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Independent Study Mentorship

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**Research Assessment #6**

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**Subject:** Semiconductors

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"'Cyclic Deposition Method for Thin Film and Manufacturing Method for Semiconductor, and Semiconductor Device' in Patent Application Approval Process (USPTO 20160300723)." *News of Science*, 6 Nov. 2016, p. 2045. *Research in Context*, go.galegroup.com/ps/i.do?p=MSIC&sw=w&u=j043905010&v=2.1&id=GALE%7CA468454483&it=r&asid=d24e3d230fa133b060a464ef5af7f8d3. Accessed 25 Oct. 2017.

Heinrich, Erik. "A penny for its thoughts." *Maclean's*, 24 Nov. 1997, p. 106. *Research in Context*, go.galegroup.com/ps/i.do?p=MSIC&sw=w&u=j043905010&v=2.1&id=GALE%7CA20041970&it=r&asid=21a2ad22c8c8331a19a7d327e0e473d8. Accessed 25 Oct. 2017.

**Assessment:**

After my interview last week at Texas Instruments, I have gained a new interest in semiconductors. I did not know anything about semiconductors when I walked to my interview but after talking about them for 45 minutes with Mr. Doke, it intrigued me to research them further. This is one of the first times that I actually chose to research a specific thing inside the vast field of chemical engineering looking to get specific information about semiconductors and not something that goes along with chemical engineering as a whole and learning about it at that specific moment.

The articles I researched, “'Cyclic Deposition Method for Thin Film and Manufacturing Method for Semiconductor, and Semiconductor Device' in Patent Application Approval Process” and "A penny for its thoughts", explained the composition of a semiconductor. A semiconductor essentially looks like an overloaded circuit board with wires overlapping and connecting everywhere but the circuit board it the size of your thumbnail or perhaps smaller. These articles gave insight on how a semiconductor is created. It appears to be an industrial process when you look at it from the big picture but the tiny details that are overlooked on how the processing system is inserted inside. At this point, the chemical engineering aspect dominates the process of making a semiconductor. This a difficult challenge to overcome. Every year, devices are advancing to the future by changing the design and adding new features. These new features are available due to the advancing semiconductor, however, the semiconductor has to be ideal in size for it to work with the device. It is obvious how tiring and stressful being a chemical engineer working with semiconductors might be. Trying to beat a deadline, looking for a more efficient method, and solving issues requires dedication and persistence. At the moment, chemical engineers are working with electrical engineers and semiconductor architects to implement copper into their semiconductors. The main goal they are trying to reach with this is to make the processor fast and reliable. The copper would replace the existing aluminum inside the chip because the physics behind it shows that copper is one of the best electrical conductors while also being cost-effective. Trying to find a way that correctly implements copper is a lot harder than it sounds. The current semiconductors that contain aluminum work well with the silicon wafer that it sits on. The copper, however, bleeds into the silicon wafer and does not work the way it is intended to. To fix this problem, chemical engineers experiment with different substances to prevent this from occurring. Numerous trials and errors will be made to take a step closer to producing this new advancement. Giving up does not get you anywhere in this field and fighting that urge might be the hardest part of this job. As a whole, the world now relies on semiconductor and creating these microelectronic devices has a huge impact.

Overall with this research, the first thing that stood out to me is that making semiconductors is not easy at all. Not everyone can pursue this task. A dedicated person with a great amount of patience is required. A problem solver is needed, not a person who creates problems for the team by getting frustrated. One of my long-term goals is to become a positive person. It is difficult not to notice that I could potentially create semiconductors which can help me learn to stay positive in a hard time. By doing all this, I would be able to make an impact on the world. With this research, I can feel myself inch further into my journey of chemical engineering and am curious to where this research over semiconductors will end up taking me.

**Articles:**

"Cyclic Deposition Method for Thin Film and Manufacturing Method for Semiconductor, and Semiconductor Device" in Patent Application Approval Process (USPTO 20160300723)

***News of Science.*** (Nov. 6, 2016): p2045.

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Full Text:

2016 NOV 6 (VerticalNews) -- By a News Reporter-Staff News Editor at News of Science -- A patent application by the inventors KIM, Hai-Won (Icheon-si, Gyeonggi-do, KR); KIM, Seok-Yun (Yongin-si, Gyeonggi-do, KR), filed on September 23, 2014, was made available online on October 20, 2016, according to news reporting originating from Washington, D.C., by VerticalNews correspondents.

This patent application is assigned to Eugene Technologyco., Ltd.

The following quote was obtained by the news editors from the background information supplied by the inventors: "With the advance of semiconductor industries and the requirements of users, recently, electronic devices are being more highly integrated and have high performance, and thus, semiconductor devices that are the main components of the electronic devices are also required to be highly integrated and have high performance. However, it is difficult to realize a fine structure for highly integrating semiconductor devices.

"For example, a thinner insulation layer is required for realizing the fine structure, but if the insulation layer is formed to a thin thickness, layer properties such as insulation characteristic are degraded. Also, it is becoming difficult to form a thin film with a thin thickness and obtain excellent step coverage."

In addition to the background information obtained for this patent application, VerticalNews journalists also obtained the inventors' summary information for this patent application: "The present invention provides a method of cyclically depositing a thin film in which it is possible to deposit an oxide having an excellent layer property and step coverage, a semiconductor manufacturing method, and a semiconductor device.

"The present invention also provides thin film in which the erasing speed of a semiconductor device has increased, a semiconductor manufacturing method, and a semiconductor device.

"Other objects of the present invention will be clarified through the following detailed description and the accompanying drawings. .

"According to an aspect, a method of cyclically depositing a thin film includes performing an oxide depositing operation of repeatedly performing a deposition operation, a first purge operation, a reaction operation, and a second purge operation, wherein the deposition operation deposits silicon on a target by injecting a silicon precursor into a chamber into which the target is loaded, the first purge operation removes a non-reacted silicon precursor and a reacted byproduct from inside the chamber, the reaction operation supplies a first reaction source including oxygen into the chamber to form the deposited silicon as an oxide including silicon, and the second purge operation removes a non-reacted first reaction source and a reacted byproduct from the inside of the chamber; and performing a plasma processing operation of supplying plasma made of a second reaction source including nitrogen to the inside of the chamber to process the oxide including the silicon.

"The first reaction source may be one or more gases selected from the group including O.sub.2, O.sub.3, and N.sub.2O.

"The plasma treatment operation may include injecting one or more ignition gases selected from the group including Ar, He, Kr and Xe and generating the plasma from the second reaction source.

"The reaction operation may include using, O.sub.2-(oxygen anion) or O\* (oxygen radical) formed by using plasma at O.sub.2 atmosphere, as the first reaction source.

"The second reaction source may be one or more gases selected from the group including N.sub.2 and NH.sub.3.

"In the oxide deposition operation, an internal pressure of the chamber may be 0.01 Torr to 10 Torr.

"In the plasma treatment operation, an internal pressure of the chamber may be 0.01 Torr to 10 Torr.

"Before the plasma treatment operation, the deposition operation, the first purge operation, the reaction operation and the second purge operation may be repeated three times to fifty times.

"The oxide deposition operation and the plasma treatment operation may be repeated.

"According to another aspect, it is possible to deposit a tunnel oxide through any one of the methods.

"A thickness of the tunnel oxide may be 20 .ANG. to 100 .ANG.

"A nitrogen concentration in the tunnel oxide may be 0.5 atomic % to 20 atomic %.

"A capture layer, a charge blocking layer and a gate layer may be sequentially formed on the tunnel oxide.

"According to another embodiment, in a non-volatile memory cell in which a tunnel oxide and a capture layer, a charge blocking layer, and a gate layer are sequentially stacked, a nitrogen concentration in the tunnel oxide may be 0.5 atomic % to 20 atomic %.

BRIEF DESCRIPTION OF THE DRAWINGS

"FIG. 1 is a flowchart illustrating a method of cyclically depositing a thin film, according to an embodiment of the present invention.

"FIG. 2 is a schematic, sectional view of a semiconductor manufacturing apparatus performing a method of cyclically depositing a thin film, according to an embodiment of the present invention.

"FIG. 3 represents the progress of a method of cyclically depositing a thin film, according to an embodiment of the present invention.

"FIGS. 4A to 4C are sectional views illustrating an operation of depositing silicon, according to an embodiment of the present invention.

"FIGS. 5A to 5C are sectional views illustrating an operation of forming an oxide including silicon, according to an embodiment of the present invention.

"FIG. 6 is a sectional view illustrating an oxide formed of a plurality of silicon, according to an embodiment of the present invention.

"FIGS. 7A to 7C are sectional views of an operation of performing plasma treatment on an oxide, according to an embodiment of the present invention.

"FIG. 8 is a cross-sectional view of an oxide including silicon according to another embodiment of the present invention.

"FIG. 9 is a graph of the composition ratio of the oxide of FIG. 8.

"FIG. 10 is a cross-sectional view of a charge trap type semiconductor device.

"FIG. 11 illustrates an energy band in a semiconductor device.

"FIG. 12 is a graph of the erasing property of a semiconductor device."

URL and more information on this patent application, see: KIM, Hai-Won; KIM, Seok-Yun. Cyclic Deposition Method for Thin Film and Manufacturing Method for Semiconductor, and Semiconductor Device. Filed September 23, 2014 and posted October 20, 2016. Patent URL: http://appft.uspto.gov/netacgi/nph-Parser?Sect1=PTO2&Sect2=HITOFF&u=%2Fnetahtml%2FPTO%2Fsearch-adv.html&r=1626&p=33&f=G&l=50&d=PG01&S1=20161013.PD.&OS=PD/20161013&RS=PD/20161013

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**Gale Document Number:**  GALE|A468454483

A penny for its thoughts

Erik Heinrich

***Maclean's.*** (Nov. 24, 1997): p106.

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<http://www2.macleans.ca/>

Full Text:

The Duchess of Windsor once said that a woman could never be too rich or too thin. A similar if less glamorous maxim applies to computers: a micro- processor-the chip that is the brain of any desktop or portable PC-can never be too fast or too powerful.

To stay abreast of the demands software developers place on their products, semiconductor makers have for years used every technical trick in the book to crowd as many circuits as possible onto a silicon wafer that is roughly the size of a human thumbnail. Their achievements have been little short of miraculous, with today's state-of-the-art Pentium II chips packing the equi- valent of 7.5 million transistors. Yet over the next 12 months, the chip industry is poised to take another huge leap forward with the introduction of an entirely new type of semiconductor-one that promises to make computers sig- nificantly faster and more powerful, as well as less expensive.

The breakthrough, announced recently by computing giant IBM Corp. of Armonk, N.Y., is a process that will allow chip makers to substitute copper for aluminum in the production of semiconductors. Copper's advantages over aluminum-the chip industry's metal of choice for more than 30 years-have been known for a long time: any first-year physics student knows that copper is a superior electrical conductor. But copper posed a number of problems, among them its tendency to bleed into silicon when the two were affixed.

Now, after more than a decade of research, IBM has come up with a solution, a special compound that prevents the copper from mixing with the silicon. And because copper is better at moving electric signals than aluminum, IBM has managed to shrink the circuitry without impeding the flow of instructions. The new process-called CMOS 7S-makes possible a circuit width of 0.2 microns, one-five-hundredth as wide as a human hair and 20 per cent thinner than the circuits found in today's most powerful microprocessors. Narrower circuits mean a smaller chip, and thus a shorter distance for electric currents to travel. To use the analogy of a jogging track, the researchers have shrunk the lanes and increased their number to accommodate more runners, while simultaneously reducing the distance needed to complete a lap.

The result is a semiconductor that is up to 40 per cent faster than its con- ventional counterpart. It is also about 30 per cent less expensive to produce and requires less power to operate. "Over time this could impact virtually every chip made," says IBM spokesman Bill O'Leary. Adds Gaylen Duncan, presi- dent and chief executive of the Information Technology Association of Canada: "IBM has opened up the door to a whole sequence of breakthroughs. This is not just about making computer chips better, it's about making them differently."

Initially, IBM's superchip will not have much impact on the market for home computers. "It takes time to work in the new technology," says O'Leary. Intel Corp. of Santa Clara, Calif., supplies 85 per cent of the chips used in PCs, including most of those made by IBM-and Intel has yet to figure out how to make a copper semiconductor. IBM's plan for 1998 is to continue using Intel chips in its PCs, while introducing copper semiconductors in areas such as memory chips and graphic cards. Initially, however, the biggest impact could be in the market for servers and mainframes, the workhorses of corporate North America. The first generation of CMOS 7S servers and mainframes is expected to appear in 1998. The new chips are being manufactured in limited quantity at IBM's plant in Fishkill, N.Y., but mass production is expected to begin soon in Burlington, Vt.

Anthony DeCristofaro, president and chief executive of MGI Software Corp. of Richmond Hill, Ont., a leading developer of multimedia software, says that IBM has set the stage for what he calls the video-computing age. "Making the desktop more intense in terms of MIPS [millions of instructions per second] is going to help open up new industries," says DeCristofaro, referring to the convergence of digital video technology with high-powered PCs, the Internet and corporate computer networks.

Doug Perovic, the 35-year-old chairman of the department of metallurgy and materials science at the University of Toronto, says that IBM's breakthrough demonstrates the continued relevance of Moore's Law. More than 30 years ago, Intel co-founder Gordon Moore predicted that computers would double in power and speed every 18 months. Now, Perovic expects researchers to turn their attention to the next major challenge: finding a way to produce computer chips with circuitry measuring less than 0.1 microns in width. "If we can find a way to do that," he adds, "it might be possible to create computers 10, even 50 times faster than they are today."

**Source Citation**   (MLA 8th Edition)

Heinrich, Erik. "A penny for its thoughts." *Maclean's*, 24 Nov. 1997, p. 106. *Research in Context*, go.galegroup.com/ps/i.do?p=MSIC&sw=w&u=j043905010&v=2.1&id=GALE%7CA20041970&it=r&asid=21a2ad22c8c8331a19a7d327e0e473d8. Accessed 25 Oct. 2017.

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