

**IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MASSACHUSETTS**

PRESIDENT AND FELLOWS OF)	
HARVARD COLLEGE)	COMPLAINT
)	
Plaintiff,)	
)	Civil Action No. _____
v.)	
)	
MICRON TECHNOLOGY, INC.)	
)	JURY TRIAL DEMANDED
Defendant.)	
)	
)	
)	
)	

COMPLAINT

Plaintiff, President and Fellows of Harvard College (“Harvard”), by and through its counsel, Pepper Hamilton LLP, for its Complaint against Defendant Micron Technology, Inc. (“Micron”), 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 Micron Technology, Inc. is a Delaware corporation with its principal place of business at 8000 S. Federal Way, Boise, ID 83707.

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 Micron at least based upon Micron's contacts with the forum and the nature of the infringing activity alleged herein. Upon information and belief, Micron 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 Micron has committed acts of patent infringement within the Commonwealth of Massachusetts by, *inter alia*, selling, offering for sale, 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 a long history of benefiting the public through its research programs. Harvard recognizes that the public benefits from new products and processes resulting 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 that

results 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 for 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 is 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 and 8,334,016 (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. ALD requires a number of process 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 by the Asserted Patents solve some of the problems associated with the production of semiconductors at smaller sizes. The inventions claimed by 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. Micron advertises that it is a leader in advanced semiconductor systems with a broad portfolio of high-performance memory technologies, including DRAM, as well as other types of memory, such as NAND Flash. Upon information and belief, Micron markets its products through its internal sales force, independent sales representatives, and distributors to original equipment manufacturers and retailers around the world, including throughout the United States and within the Commonwealth of Massachusetts. Micron obtains the products it

sells from wholly-owned manufacturing facilities, including manufacturing facilities in the United States. Micron continually offers new generations of products with improved performance characteristics, including higher data transfer rates, reduced package sizes, lower power consumption, improved read/write reliability, and increased memory density. In 2015, the majority of Micron's DRAM production was manufactured with 25nm line-width process technologies. Micron expects that by the second half of 2016, the majority of its DRAM production will be manufactured on its 20nm line-width process technology.¹

15. Upon information and belief, Micron's manufacturing facilities in the United States manufacture certain products in an infringing manner, using ALD processes and materials claimed by the Asserted Patents. For example, upon information and belief, Micron's manufacturing facilities in the United States manufacture DRAM devices using the ALD processes and materials claimed by the Asserted Patents.

16. Upon information and belief, Micron's products that are manufactured using the ALD processes and materials claimed by the Asserted Patents are sold individually, as well as incorporated into computing, consumer, enterprise, networking, mobile, and automotive products, throughout the United States, including within the Commonwealth of Massachusetts. For example, Micron's DDR4 DRAM is sold individually, and incorporated in other products, throughout the United States, including within the Commonwealth of Massachusetts.

17. Micron operates a public website, micron.com, which is accessible in the Commonwealth of Massachusetts. Through micron.com, Micron advertises its products, such as its DRAM memory. Micron's website provides, among other information, technical and

¹ 2015 Annual Report on Form 10-K of Micron Technology, Inc., *available at* <http://investors.micron.com/sec.cfm?view=all>.

purchasing information regarding its products. Micron's website includes a page dedicated to "How to Buy" Micron's products, including DRAM memory.

18. Micron's semiconductor memory products are offered under, at least, the brand name Crucial. The brand name Crucial is a registered trademark of Micron. Through its public website, micron.com, Micron leads potential customers to crucial.com. Crucial.com is a public website, which is accessible in the Commonwealth of Massachusetts. Through crucial.com, customers throughout the United States, including within the Commonwealth of Massachusetts, can buy Micron products, such as DRAM products. For example, through crucial.com a customer in the Commonwealth of Massachusetts can order Micron DRAM memory such as Crucial 4GB DDR4-2133 UDIMM.

19. Upon information and belief, Micron has infringed and continues to infringe the Asserted Patents by manufacturing products using the ALD processes and materials claimed by the Asserted Patents. Additionally, Micron 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.

20. Micron 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)**

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

22. On November 29, 2005, the United States Patent and Trademark Office ("USPTO") duly and legally issued U.S. Patent No. 6,969,539, entitled "Vapor Deposition of Metal Oxides, Silicates and Phosphates, and Silicon Dioxide," to inventors Roy G. Gordon, Jill

Becker, Dennis Hausmann, and Seigi Suh (the “’539 Patent”). A true and correct copy of the ’539 Patent is attached as Exhibit A to this Complaint.

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

24. Upon information and belief, at least certain Micron DRAM memory products are made using a process that includes all of the limitations of one or more of the claims of the ’539 Patent. Upon information and belief, Micron makes these memory products in the United States. Upon information and belief, Micron directly or indirectly, uses, sells, and/or offers for sale these memory products throughout the United States, including within the Commonwealth of Massachusetts.

25. Micron further violates 35 U.S.C. § 271(g), to the extent Micron makes DRAM memory products 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

26. Upon information and belief, certain Micron processors are made using the process claimed by one or more claims of the ’539 Patent. The analysis below demonstrates how Micron’s DRAM is 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 Micron.

1. Claim 24

27. Upon information and belief, at least Micron's DRAM memory 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:*

28. Upon information and belief, Micron performs a process for forming a metal oxide as part of its manufacturing of certain Micron DRAM memory chips.

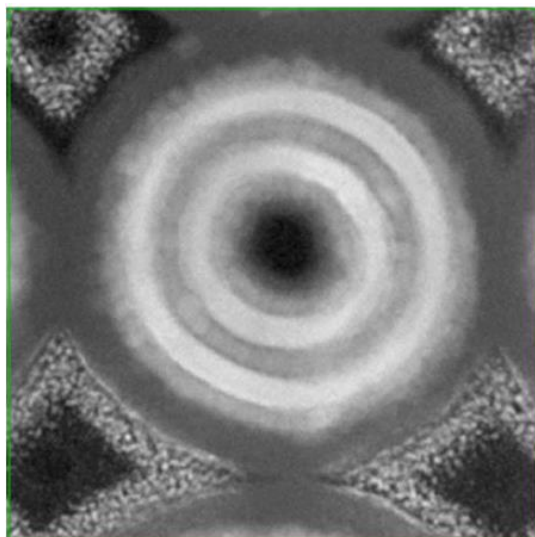
29. DRAM memory chips are microelectronic devices that include insulators containing metal oxide.²



30. Micron uses ALD for DRAM capacitor dielectric films.³ ALD is typically used for DRAM capacitor dielectrics due to the required high aspect ratios.⁴

² See Micron, DRAM, <https://www.micron.com/products/dram>; Micron, DDR4, <https://www.micron.com/products/dram/ddr4-sdram>.

31. For example, a teardown image of a Micron DRAM memory chip, shows a capacitor dielectric that includes a zirconium oxide (ZrO_2), metal oxide layer.⁵



High-Angle Annular Dark-Field (HAADF) image of Micron DDR4 DRAM capacitor

- 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.*

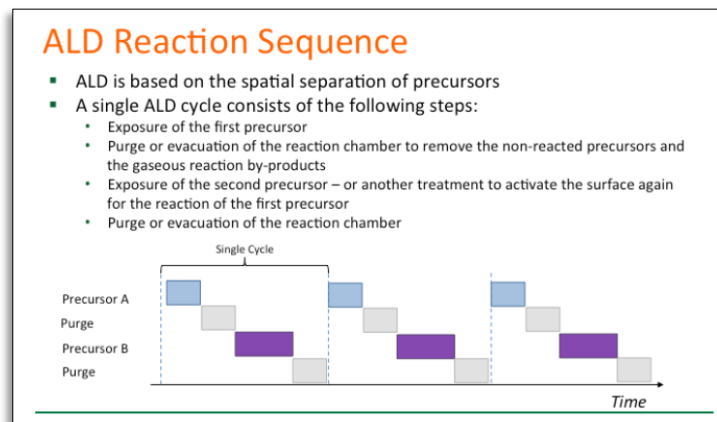
32. Upon information and belief, Micron performs a process wherein a heated surface is exposed alternately to the vapor of one or more metal amides having an amido group selected from the group consisting of dialkylamido, disilylamido and (alkyl)(sily) amido moieties, and then to the vapors of water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

³ See M. Leskelä, Industrial Applications of Atomic Layer Deposition (ALD), 10th MIICS Conference, Mikkeli, March 18, 2010, *available at* <http://www.miics.net/archive/getfile.php?file=162>; *see also* Micron unveils new DRAM blueprint, EETimes (June 16, 2004), http://www.eetimes.com/document.asp?doc_id=1150471.

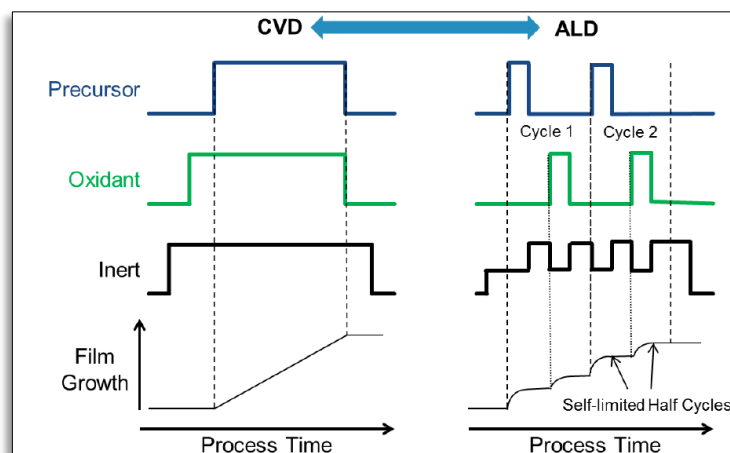
⁴ See Clark, Robert D., Emerging Applications for High K Materials in VLSI Technology, Materials 2014, 7(4), 2913-2944, *available at* <http://www.mdpi.com/1996-1944/7/4/2913>.

⁵ See TECHNOLOGY ROADMAP of DRAM for Three Major manufacturers: Samsung, SK-Hynix and Micron (Oct. 2014), *available at* http://www.techinsights.com/uploadedFiles/Public_Website/Content_-_Primary/Marketing/2015/TechServices/TechInsights-DRAMRoadmap2014.ppt; *see also* Carl Wintgens, *The 50-nm DRAM battle rages on: An overview of Micron's technology*, EETimes (Mar. 23, 2009), http://www.eetimes.com/document.asp?doc_id=1170601 (identifying that Micron uses zirconium oxide dielectric).

33. The step of exposing a heated surface alternately to vapor is part of ALD, as described by the presentation slide shown below.⁶



This is further illustrated by the process schematic, shown below, which shows a basic gas-flow sequence to the chamber for Chemical Vapor Deposition and for ALD.⁷



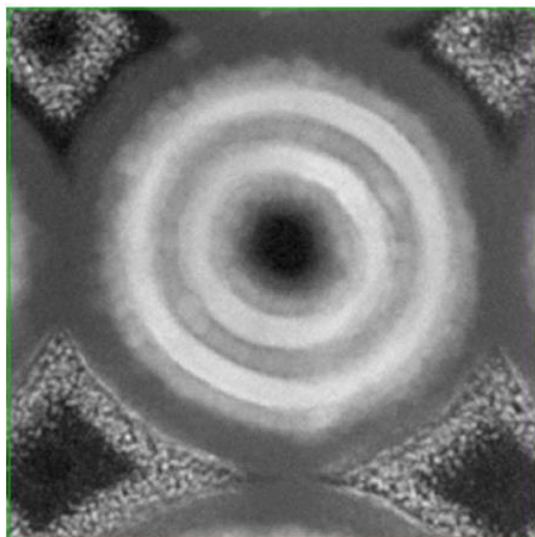
34. ALD is typically used for DRAM capacitor dielectrics due to the high aspect ratios required.⁸ Micron uses ALD for DRAM capacitor dielectric films.⁹ For example,

⁶ See Atomic Layer Deposition Overview, Ultratech/CambridgeNanotech <http://www.cambridgenanotechald.com/atomic-layer-deposition-tutorial.shtml#>.

⁷ 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>.

⁸ See *id.*

teardown images of Micron DRAM memory chips show a capacitor dielectric that includes a zirconium oxide (ZrO_2), metal oxide layer.¹⁰



High-Angle Annular Dark-Field (HAADF) image of Micron DDR4 DRAM capacitor

35. In DRAM applications, “[a]lkylamides are the most commonly used precursors for HfO_2 ” ALD films.¹¹ Further, tetrakis (ethyl-methylamino) zirconium is one of the “most popular precursors...in industrial manufacturing of DRAM.”¹² Thus, upon information and belief, a heated surface is exposed to a vapor comprising tetrakis (ethyl-methylamino) zirconium, which is a metal amide having an amido group selected from the group consisting of dialkylamido, disilylamido and (alkyl)(silyl) amido moieties.

⁹ See M. Leskelä, Industrial Applications of Atomic Layer Deposition (ALD), 10th MIICS Conference, Mikkeli, March 18, 2010, *available at* <http://www.miics.net/archive/getfile.php?file=162>; *see also* Micron unveils new DRAM blueprint, EETimes (June 16, 2004), http://www.eetimes.com/document.asp?doc_id=1150471.

¹⁰ *See also* TECHNOLOGY ROADMAP of DRAM for Three Major manufacturers: Samsung, SK-Hynix and Micron, Oct 2014, *available at* http://www.techinsights.com/uploadedFiles/Public_Website/Content_-_Primary/Marketing/2015/TechServices/TechInsights-DRAMRoadmap2014.ppt; *see also* Carl Wintgens, *The 50-nm DRAM battle rages on: An overview of Micron's technology*, EETimes (Mar. 23, 2009), http://www.eetimes.com/document.asp?doc_id=1170601 (identifying that Micron uses zirconium oxide dielectric).

¹¹ *Atomic Layer Deposition for Semiconductors*, Hwang, Cheol Seong et. al., at 95. <http://www.springer.com/us/book/9781461480532>.

¹² *See* Wada, Senji, et.al., “Development of ALD Precursors for Semiconductor Devices”, *Atomic Layer Deposition Applications 4*, ECS Transactions, Volume 16, Issue 4, pages 103-111 (2008).

36. 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[.]”¹³ Thus, upon information and belief, the heated surface is exposed to water vapor in the process performed by Micron.

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

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

38. On December 18, 2012, the USPTO duly and legally issued U.S. Patent No. 8,334,016, entitled “Vapor Deposition of Metal Oxides, Silicates and Phosphates, and Silicon Dioxide,” to inventors Roy G. Gordon, Jill Becker, Dennis Hausmann, and Seigi Suh (“the ’016 Patent”), as a continuation of U.S. Patent No. 7,507,848, which is a continuation of the ’539 Patent. A true and correct copy of the ’016 Patent is attached as Exhibit B to this Complaint.

39. Upon information and belief, in violation of 35 U.S.C. § 271, Micron 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 1, 2, 7, and 8, by, without limitation, making products using the process claimed by one or more claims of the ’016 Patent. Micron 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 throughout the United States, including within the Commonwealth of Massachusetts.

¹³ 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.

40. Upon information and belief, at least, Micron DDR4 DRAM memory products 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, 7, and 8. Upon further information and belief, Micron makes these memory products in the United States. Upon information and belief, Micron, directly or indirectly, uses, sells, and/or offers for sale these memory products throughout the United States, including within the Commonwealth of Massachusetts.

41. Micron further violates 35 U.S.C. § 271(g) to the extent it makes DRAM memory products 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

42. Upon information and belief, certain Micron processors are made using the process claimed by one or more claims of the '016 Patent, including at least claims 1, 2, 7, and 8. The analysis below demonstrates how Micron's DRAM is 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 Micron.

1. Claim 1

43. Upon information and belief, at least, Micron's DRAM memory chips 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:*

44. Upon information and belief, Micron performs a process for making an insulator in a microelectronic device. Upon information and belief, Micron performs a process for making

an insulator as part of its manufacturing of Micron DRAM memory chips. DRAM memory chips are microelectronic devices that include insulators.¹⁴



45. Micron uses ALD for DRAM capacitor dielectric films.¹⁵ ALD is typically used for DRAM capacitor dielectric films due to the high aspect ratios required.¹⁶

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

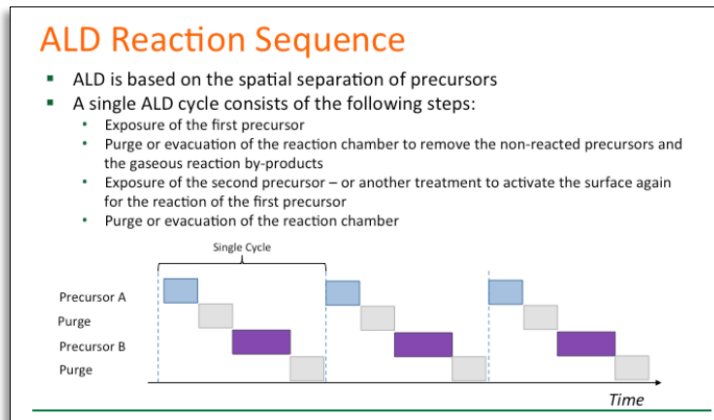
46. Upon information and belief, Micron introduces a first reactant component into a deposition chamber. The step of introducing a first reactant component into a deposition chamber is part of ALD, as described by the presentation slide shown below.¹⁷

¹⁴ See Micron, DRAM, <https://www.micron.com/products/dram>; Micron, DDR4, <https://www.micron.com/products/dram/ddr4-sdram>.

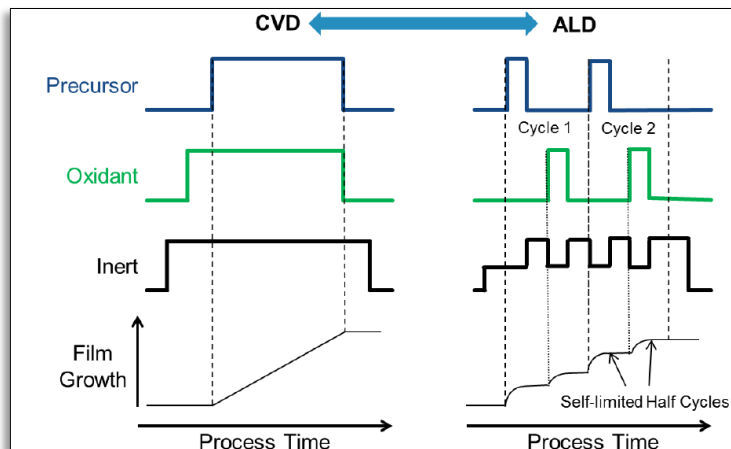
¹⁵ See M. Leskelä, Industrial Applications of Atomic Layer Deposition (ALD), 10th MIICS Conference, Mikkeli, March 18, 2010, *available at* <http://www.miics.net/archive/getfile.php?file=162>; *see also* Micron unveils new DRAM blueprint, EETimes (June 16, 2004), http://www.eetimes.com/document.asp?doc_id=1150471.

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 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.¹⁸



47. ALD is typically used for DRAM capacitor dielectric films due to the high aspect ratios required.¹⁹ Micron uses ALD for DRAM capacitor dielectric films.²⁰

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

¹⁸ 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>.

¹⁹ See *id.*

²⁰ See M. Leskelä, Industrial Applications of Atomic Layer Deposition (ALD), 10th MIICS Conference, Mikkeli, March 18, 2010, available at <http://www.miics.net/archive/getfile.php?file=162>; see also Micron unveils new DRAM blueprint, EETimes (June 16, 2004), http://www.eetimes.com/document.asp?doc_id=1150471.

48. Upon information and belief, Micron 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.²¹ ALD is typically used for DRAM capacitor dielectric films due to the high aspect ratios required. Micron uses ALD for DRAM capacitor dielectric films.²²

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

49. Upon information and belief, Micron 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.²³ ALD is typically used for DRAM capacitor dielectric films due to the high aspect ratios required. Micron uses ALD for DRAM capacitor dielectric films.²⁴

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

50. Upon information and belief, Micron performs the process wherein deposition of the first reactant component and the second reactant component are self-limiting. The process

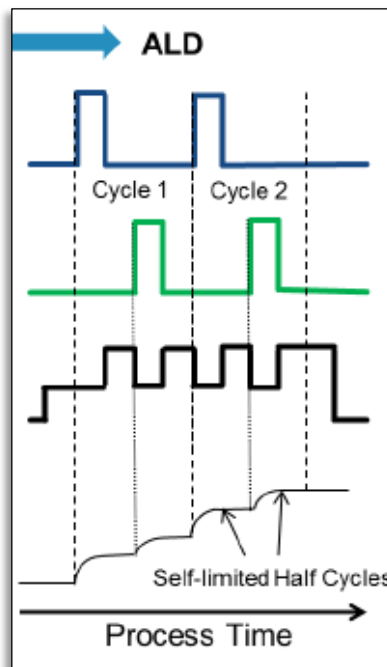
²¹ See Atomic Layer Deposition Overview, Ultratech/CambridgeNanotech <http://www.cambridgenanotechald.com/atomic-layer-deposition-tutorial.shtml#>; see also Clark, Robert D., *Emerging Applications for High K Materials in VLSI Technology*, Materials 2014, 7(4), 2913-2944, available at <http://www.mdpi.com/1996-1944/7/4/2913>.

²² See M. Leskelä, Industrial Applications of Atomic Layer Deposition (ALD), 10th MIICS Conference, Mikkeli, March 18, 2010, available at <http://www.miics.net/archive/getfile.php?file=162>; see also Micron unveils new DRAM blueprint, EETimes (June 16, 2004), http://www.eetimes.com/document.asp?doc_id=1150471.

²³ 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>.

²⁴ See M. Leskelä, Industrial Applications of Atomic Layer Deposition (ALD), 10th MIICS Conference, Mikkeli, March 18, 2010, available at <http://www.miics.net/archive/getfile.php?file=162>; see also Micron unveils new DRAM blueprint, EETimes (June 16, 2004), http://www.eetimes.com/document.asp?doc_id=1150471.

wherein deposition of the first reactant component and the second reactant component are self-limiting is part of ALD.²⁵



51. ALD is typically used for DRAM capacitor dielectric films due to the high aspect ratios required. Micron uses ALD for DRAM capacitor dielectric films.²⁶

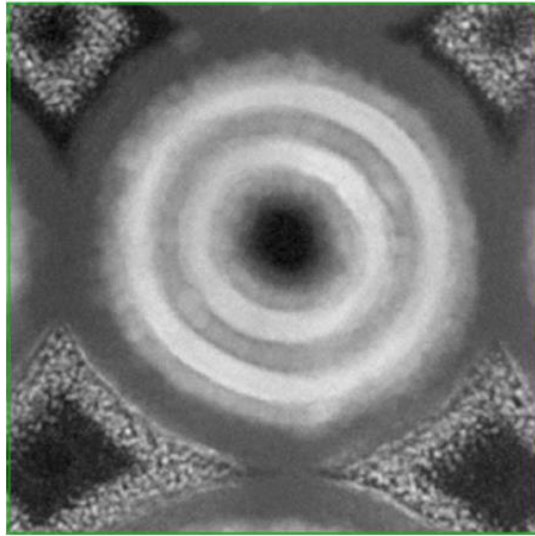
f. *wherein said first reactant component comprises a metal alkylamide;*

52. Upon information and belief, Micron performs the process wherein the first reactant component comprises a metal alkylamide. Teardown images of Micron's DRAM memory chip show a capacitor dielectric insulator that includes a zirconium oxide layer.²⁷

²⁵ 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>.

²⁶ See M. Leskelä, Industrial Applications of Atomic Layer Deposition (ALD), 10th MIICS Conference, Mikkeli, March 18, 2010, available at <http://www.miics.net/archive/getfile.php?file=162>; see also Micron unveils new DRAM blueprint, EETimes (June 16, 2004), http://www.eetimes.com/document.asp?doc_id=1150471.

²⁷ See TECHNOLOGY ROADMAP of DRAM for Three Major manufacturers: Samsung, SK-Hynix and Micron, Oct 2014, available at http://www.techinsights.com/uploadedFiles/Public_Website/Content_-_Primary/Marketing/2015/TechServices/TechInsights-DRAMRoadmap2014.ppt; see also Carl Wintgens, *The 50-*



High-Angle Annular Dark-Field (HAADF) image of Micron DDR4 DRAM capacitor

53. Further, tetrakis (ethyl-methylamino) zirconium is one of the “most popular precursors...in industrial manufacturing of DRAM.”²⁸ In DRAM applications “[a]lkylamides are the most commonly used precursors... for ZrO_2 ” ALD films.²⁹ Thus, upon information and belief, the first reactant is tetrakis (ethyl-methylamino) zirconium, which is a metal alkylamide.

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

54. Upon information and belief, Micron performs a process wherein the second reactant component interacts with the deposited first reactant component to form the insulator. Teardown images of Micron’s DRAM memory chip show a capacitor dielectric insulator that is

nm DRAM battle rages on: An overview of Micron’s technology, EETimes (Mar. 23, 2009), http://www.eetimes.com/document.asp?doc_id=1170601 (identifying that Micron uses zirconium oxide dielectric).

²⁸ Wada, Senji, et.al., “Development of ALD Precursors for Semiconductor Devices”, *Atomic Layer Deposition Applications 4*, ECS Transactions, Volume 16, Issue 4, pages 103-111 (2008).

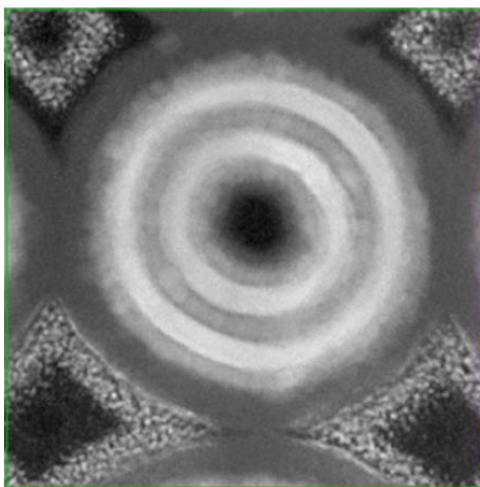
²⁹ *Atomic Layer Deposition for Semiconductors*, Hwang, Cheol Seong et. al., at 95. <http://www.springer.com/us/book/9781461480532>.

formed by the ALD process with the second component interacting with the first reactant.³⁰

Micron uses ALD for DRAM capacitor dielectric films.³¹

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

55. Upon information and belief, Micron performs a process wherein the insulator comprises oxygen and the metal from the metal alkylamide. Teardown images of a Micron DRAM chip show a capacitor dielectric insulator that includes a zirconium oxide (ZrO_2), metal oxide layer. The zirconium oxide layer includes oxygen and the zirconium metal from the metal alkylamide.³²



High-Angle Annular Dark-Field (HAADF) image of Micron DDR4 DRAM capacitor

³⁰ See TECHNOLOGY ROADMAP of DRAM for Three Major manufacturers: Samsung, SK-Hynix and Micron, Oct 2014, available at http://www.techinsights.com/uploadedFiles/Public_Website/Content_-_Primary/Marketing/2015/TechServices/TechInsights-DRAMRoadmap2014.ppt; see also Carl Wintgens, *The 50-nm DRAM battle rages on: An overview of Micron's technology*, EETimes (Mar. 23, 2009), http://www.eetimes.com/document.asp?doc_id=1170601 (identifying that Micron uses zirconium oxide dielectric).

³¹ See M. Leskelä, Industrial Applications of Atomic Layer Deposition (ALD), 10th MIICS Conference, Mikkeli, March 18, 2010, available at <http://www.miics.net/archive/getfile.php?file=162>; see also Micron unveils new DRAM blueprint, EETimes (June 16, 2004), http://www.eetimes.com/document.asp?doc_id=1150471.

³² See TECHNOLOGY ROADMAP of DRAM for Three Major manufacturers: Samsung, SK-Hynix and Micron, Oct 2014, available at http://www.techinsights.com/uploadedFiles/Public_Website/Content_-_Primary/Marketing/2015/TechServices/TechInsights-DRAMRoadmap2014.ppt; see also Carl Wintgens, *The 50-nm DRAM battle rages on: An overview of Micron's technology*, EETimes (Mar. 23, 2009), http://www.eetimes.com/document.asp?doc_id=1170601 (identifying that Micron uses zirconium oxide dielectric).

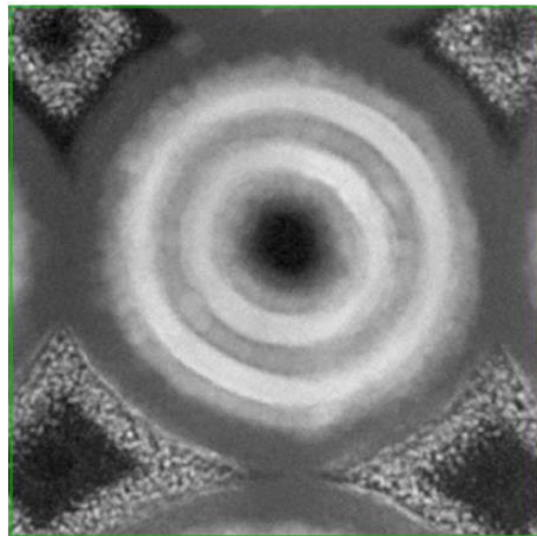
56. Further, tetrakis (ethyl-methylamino) zirconium is one of the “most popular precursors...in industrial manufacturing of DRAM.”³³ Thus, upon information and belief, the metal (zirconium) is from tetrakis (ethyl-methylamino) zirconium, which is a metal alkylamide.

2. Claim 2

57. Upon information and belief, at least, Micron’s DRAM memory chips 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.*

58. Upon information and belief, Micron performs the process of claim 1, wherein the insulator insulates a gate or a capacitor. For example, teardown images of Micron’s DRAM memory chip show a capacitor dielectric insulator that includes a zirconium oxide layer.³⁴



High-Angle Annular Dark-Field (HAADF) image of Micron DDR4 DRAM capacitor

³³ Wada, Senji, et.al., “Development of ALD Precursors for Semiconductor Devices”, Atomic Layer Deposition Applications 4, ECS Transactions, Volume 16, Issue 4, pages 103-111 (2008); *see also Atomic Layer Deposition for Semiconductors*, Hwang, Cheol Seong et. al., at 95.
<http://www.springer.com/us/book/9781461480532>.

³⁴ *See TECHNOLOGY ROADMAP of DRAM for Three Major manufacturers: Samsung, SK-Hynix and Micron*, Oct 2014, *available at* http://www.techinsights.com/uploadedFiles/Public_Website/Content_-_Primary/Marketing/2015/TechServices/TechInsights-DRAMRoadmap2014.ppt; *see also* Carl Wintgens, *The 50-nm DRAM battle rages on: An overview of Micron’s technology*, EETimes (Mar. 23, 2009), http://www.eetimes.com/document.asp?doc_id=1170601 (identifying that Micron uses zirconium oxide dielectric).

3. Claim 7

59. Upon information and belief, at least, Micron's DRAM memory chips are made using a process that practices each element of claim 7 of the '016 Patent.

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

60. Upon information and belief, Micron performs the process of claim 2, wherein the metal alkylamide is a zirconium dialkylamide. For example, tetrakis (ethyl-methylamino) zirconium is one of the "most popular precursors...in industrial manufacturing of DRAM."³⁵ In DRAM applications "[a]lkylamides are the most commonly used precursors... for ZrO₂" ALD films.³⁶ Thus, upon information and belief, the metal alkylamide is tetrakis(ethyl-methylamino)zirconium, which is a zirconium dialkylamide.

4. Claim 8

61. Upon information and belief, at least, Micron's DRAM memory chips are made using a process that practices each element of claim 8 of the '016 Patent.

- a. *The process as in claim 7, wherein the zirconium dialkylamide is tetrakis (ethylmethylamido) zirconium.*

62. Upon information and belief, Micron performs the process of claim 7, wherein the zirconium dialkylamide is tetrakis (ethylmethylamido) zirconium. For example, tetrakis (ethyl-methylamino) zirconium is one of the "most popular precursors...in industrial manufacturing of DRAM."³⁷ In DRAM applications "[a]lkylamides are the most commonly used precursors... for

³⁵ Wada, Senji, et.al., "Development of ALD Precursors for Semiconductor Devices", Atomic Layer Deposition Applications 4, ECS Transactions, Volume 16, Issue 4, pages 103-111 (2008).

³⁶ *Atomic Layer Deposition for Semiconductors*, Hwang, Cheol Seong et. al., at 95. <http://www.springer.com/us/book/9781461480532>.

³⁷ Wada, Senji, et.al., "Development of ALD Precursors for Semiconductor Devices", Atomic Layer Deposition Applications 4, ECS Transactions, Volume 16, Issue 4, pages 103-111 (2008).

ZrO₂” ALD films.³⁸ Thus, upon information and belief, the zirconium dialkylamide reactant is tetrakis (ethylmethyamido) zirconium.

PRAYER FOR RELIEF

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

- A. A finding that Micron has directly infringed the Asserted Patents;
- B. An award to Harvard of royalty or lost-profit based damages adequate to compensate it for Micron’s infringement of the ’539 and ’016 patents, such damages to be determined by a jury;
- C. A permanent injunction against Micron, 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 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
- 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.

³⁸ *Atomic Layer Deposition for Semiconductors*, Hwang, Cheol Seong et. al., at 95.
<http://www.springer.com/us/book/9781461480532>.

Dated: 6/24/2016

Respectfully submitted,

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