '539 Patent abroad, and imports them into the United States.

A. Direct Infringement of the '539 Patent

27. Upon information and belief, certain GlobalFoundries processors are made using the process claimed by one or more claims of the '539 Patent. The analysis below demonstrates

how GlobalFoundries' processors are made using a process claimed by one or more claims of the '539 Patent. The claim and products analyzed below are exemplary and are not intended to limit Harvard's allegations. The analysis is based on information available to Harvard before discovery in this action. Harvard reserves the right to assert any additional claims of the '539 Patent against any infringing acts by GlobalFoundries.

1. Claim 24

28. Upon information and belief, at least the Power7+ processor manufactured within the United States is made using a process that practices each element of claim 24 of the '539 Patent.

a. *A process for forming a metal oxide, comprising:*

29. Upon information and belief, GlobalFoundries performs a process for forming a metal oxide as part of its manufacturing of certain processors, including at least the Power7+ processors.

30. Power7+ processors are microelectronic devices that include insulators containing metal oxide. GlobalFoundries purchased IBM's chip manufacturing operations.[3] Power processors include embedded DRAM (eDRAM), as shown by the image below.[4]

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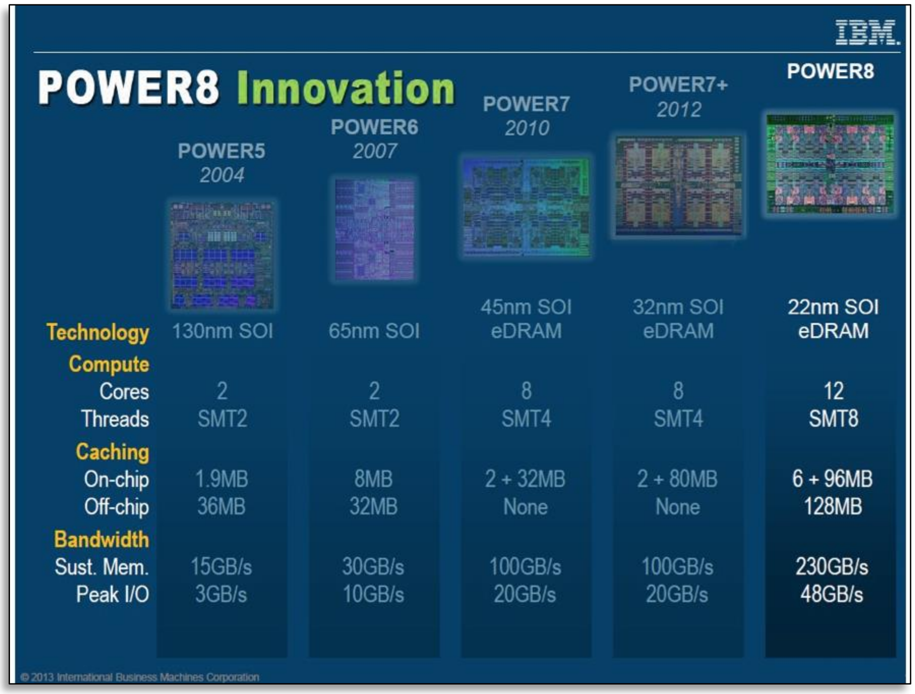
[3] *See* Press Releases, GlobalFoundries (July 1, 2015) http://globalfoundries.com/newsroom/press-releases/2015/07/01/globalfoundries-completes-acquisition-of-ibm-microelectronics-business; Jessica Lipsky, *IBM-GlobalFoundries Deal Finalized*, EE Times (July 1, 2015), http://www.eetimes.com/document.asp?doc_id=1327029; Seamus Quinn, *GlobalFoundries gets $1.5 billion to make Power chips*, PowerWireeu (Oct. 20 2014), http://powerwire.eu/globalfoundries-gets-1-5-billion-to-make-power-chips.

[4] Barry Pangrle, *HotChips: Power8*, Semiconductor Engineering (Sept. 12, 2013), http://semiengineering.com/hotchips-power8/; *see also* Tom R. Hafhill, *Power8 Hits the Merchant Market*, The Linley Group Microprocessor Report (Dec. 29, 2014), http://www-03.ibm.com/systems/power/advantages/smartpaper/memory-bandwidth.html; Jeffrey Stuecheli, *Power Technology For a Smarter Future*, IBM Corporation (2014), https://www.ibm.com/developerworks/community/wikis/form/anonymous/api/wiki/61ad9cf2-c6a3-4d2c-b779-61ff0266d32a/page/1cb956e8-4160-4bea-a956-e51490c2b920/attachment/16bd2505-d09b-4ec6-bdbc-8ca1c668e602/media/POWER8_VUG.pdf.



GlobalFoundries fabricates Power processors, including at least the Power7+, that include eDRAM within the United States.[5]

31. The Power processor eDRAM includes insulators in the form of trench capacitor dielectrics that contain metal oxide.[6] For example, the image below shows the deep trench capacitor on the Power processor 45nm silicon on insulator process, which is exemplary of the Power processor eDRAM trench capacitors.[7]

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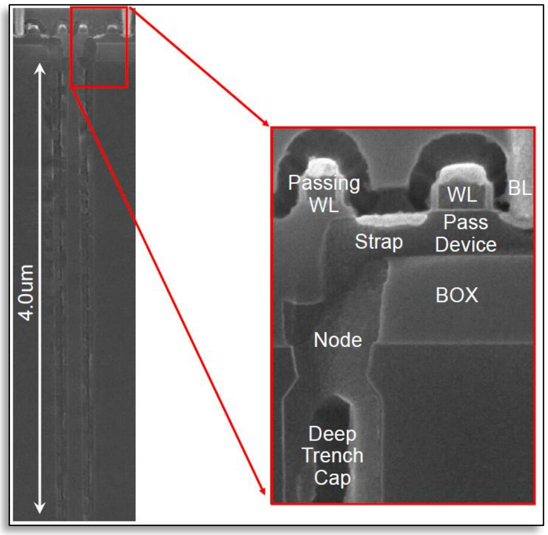
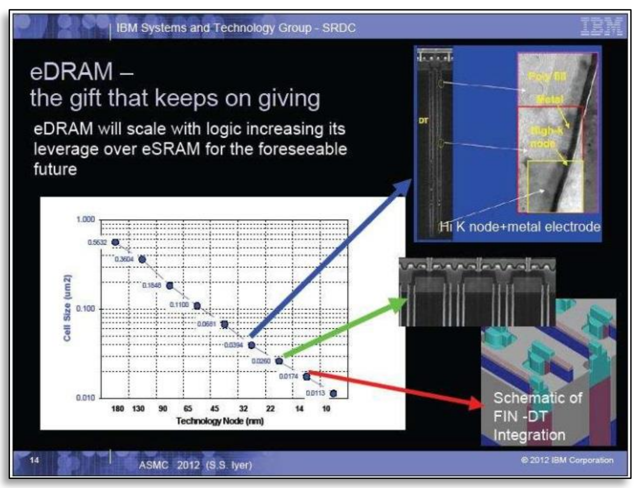
[5] 2012 Press Release, GlobalFoundries (Jan. 10, 2012), http://www.globalfoundries.com/newsroom/press-releases/2012-press-releases/2014/03/01/ibm-and-globalfoundries-begin-first-production-at-new-york's-latest-semiconductor-fab.

[6] David Kanter, *IBM's eDRAM on 32nm SOI*, Real World Technologies (Feb. 15, 2011), http://www.realworldtech.com/iedm-2010/3/.

[7] *Id.*



32. The Power processors have a history of trench capacitor dielectrics that contain metal oxide in their eDRAM as illustrated by the roadmap for eDRAM shown below.[8]



These trenches are further illustrated in the image below, which shows a scanning electron microscope image of a cross-section of eDRAM trench capacitors on the left and plan-view and

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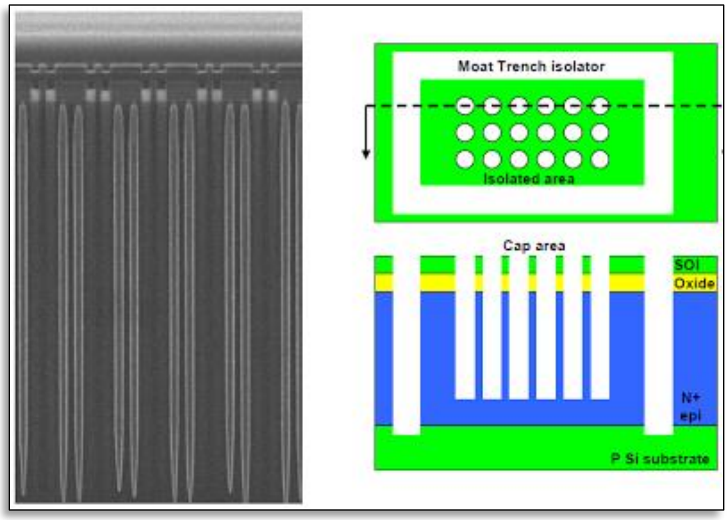
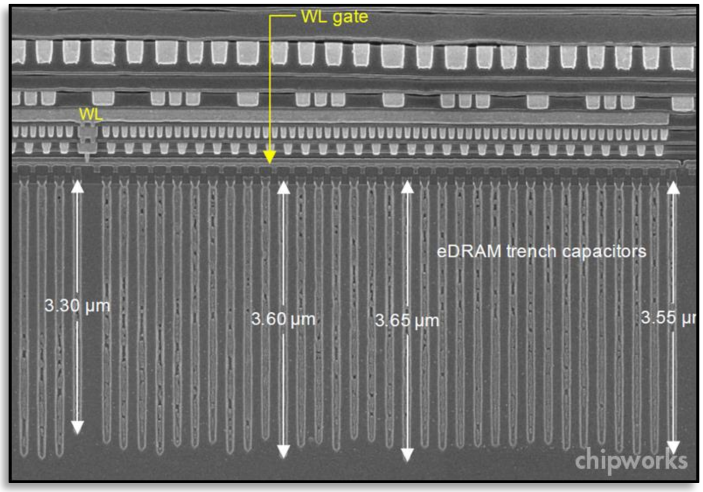
[8] *IBM Surprises with 22nm details at IEDM*, Solid State Technology (Dec. 12, 2012), http://electroiq.com/chipworks_real_chips_blog/2012/12/12/ibm-surprises-with-22nm-details-at-iedm/.

cross-section schematics of decoupling and isolation trenches, showing an N+ epi plate, on the right.[9]



The image below shows deep trench technology in Power7+ eDRAM.[10]



33. The Power processors' deep-trench capacitors in eDRAM contain a high-k dielectric that includes a hafnium oxide (HfO_2) metal oxide layer, at least in the Power7+

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[9] *Id.*

[10] *Intel's e-DRAM Shows Up in the Wild*, Solid State Technology (Feb. 7, 2014), http://electroiq.com/chipworks_real_chips_blog/2014/02/07/intels-e-dram-shows-up-in-the-wild/.

processor.[11] This is shown, for example, by the transmission electron microscope image of an exemplary Power7+ processor high-k dielectric deep trench node stack, shown below.[12]

b. *exposing a heated surface alternately to the vapor of one or more metal amides having an amido group selected from the group consisting of dialkylamido, disilylamido and (alkyl)(sily) amido moieties, and then to the vapors of water or an alcohol.*

34. Upon information and belief, GlobalFoundries performs a process wherein a heated surface is exposed alternately to the vapor of one or more metal amides having an amido group selected from the group consisting of dialkylamido, disilylamido and (alkyl)(sily) amido moieties, and then to the vapors of water or an alcohol.

35. The step of exposing a heated surface alternately to vapor is part of ALD, as described by the presentation slide shown below.[13]

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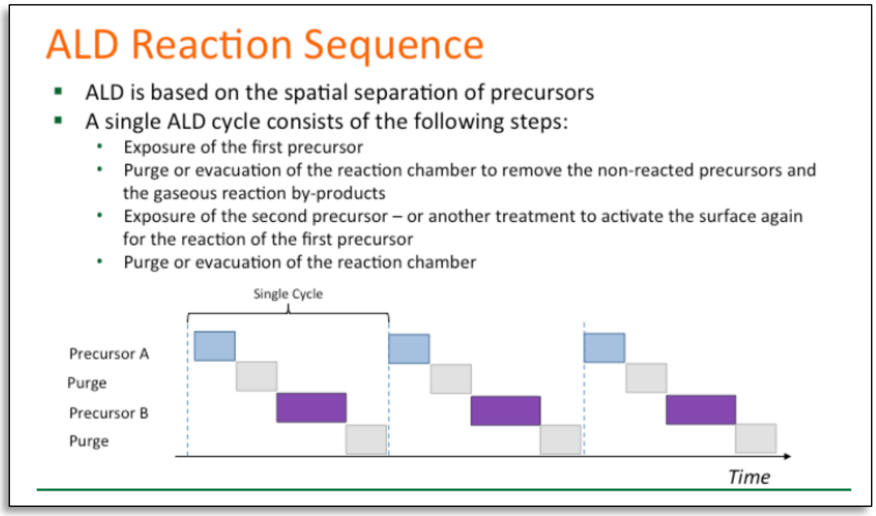
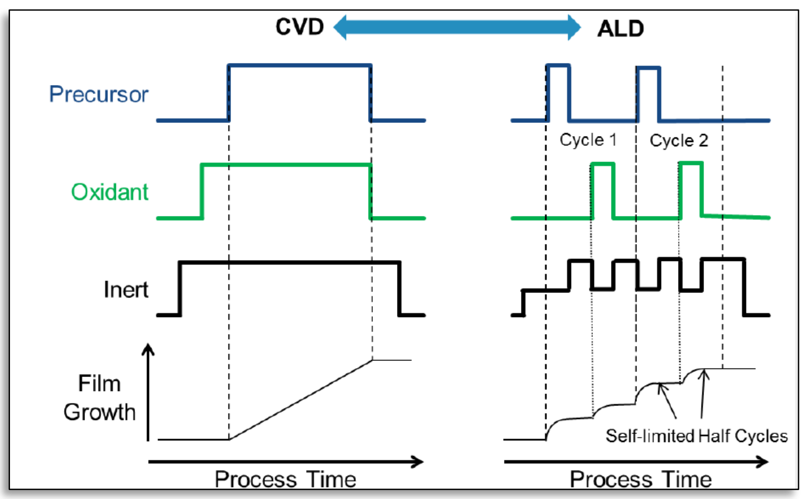
[11] David Kanter, *IBM's eDRAM on 32nm SOI*, Real World Technologies (Feb. 15, 2011), http://www.realworldtech.com/iedm-2010/3/.

[12] N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

[13] *See* Atomic Layer Deposition Overview, Ultratech/CambridgeNanotech, http://www.cambridgenanotechald.com/atomic-layer-deposition-tutorial.shtml#.



This is further illustrated by the process schematic, below, which shows a basic gas-flow sequence to the chamber for Chemical Vapor Deposition and for ALD.[14]



36. GlobalFoundries manufactures eDRAM which utilizes high-k dielectrics for eDRAM capacitors deposited via ALD.[15]

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[14] Clark, Robert D., *Emerging Applications for High K Materials in VLSI Technology*, Materials 2014, 7(4), 2913-2944, *available at* http://www.mdpi.com/1996-1944/7/4/2913.

[15] *See* J. Sundqvist, *Beyond DRAM capacitors and HKMG*, Fraunhofer, (2013), http://www.cnt.fraunhofer.de/content/dam/cnt/de/documents/High-k%20f%C3%BCr%20Alle%20Beyond%20DRAM%20capacitors%20and%20HKMG.pdf ; *see also* N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at*

37. ALD is typically used for DRAM capacitor dielectrics due to the high aspect ratios required.[16] For example, the Power processors' deep-trench capacitors in eDRAM contain a high-k dielectric that includes a hafnium oxide (HfO_2) metal oxide layer, at least in the Power7+ processor.[17] This is shown, for example, by the transmission electron microscope image of an exemplary high-k dielectric deep-trench node stack, shown below.[18]

38. Further, "[a]lkylamides are the most commonly used precursors for HfO_2" ALD films.[19] "Due to the superior properties of the films grown from the alkylamides, alkylamides ($Hf(NEtMe)_4$ [TEMAH] and $Zr(NEtMe)_4$ [TEMAZ] in particular) have received great attention as promising precursors for HfO_2 and ZrO_2 ALD in memory applications."[20] Thus, upon

http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

[16] *See* Clark, Robert D., Emerging Applications for High K Materials in VLSI Technology, Materials 2014, 7(4), 2913-2944, *available at* http://www.mdpi.com/1996-1944/7/4/2913.

[17] David Kanter, *IBM's eDRAM on 32nm SOI*, Real World Technologies (Feb 15, 2011), http://www.realworldtech.com/iedm-2010/3/.

[18] N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

[19] *Atomic Layer Deposition for Semiconductors*, Hwang, Cheol Seong et. al., at 95., http://www.springer.com/us/book/9781461480532.

[20] *Id.*

information and belief, a heated surface is exposed to a vapor comprising $Hf(NEtMe)_4$, which is a metal amide having an amido group selected from the group consisting of dialkylamido, disilylamido and (alkyl)(sily) amido moieties.

39. Further, "ALD of metal oxides involves the reaction of a metal oxide precursor with an oxygen source. Water is the most commonly used oxygen precursor[.]"[21] Thus, upon information and belief, a heated surface is exposed to water vapor.

COUNT II
(INFRINGEMENT OF U.S. PATENT NO. 7,507,848)

40. Harvard hereby re-alleges and incorporates by reference the foregoing paragraphs of the Complaint as if fully set forth herein.

41. On March 24, 2009, the USPTO duly and legally issued the '848 Patent, entitled "Vapor Deposition of Metal Oxides, Silicates and Phosphates, and Silicon Dioxide," to inventors Roy G. Gordon, Jill Becker, Dennis Hausmann, and Seigi Suh, which is a continuation of the '539 Patent. A true and correct copy of the '848 Patent is attached as Exhibit B to this Complaint.

42. Upon information and belief, in violation of 35 U.S.C. § 271, GlobalFoundries and its subsidiaries have directly infringed and continue to directly infringe, either literally or under the doctrine of equivalents, one or more claims of the '848 Patent, including at least claims 1, 3, 4, and 5 by, without limitation, making, using, selling, and/or offering for sale chemical products claimed by one or more claims of the '848 Patent.

43. Upon information and belief, GlobalFoundries uses a chemical product claimed by one or more claims of the '848 Patent, including at least claims 1, 3, 4, and 5 to make certain GlobalFoundries processors. Upon information and belief, GlobalFoundries makes these

[21] Clavel, G.; Marichy, C.; and Pinna, N., ALD of Nanostructured Materials, Chapter 4.2 - Sol-Gel and ALD: An Overview. (2012), Wiley-VCH, page 63.

processors in the United States. Upon information and belief, GlobalFoundries, directly or indirectly, uses, sells, and/or offers for sale these processors in the United States, and/or imports these processors into the United States.

A. Direct Infringement of the ’848 Patent

44. Upon information and belief, GlobalFoundries uses a reagent in a thin-film deposition process as claimed by the ’848 Patent, including at least claims 1, 3, 4, and 5. The analysis below demonstrates how GlobalFoundries’ use of a reagent in a thin-film deposition process meets all elements of one or more claims of the ’848 Patent. The claim and products analyzed below are meant to be exemplary and are not intended to limit Harvard’s allegations. The analysis is based on information available to Harvard before discovery in this action. Harvard reserves the right to assert any additional claims of the ’848 Patent against any infringing acts by GlobalFoundries.

1. Claim 1

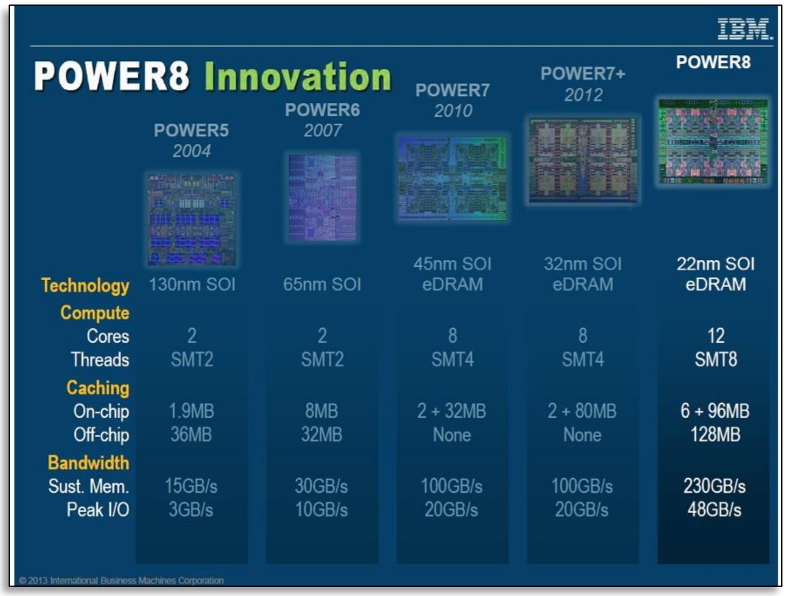
45. Upon information and belief, GlobalFoundries uses a reagent in a thin-film deposition process that practices each element of claim 1 of the ’848 Patent by making an insulator as part of its manufacturing of certain processors.

a. *A reagent for use in a thin film deposition process, the reagent comprising* $Hf(NEtMe)_4$*.*

46. Upon information and belief, GlobalFoundries uses a reagent in a thin film deposition process, the reagent comprising $Hf(NEtMe)_4$. For example, GlobalFoundries performs a thin-film deposition process by making an insulator as part of its manufacturing of

certain processors, at least including the Power7+ and Power8 processors. GlobalFoundries purchased IBM's chip manufacturing operations.[22]

47. Power processors include embedded DRAM ("eDRAM"), as shown by the image below.[23]



The eDRAM includes insulators in the form of trench capacitor dielectrics.[24] For example, the image below shows the deep trench capacitor on 45nm silicon on insulator process, which is exemplary of the Power processors' eDRAM trench capacitors.[25]

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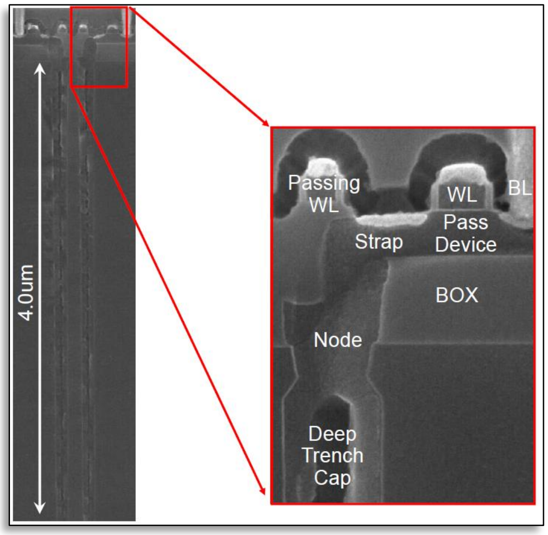
[22] *See* Press Releases, GlobalFoundries (July 1, 2015), http://globalfoundries.com/newsroom/press-releases/2015/07/01/globalfoundries-completes-acquisition-of-ibm-microelectronics-business; Jessica Lipsky, *IBM-GlobalFoundries Deal Finalized*, EE Times (July 1, 2015), http://www.eetimes.com/document.asp?doc_id=1327029; Seamus Quinn, *GlobalFoundries gets $1.5 billion to make Power chips*, PowerWireeu (Oct. 20 2014), http://powerwire.eu/globalfoundries-gets-1-5-billion-to-make-power-chips.

[23] Barry Pangrle, *HotChips: Power8*, Semiconductor Engineering (Sept. 12, 2013), http://semiengineering.com/hotchips-power8/; *see also* Tom R. Hafhill, *Power8 Hits the Merchant Market*, The Linley Group Microprocessor Report (Dec. 29, 2014), http://www-03.ibm.com/systems/power/advantages/smartpaper/memory-bandwidth.html.

[24] David Kanter, *IBM's eDRAM on 32nm SOI*, Real World Technologies (Feb. 15, 2011), http://www.realworldtech.com/iedm-2010/3/.

[25] *Id.*



48. GlobalFoundries performs a thin film deposition process via ALD.[26] ALD is typically used for DRAM capacitor dielectrics due to the high aspect ratios required. For example, some of the Power processors' deep-trench capacitors in eDRAM contain a high-k dielectric that includes a hafnium oxide (HfO_2) metal oxide layer. This is shown, for example, by the transmission electron microscope image of an exemplary Power7+ processor high-k dielectric deep-trench node stack, shown below.[27]

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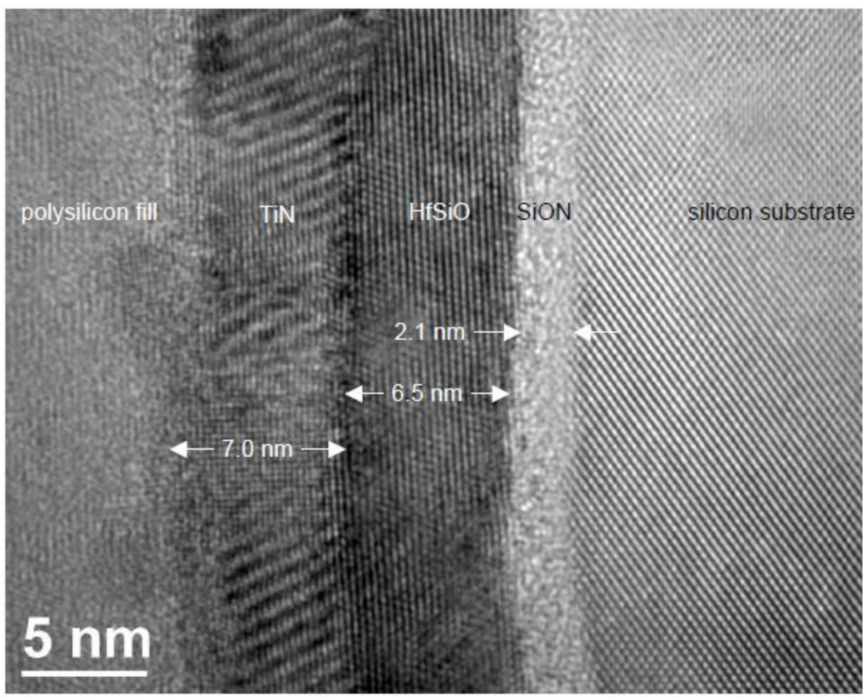
[26] *See* J. Sundqvist, *Beyond DRAM capacitors and HKMG*, Fraunhofer, (2013), http://www.cnt.fraunhofer.de/content/dam/cnt/de/documents/High-k%20f%C3%BCr%20Alle%20Beyond%20DRAM%20capacitors%20and%20HKMG.pdf; *see also* N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

[27] N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

49. Further, Power8 server processors, such as those found in the Tyan server, BSP010G70V8HR-2, include a hafnium silicate dielectric layer.[28] The image below is a transmission electron microscopy lattice image of a Power8 processor trench capacitor sidewall.



50. Further, "[a]lkylamides are the most commonly used precursors for HfO_2" ALD films.[29] "Due to the superior properties of the films grown from the alkylamides, alkylamides

[28] *See* Chip Works, IBM 00NG082, https://chipworks.secure.force.com/catalog/ProductDetails?sku=IBM-00NG082&viewState=DetailView&cartID=&g=&parentCategory=&navigationStr=CatalogSearchInc&searchText=Tyan%20power8.

($Hf(NEtMe)_4$ [TEMAH] and $Zr(NEtMe)_4$ [TEMAZ], in particular) have received great attention as promising precursors for HfO_2 and ZrO_2 ALD in memory applications."[30] In addition, TEMAH has been demonstrated for use as a precursor to form a HfSiO dielectric layer in DRAM trench applications similar to the Power8 trench capacitor.[31] TEMAH is a synonym for tetrakis (ethylmethylamido) hafnium.[32] Thus, upon information and belief, the reagent is tetrakis (ethylmethylamido) hafnium.

COUNT III
(INFRINGEMENT OF U.S. PATENT NO. 8,334,016)

51. Harvard hereby re-alleges and incorporates by reference the foregoing paragraphs of the Complaint as if fully set forth herein.

52. On December 18, 2012, the USPTO duly and legally issued the '016 Patent, entitled "Vapor Deposition of Metal Oxides, Silicates and Phosphates, and Silicon Dioxide," to inventors Roy G. Gordon, Jill Becker, Dennis Hausmann, and Seigi Suh, as a continuation of the '848 Patent, which is a continuation of the '539 Patent. A true and correct copy of the '016 Patent is attached as Exhibit C to this Complaint.

53. Upon information and belief, in violation of 35 U.S.C. § 271, GlobalFoundries and its subsidiaries have directly infringed and continue to directly infringe, either literally or under the doctrine of equivalents, one or more claims of the '016 Patent including at least claims

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[29] Atomic Layer Deposition for Semiconductors, Hwang, Cheol Seong et. al., at 95. http://www.springer.com/us/book/9781461480532.

[30] *Id.*

[31] *See Recent Developments in ALD Technology for 50 nm Trench DRAM Applications*, Schroeder, Uwe, et. al., ECS Transactions 1(5), July 2006, *available at* https://www.researchgate.net/publication/266635170_Recent_Developments_in_ALD_Technology_for_50_nm_Trench_DRAM_Applications.

[32] *See* Tetrakis(ethylmethylamido)hafnium(IV), Sigma-Aldrich, http://www.sigmaaldrich.com/catalog/product/aldrich/553123?lang=en&region=US.

1, 2, 3, and 4 by, without limitation, making products using the process claimed by one or more claims of the ’016 Patent. GlobalFoundries and its subsidiaries have infringed and continue to infringe the ’016 Patent, either literally or under the doctrine of equivalents, by, without limitation, using, offering for sale and/or selling, those products within the United States.

54. Upon information and belief, at least certain GlobalFoundries processors are made using a process that includes all of the limitations of one or more of the claims of the ’016 Patent including at least claims 1, 2, 3, and 4. Upon information and belief, GlobalFoundries makes these processors in the United States. Upon information and belief, GlobalFoundries, directly or indirectly, uses, sells, and/or offers for sale these processors within the United States.

55. GlobalFoundries further violates 35 U.S.C. § 271(g) to the extent GlobalFoundries makes products, at least including Power8 processors, using a process that includes all of the limitations of one or more of the claims of the ’016 Patent abroad, and imports them into the United States.

A. Direct Infringement of the ’016 Patent

56. Upon information and belief, certain GlobalFoundries processors are made using the process claimed by one or more claims of the ’016 Patent including at least claims 1, 2, 3, and 4. The analysis below demonstrates how GlobalFoundries’ processors are made using a process claimed by one or more claims of the ’016 Patent. The claims and products analyzed below are exemplary and are not intended to limit Harvard’s allegations. The analysis is based on information available to Harvard before discovery in this action. Harvard reserves the right to assert any additional claims of the ’016 Patent against any infringing acts by GlobalFoundries.

1. Claim 1

57. Upon information and belief, at least the Power7+ and Power8 processors, manufactured by GlobalFoundries within the United States, are made using a process that practices each element of claim 1 of the ’016 Patent.

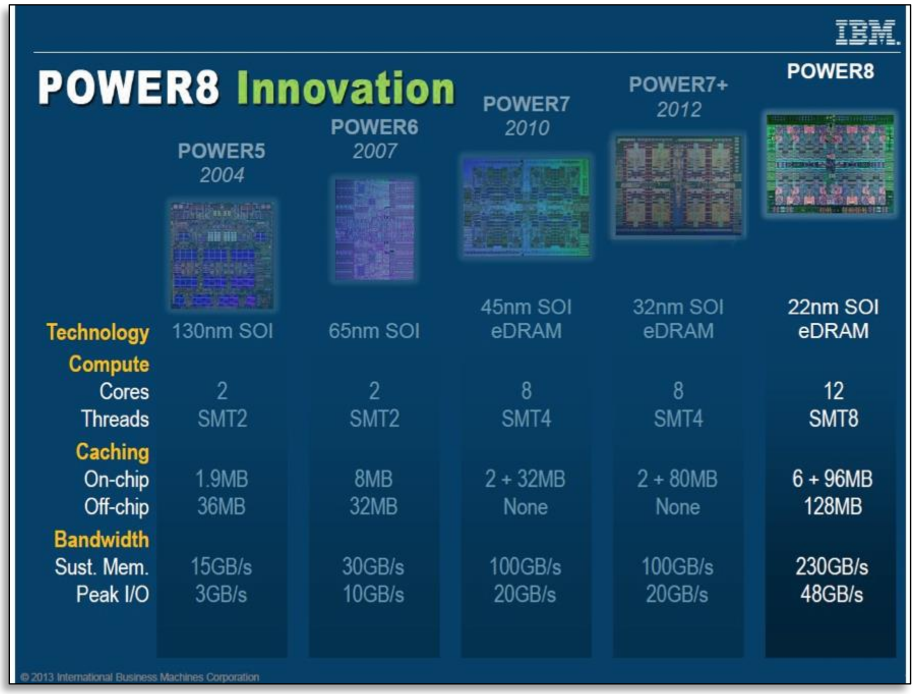
a. *A process for making an insulator in a microelectronic device, the process comprising:*

58. Upon information and belief, GlobalFoundries performs a process for making an insulator in a microelectronic device. Upon information and belief, GlobalFoundries performs a process for making an insulator as part of its manufacturing of certain processors, including at least the Power7+ and Power8 processors. Power processors are microelectronic devices that include insulators.

59. GlobalFoundries purchased IBM’s chip manufacturing operations.[33] Power processors include embedded DRAM (eDRAM), as shown by the image below.[34]

[33] *See* Press Releases, GlobalFoundries (July 1, 2015) http://globalfoundries.com/newsroom/press-releases/2015/07/01/globalfoundries-completes-acquisition-of-ibm-microelectronics-business; Jessica Lipsky, *IBM-GlobalFoundries Deal Finalized*, EE Times (July 1, 2015), http://www.eetimes.com/document.asp?doc_id=1327029; Seamus Quinn, *GlobalFoundries gets $1.5 billion to make Power chips*, PowerWireeu (Oct. 20 2014), http://powerwire.eu/globalfoundries-gets-1-5-billion-to-make-power-chips.

[34] Barry Pangrle, *HotChips: Power8*, Semiconductor Engineering (Sept. 12, 2013), http://semiengineering.com/hotchips-power8/; *see also* Tom R. Hafhill, Power8 Hits the Merchant Market, The Linley Group Microprocessor Report (Dec. 29, 2014), http://www-03.ibm.com/systems/power/advantages/smartpaper/memory-bandwidth.html; Jeffrey Stuecheli, *Power Technology For a Smarter Future*, IBM Corporation (2014), https://www.ibm.com/developerworks/community/wikis/form/anonymous/api/wiki/61ad9cf2-c6a3-4d2c-b779-61ff0266d32a/page/1cb956e8-4160-4bea-a956-e51490c2b920/attachment/16bd2505-d09b-4ec6-bdbc-8ca1c668e602/media/POWER8_VUG.pdf.



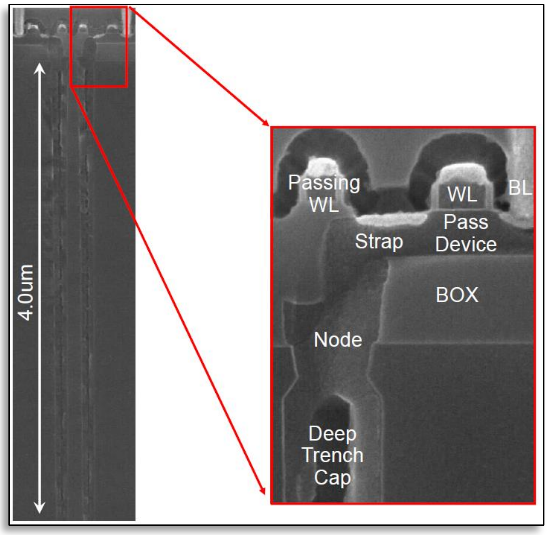
GlobalFoundries fabricates Power processors that include eDRAM within the United States.[35]

60. The eDRAM includes insulators in the form of trench capacitor dielectrics that contain metal oxide.[36] For example, the image below shows the deep-trench capacitor on a 45nm silicon on insulator process, which is exemplary of Power processor eDRAM trench capacitors.[37]

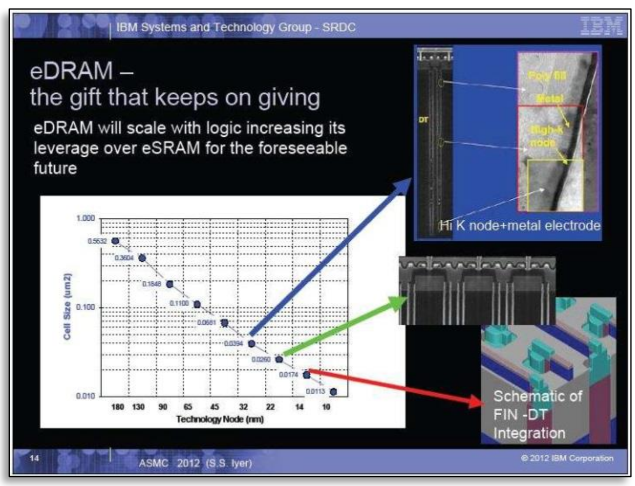
[35] 2012 Press Release, GlobalFoundries (Jan. 10, 2012), http://www.globalfoundries.com/newsroom/press-releases/2012-press-releases/2014/03/01/ibm-and-globalfoundries-begin-first-production-at-new-york's-latest-semiconductor-fab.

[36] David Kanter, *IBM's eDRAM on 32nm SOI*, Real World Technologies (Feb. 15, 2011), http://www.realworldtech.com/iedm-2010/3/.

[37] *Id.*



61. The Power processors have a history of trench capacitor dielectrics that contain metal oxide in their eDRAM, as illustrated by the roadmap for eDRAM shown below.[38]



These trenches are further illustrated by the image below, which shows a scanning electron microscope cross-section of eDRAM trench capacitors on the left and plan-view and cross-section schematics of decoupling and isolation trenches, showing N+ epi plate, on the right.[39]

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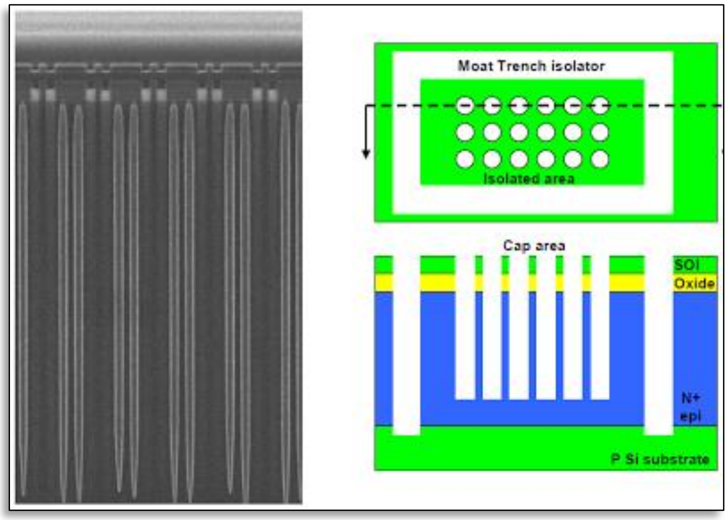
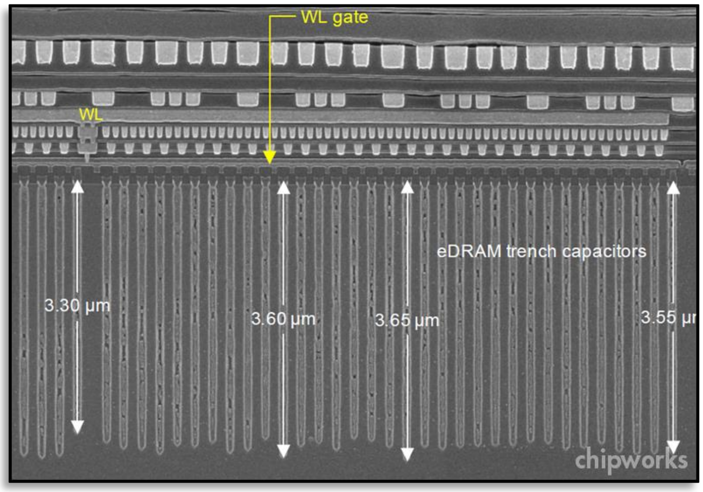
[38] *IBM Surprises with 22nm details at IEDM*, Solid State Technology (Dec. 12, 2012), http://electroiq.com/chipworks_real_chips_blog/2012/12/12/ibm-surprises-with-22nm-details-at-iedm/.

[39] *Id.*



62. The image below shows deep-trench technology in Power7+ eDRAM.[40]

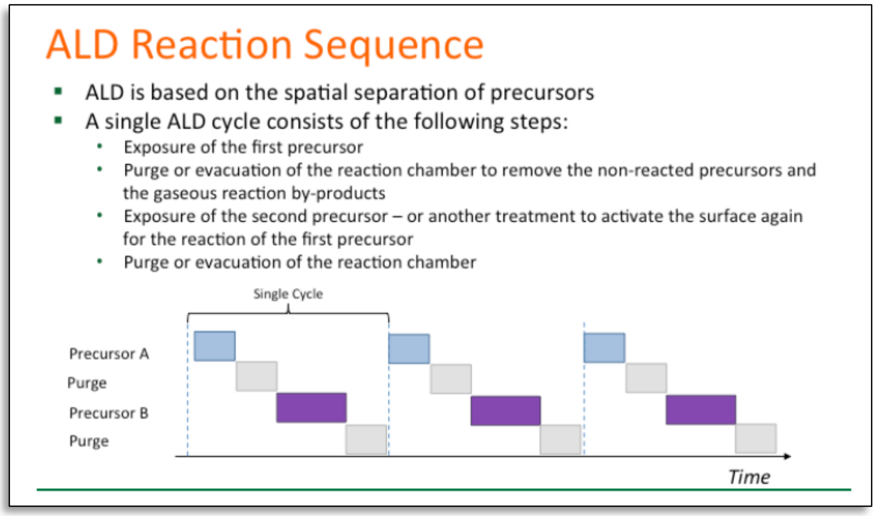


b. *introducing a first reactant component into a deposition chamber;*

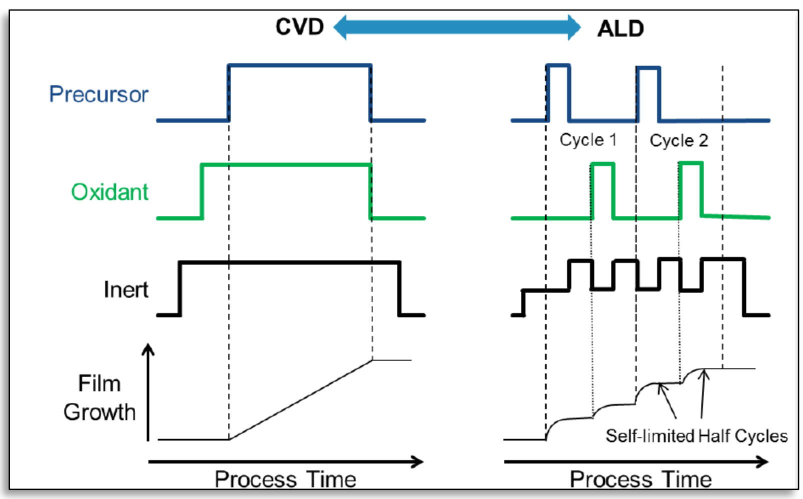
63. Upon information and belief, GlobalFoundries introduces a first reactant component into a deposition chamber. The step of introducing a first reactant component into a deposition chamber is part of ALD, as described by the presentation slide shown below.[41]

[40] *Intel's e-DRAM Shows Up in the Wild*, Solid State Technology (Feb. 7, 2014), http://electroiq.com/chipworks_real_chips_blog/2014/02/07/intels-e-dram-shows-up-in-the-wild/.

[41] *See* Atomic Layer Deposition Overview, Ultratech/CambridgeNanotech, http://www.cambridgenanotechald.com/atomic-layer-deposition-tutorial.shtml#.



This is further illustrated by the process schematic, below, which shows a basic gas-flow sequence to the chamber for Chemical Vapor Deposition and for ALD.[42]



64. ALD is typically used for DRAM capacitor dielectrics due to the high aspect ratios required.[43] GlobalFoundries manufactures eDRAM, which utilizes high-k dielectrics for eDRAM capacitors deposited via ALD.[44]

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[42] Clark, Robert D., *Emerging Applications for High K Materials in VLSI Technology*, Materials 2014, 7(4), 2913-2944, *available at* http://www.mdpi.com/1996-1944/7/4/2913.

[43] *See id.*

c. *introducing a second reactant component into the deposition chamber; and*

65. Upon information and belief, GlobalFoundries introduces a second reactant component into a deposition chamber. The step of introducing a second reactant component into a deposition chamber is part of ALD.[45] ALD is typically used for DRAM capacitor dielectrics due to the required high aspect ratios.[46] GlobalFoundries manufactures eDRAM, which utilizes high-k dielectrics for eDRAM capacitors deposited via ALD.[47]

d. *alternately repeating introducing the first reactant component and the second reactant component into the deposition chamber;*

66. Upon information and belief, GlobalFoundries alternately repeats introducing the first reactant component and the second reactant component into the deposition chamber. Alternately repeating introducing the first reactant component and the second reactant component into the deposition chamber is part of ALD.[48] ALD is typically used for DRAM

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[44] *See* J. Sundqvist, *Beyond DRAM capacitors and HKMG*, Fraunhofer, (2013), http://www.cnt.fraunhofer.de/content/dam/cnt/de/documents/High-k%20f%C3%BCr%20Alle%20Beyond%20DRAM%20capacitors%20and%20HKMG.pdf; *see also* N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

[45] *See* Atomic Layer Deposition Overview, Ultratech/CambridgeNanotech, http://www.cambridgenanotechald.com/atomic-layer-deposition-tutorial.shtml#; *see also* Clark, Robert D., *Emerging Applications for High K Materials in VLSI Technology*, Materials 2014, 7(4), 2913-2944, *available at* http://www.mdpi.com/1996-1944/7/4/2913.

[46] *See* Clark, Robert D., Emerging Applications for High K Materials in VLSI Technology, Materials 2014, 7(4), 2913-2944, *available at* http://www.mdpi.com/1996-1944/7/4/2913.

[47] *See* J. Sundqvist, *Beyond DRAM capacitors and HKMG*, Fraunhofer, (2013), http://www.cnt.fraunhofer.de/content/dam/cnt/de/documents/High-k%20f%C3%BCr%20Alle%20Beyond%20DRAM%20capacitors%20and%20HKMG.pdf; *see also* N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

[48] *See* Atomic Layer Deposition Overview, Ultratech/CambridgeNanotech, http://www.cambridgenanotechald.com/atomic-layer-deposition-tutorial.shtml#; *see also* Clark, Robert D.,

capacitor dielectrics due to the required high aspect ratios.[49] GlobalFoundries manufactures eDRAM which utilizes high-k dielectrics for eDRAM capacitors deposited via ALD.[50]

e. *wherein deposition of the first reactant component and the second reactant component are self-limiting;*

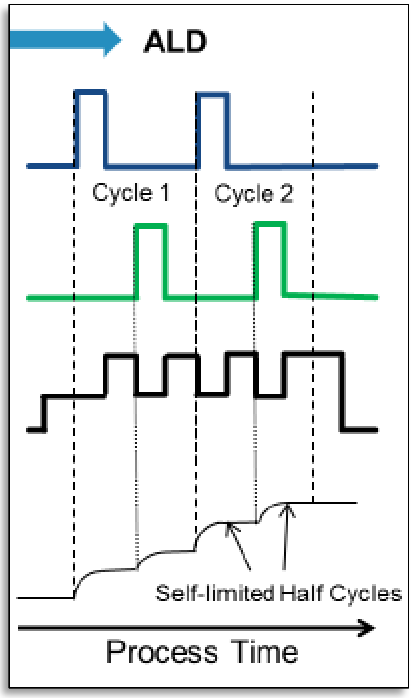
67. Upon information and belief, GlobalFoundries performs the process wherein deposition of the first reactant component and the second reactant component are self-limiting. The process wherein deposition of the first reactant component and the second reactant component are self-limiting is part of ALD as shown in the exemplary ALD process figure, below.[51]

Emerging Applications for High K Materials in VLSI Technology, Materials 2014, 7(4), 2913-2944, *available at* http://www.mdpi.com/1996-1944/7/4/2913.

[49] *See* Clark, Robert D., Emerging Applications for High K Materials in VLSI Technology, Materials 2014, 7(4), 2913-2944, *available at* http://www.mdpi.com/1996-1944/7/4/2913.

[50] *See* J. Sundqvist, *Beyond DRAM capacitors and HKMG*, Fraunhofer, (2013) http://www.cnt.fraunhofer.de/content/dam/cnt/de/documents/High-k%20f%C3%BCr%20Alle%20Beyond%20DRAM%20capacitors%20and%20HKMG.pdf; *see also* N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

[51] Clark, Robert D., Emerging Applications for High K Materials in VLSI Technology, Materials 2014, 7(4), 2913-2944, *available at* http://www.mdpi.com/1996-1944/7/4/2913.



68. ALD is typically used for DRAM capacitor dielectrics due to the high aspect ratios required.[52] GlobalFoundries manufactures eDRAM, which utilizes high-k dielectrics for eDRAM capacitors deposited via ALD.[53]

f. *wherein said first reactant component comprises a metal alkylamide;*

69. Upon information and belief, GlobalFoundries performs the process wherein the first reactant component comprises a metal alkylamide. Some of the deep-trench capacitors in the Power processors' eDRAM contain a high-k dielectric that includes a hafnium oxide (HfO_2)

[52] *See* Clark, Robert D., Emerging Applications for High K Materials in VLSI Technology, Materials 2014, 7(4), 2913-2944, *available at* http://www.mdpi.com/1996-1944/7/4/2913.

[53] *See* J. Sundqvist, *Beyond DRAM capacitors and HKMG*, Fraunhofer, (2013) http://www.cnt.fraunhofer.de/content/dam/cnt/de/documents/High-k%20f%C3%BCr%20Alle%20Beyond%20DRAM%20capacitors%20and%20HKMG.pdf; *see also* N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

metal oxide layer.[54] This is shown, for example, by the transmission electron microscope image of an exemplary Power7+ high-k dielectric deep trench node stack, shown below.[55]

70. Further, Power8 server processors, such as those found in the Tyan Server, BSP010G70V8HR-2, include a hafnium silicate dielectric layer.[56] The image below is a transmission electron microscopy lattice image of a Power8 processor trench capacitor sidewall.

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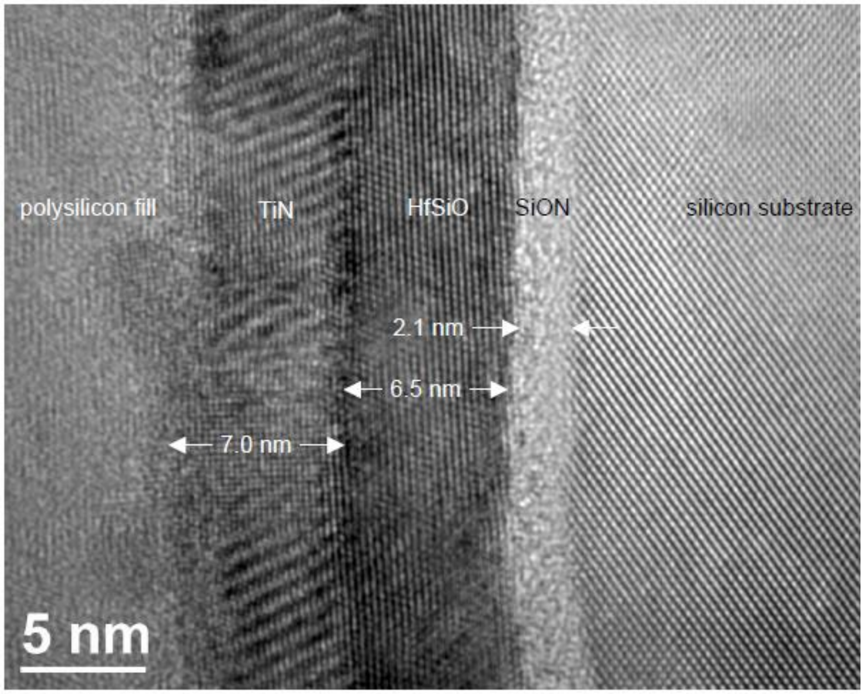
[54] David Kanter, *IBM's eDRAM on 32nm SOI*, Real World Technologies (Feb. 15, 2011), http://www.realworldtech.com/iedm-2010/3/.

[55] N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

[56] *See* Chipworks, IBM 00NG082, https://chipworks.secure.force.com/catalog/ProductDetails?sku=IBM-00NG082&viewState=DetailView&cartID=&g=&parentCategory=&navigationStr=CatalogSearchInc&searchText=Tyan%20power8.



71. Further, "[a]lkylamides are the most commonly used precursors for HfO_2" ALD films.[57] In addition, TEMAH has been demonstrated for use as a precursor to form a HfSiO dielectric layer in DRAM trench applications similar to the Power8 trench capacitor.[58]

72. Thus, upon information and belief, the first reactant is a metal alkylamide.

g. *wherein said second reactant component interacts with the deposited first reactant component to form the insulator; and*

73. Upon information and belief, GlobalFoundries performs the process wherein the second reactant component interacts with the deposited first reactant component to form the insulator. The deep-trench capacitors in the Power processors' eDRAM contain a high-k dielectric hafnium oxide layer formed by the ALD process of the second component interacting

[57] Atomic Layer Deposition for Semiconductors, Hwang, Cheol Seong et. al., at 95. http://www.springer.com/us/book/9781461480532.

[58] *See Recent Developments in ALD Technology for 50 nm Trench DRAM Applications*, Schroeder, Uwe, et. al., ECS Transactions 1(5), July 2006, *available at* https://www.researchgate.net/publication/266635170_Recent_Developments_in_ALD_Technology_for_50_nm_Trench_DRAM_Applications.

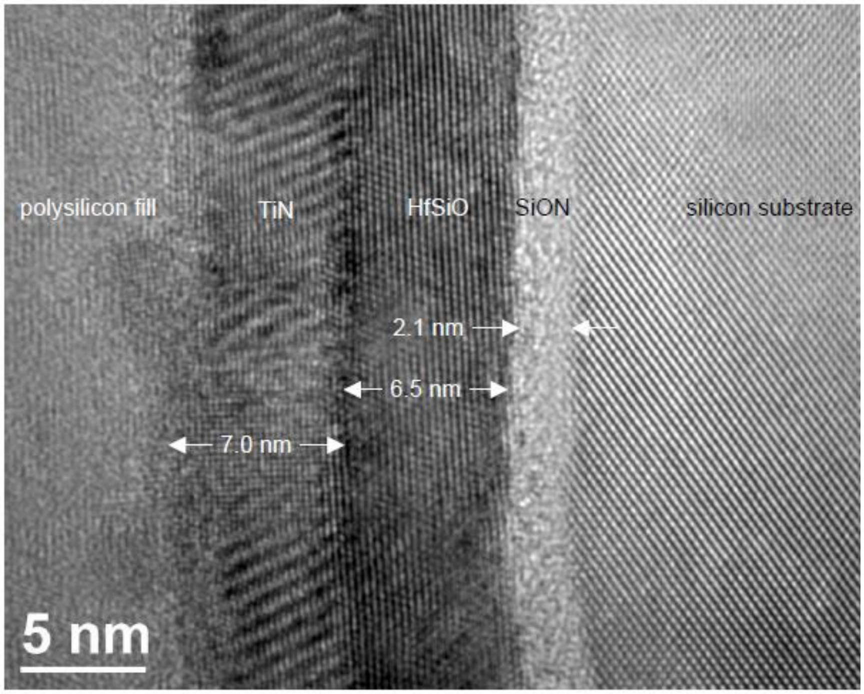
with the first reactant.[59] This is shown, for example, by the TEM image of an exemplary Power7+ high-k dielectric deep-trench node stack, below.[60]

74. Further, Power8 server processors, such as those found in the Tyan Server, BSP010G70V8HR-2, include a hafnium silicate dielectric layer.[61] The image below is a transmission electron microscopy lattice image of a Power8 processor trench capacitor sidewall.

[59] David Kanter, *IBM's eDRAM on 32nm SOI*, Real World Technologies (Feb. 15, 2011), http://www.realworldtech.com/iedm-2010/3/.

[60] N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

[61] *See* Chipworks, IBM 00NG082, https://chipworks.secure.force.com/catalog/ProductDetails?sku=IBM-00NG082&viewState=DetailView&cartID=&g=&parentCategory=&navigationStr=CatalogSearchInc&searchText=Tyan%20power8.



h. *wherein said insulator comprises oxygen and the metal from the metal alkylamide.*

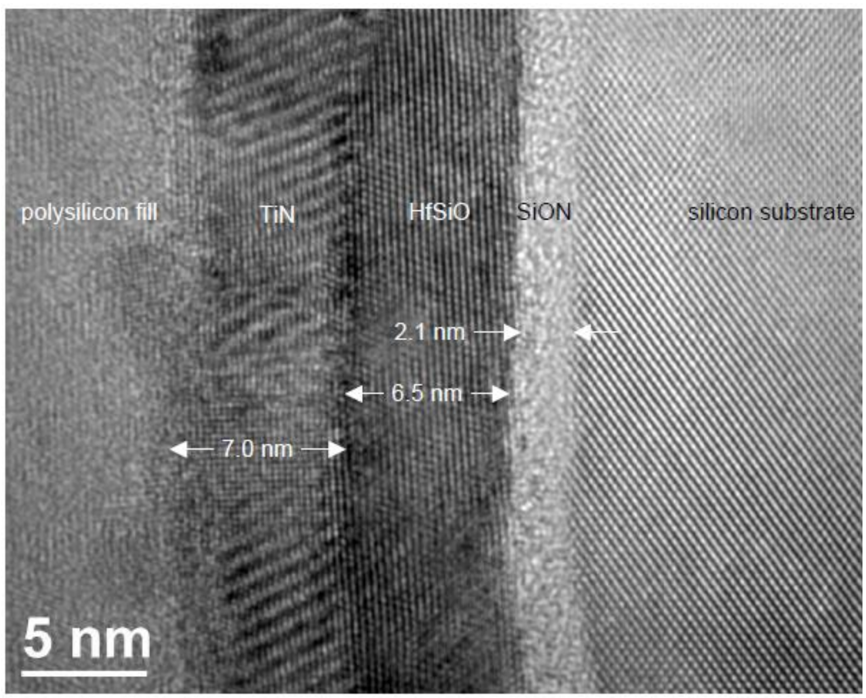
75. Upon information and belief, GlobalFoundries performs a process wherein the insulator comprises oxygen and the metal from the metal alkylamide. For example, the deep-trench capacitors in the Power processors' eDRAM contain a high-k dielectric that includes a hafnium oxide (HfO_2) metal oxide layer.[62] The hafnium oxide layer includes oxygen and the hafnium metal from the metal alkylamide.[63] This is shown, for example, by the transmission electron microscope image of an exemplary Power7+ high-k dielectric deep trench node stack, shown below.[64]

[62] David Kanter, *IBM's eDRAM on 32nm SOI*, Real World Technologies (Feb. 15, 2011), http://www.realworldtech.com/iedm-2010/3/.

[63] *Id.*

[64] N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

76. Further, Power8 server processors, such as those found in the Tyan Server, BSP010G70V8HR-2, include a hafnium silicate dielectric layer.[65] The image below is a transmission electron microscopy lattice image of a Power8 processor trench capacitor sidewall.



77. Further, "[a]lkylamides are the most commonly used precursors for HfO_2" ALD films.[66] In addition, TEMAH has been demonstrated for use as a precursor to form a HfSiO

[65] *See* Chipworks, IBM 00NG082, https://chipworks.secure.force.com/catalog/ProductDetails?sku=IBM-00NG082&viewState=DetailView&cartID=&g=&parentCategory=&navigationStr=CatalogSearchInc&searchText=Tyan%20power8.

dielectric layer in DRAM trench applications similar to the Power8 trench capacitor.[67] Thus, upon information and belief, the first reactant is a metal alkylamide.

2. Claim 2

78. Upon information and belief, at least the Power7+ and Power8 processors, manufactured by GlobalFoundries within the United States, are made using a process that practices each element of claim 2 of the '016 Patent.

a. *The process as in claim 1, wherein the insulator insulates a gate or a capacitor.*

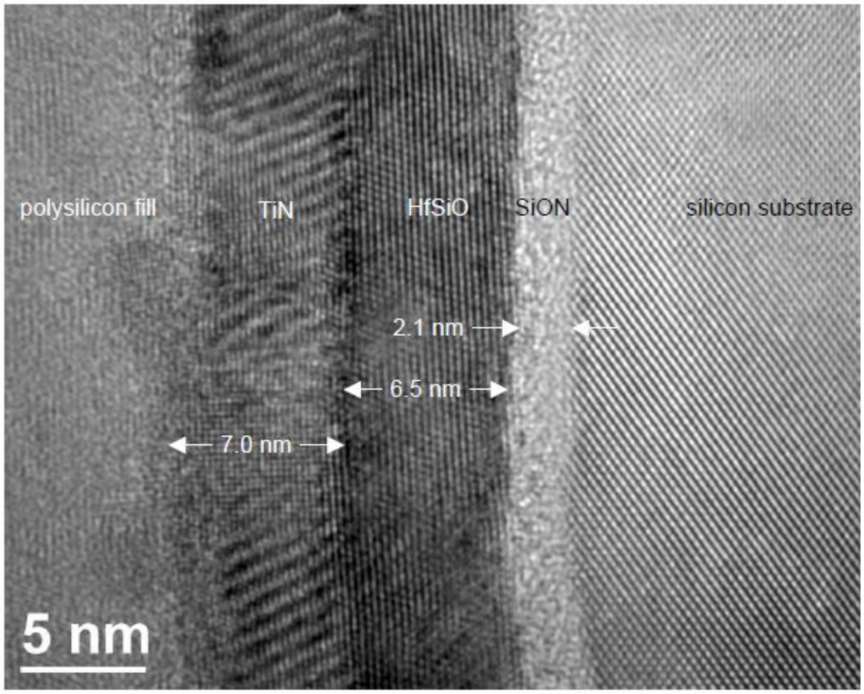
79. Upon information and belief, GlobalFoundries performs the process of claim 1, wherein the insulator insulates a gate or a capacitor. For example, the image below shows exemplary Power7+ processor deep trench capacitors in its eDRAM contain a high-k dielectric hafnium oxide layer that insulates a eDRAM capacitor.[68]

[66] Atomic Layer Deposition for Semiconductors, Hwang, Cheol Seong et. al., at 95., http://www.springer.com/us/book/9781461480532.

[67] *See Recent Developments in ALD Technology for 50 nm Trench DRAM Applications*, Schroeder, Uwe, et. al., ECS Transactions 1(5), July 2006, *available at* https://www.researchgate.net/publication/266635170_Recent_Developments_in_ALD_Technology_for_50_nm_Trench_DRAM_Applications.

[68] N. Butt, *A 0.039um2 high performance eDRAM cell based on 32nm High-K/Metal SOI technology*, in Electronic Devices Meeting (IEDM), 2010 IEEE International, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5703434&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5703434.

80. Further, Power8 server processors, such as those found in the Tyan Server, BSP010G70V8HR-2, include a hafnium silicate dielectric layer.[69] The image below is a transmission electron microscopy lattice image of a Power8 processor trench capacitor sidewall.



3. Claim 3

81. Upon information and belief, at least the Power7+ and Power8 processors, manufactured by GlobalFoundries within the United States, are made using a process that practices each element of claim 3 of the ’016 Patent.

a. *The process as in claim 2, wherein the metal alkylamide is a hafnium dialkylamide.*

82. Upon information and belief, GlobalFoundries performs the process of claim 2, wherein the metal alkylamide is a hafnium dialkylamide. For example, “[a]lkylamides are the

[69] *See* Chipworks, IBM 00NG082, https://chipworks.secure.force.com/catalog/ProductDetails?sku=IBM-00NG082&viewState=DetailView&cartID=&g=&parentCategory=&navigationStr=CatalogSearchInc&searchText=Tyan%20power8.

most commonly used precursors for HfO_2" ALD films.[70] "Due to the superior properties of the films grown from the alkylamides, alkylamides ($Hf(NEtMe)_4$ [TEMAH] and $Zr(NEtMe)_4$ [TEMAZ] in particular) have received great attention as promising precursors for HfO_2 and ZrO_2 ALD in memory applications."[71] In addition, TEMAH has been demonstrated for use as a precursor to form a HfSiO dielectric layer in DRAM trench applications similar to the Power8 trench capacitor.[72]

83. Thus, upon information and belief, the metal alkylamide is tetrakis (ethylmethylamido) hafnium, which is a hafnium dialkylamide.

4. Claim 4

84. Upon information and belief, at least the Power7+ and Power8 processors, manufactured by GlobalFoundries within the United States, are made using a process that practices each element of claim 4 of the '016 Patent.

a. *The process as in claim 3, wherein the hafnium dialkylamide is tetrakis (ethylmethylamido) hafnium.*

85. Upon information and belief, GlobalFoundries performs the process of claim 3, wherein the hafnium dialkylamide is tetrakis (ethylmethylamido) hafnium. For example, "[a]lkylamides are the most commonly used precursors for HfO_2" ALD films.[73] "Due to the superior properties of the films grown from the alkylamides, alkylamides ($Hf(NEtMe)_4$

[70] *Atomic Layer Deposition for Semiconductors*, Hwang, Cheol Seong et. al., at 95., http://www.springer.com/us/book/9781461480532.

[71] *Id.*

[72] *See Recent Developments in ALD Technology for 50 nm Trench DRAM Applications*, Schroeder, Uwe, et. al., ECS Transactions 1(5), July 2006, *available at* https://www.researchgate.net/publication/266635170_Recent_Developments_in_ALD_Technology_for_50_nm_Trench_DRAM_Applications.

[73] *Atomic Layer Deposition for Semiconductors*, Hwang, Cheol Seong et. al., at 95., http://www.springer.com/us/book/9781461480532.

[TEMAH] and $Zr(NEtMe)_4$ [TEMAZ] in particular) have received great attention as promising precursors for HfO_2 and ZrO_2 ALD in memory applications."[74] In addition, TEMAH has been demonstrated for use as a precursor to form a HfSiO dielectric layer in DRAM trench applications similar to the Power8 trench capacitor.[75]

86. TEMAH is a synonym for tetrakis (ethylmethylamido) hafnium.[76] Thus upon information and belief, the metal alkylamide is tetrakis (ethylmethylamido) hafnium.

PRAYER FOR RELIEF

WHEREFORE, Harvard requests that the Court grant the following relief:

A. A finding that GlobalFoundries has directly infringed the Asserted Patents;

B. An award to Harvard of royalty or lost-profit based damages adequate to compensate them for GlobalFoundries' infringement of the '539, '848, and '016 patents, such damages to be determined by a jury;

C. A permanent injunction against GlobalFoundries, its officers, agents, employees, and those persons in active concert or participation with it or any of them, and its successors and assigns, from continued acts of infringement of the Asserted Patents, including but not limited to being enjoined from making, using, selling, and/or offering for sale within the United States, and/or importing into the United States, any products that infringe the Asserted Patents; and

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[74] *Id.*

[75] *See Recent Developments in ALD Technology for 50 nm Trench DRAM Applications*, Schroeder, Uwe, et. al., ECS Transactions 1(5), July 2006, *available at* https://www.researchgate.net/publication/266635170_Recent_Developments_in_ALD_Technology_for_50_nm_Trench_DRAM_Applications.

[76] *See* Tetrakis(ethylmethylamido)hafnium(IV), Sigma-Aldrich, http://www.sigmaaldrich.com/catalog/product/aldrich/553123?lang=en&region=US.

D. An award to Harvard of such other and further relief as this Court deems just and proper.

DEMAND FOR JURY TRIAL

Plaintiff hereby demands a jury in accordance with Rule 38 of the Federal Rules of Civil Procedure.

Dated: 6/24/2016

Respectfully submitted,

/s/ William Belanger
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