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A STUDY ON FEDERAL AGENCIES IMPROVED SEMICONDUCTOR INDUSTRY-RELATED DATA COLLECTION FOR A ENABLING DATA-DRIVEN AND TARGETED WORKFORCE POLICIES

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Abstract

The supply networks utilised by the semiconductor industry as a whole are notoriously complex. As a direct consequence of this, natural disasters have the possibility of causing severe property damage (pandemic lockdowns, or a factory fire). When it comes to the amount of political pressure that is being exerted, it is simple to compare this scenario to a normal standoff in Mexico. Because they are both suppliers and customers, each of these divisions and the enterprises that operate inside them are dependent on one another. Theoretically, almost everyone is capable of creating a problem inside the system.On the other hand, there is a diverse selection of wrenches to choose from. How easy is it to get past the blockage or refusal of a certain company's products in this convoluted network? Certain links in the chain may be quickly replaced with only a small bit of time and effort, whilst others are practically unreplaceable no matter what you do. Companies that have employees or products that are difficult to replace have a competitive edge and are worth more. To bring together all of the above comparisons, I will claim that the person in command of the game is the one who has the most cards in their hand. According to what happened with Huawei, the United States currently possesses the majority of the important assets that cannot be replaced. China does not currently participate in any of the essential high-value areas, and it does not have any major control over any of the value chain segments that are essential to the semiconductor industry. China also does not have any major control over any of the segments that are difficult to replace. It is apparent that they are susceptible. As a consequence of this, they could cause injury. (Calhoun, 2021).

Keyword: semiconductors, high-value zones, and the supply chain

INTRODUCTION

A material is said to be a semiconductor if it possesses certain electrical qualities that make it suitable for use as a component in computers and other electronic devices. These features enable the substance to perform its function as a foundation. In most cases, it takes the form of a solid chemical element or compound that, under some conditions, but not others, is capable of conducting electricity. Because of this, it is an excellent medium for controlling electrical current and the electrical gadgets we use every day.

Insulators are materials that do not allow electrical current to flow through them, whereas conductors are materials that allow electrical current to flow through them. The characteristics of a semiconductor are intermediate between those of a conductor and an insulator. Semiconductors are the building blocks for electronic components such as diodes, integrated circuits, and transistors.

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LITERATURE REVIEW

Approximately 120 years ago, certain findings on the electrical characteristics of silver sup hide were the first step in the study that would eventually lead to the development of semiconductors. After a period of fifty years in which very little progress was made, the year 1885 saw the discovery of point contact rectifiers, which sparked a newfound interest in the field. Prior to the invention of the vacuum tube, which occurred about 1915, these devices were utilised as detectors. The development of selenium and cuprous oxide rectifiers around the year 1930 rekindled interest in semiconductors, and the publication of a decent theory of semiconductors in 1931 gave even more fuel to the movement. The following phase of active interest occurred around the time of World War II, when the cat whisker diode was brought back into use and evolved into an outstanding radar detector. This field of research was given such a significant boost when the transistor was announced in 1948; as a result, it has grown to become a true behemoth in the last few years, and semiconductor electronics is now considered a major field of effort. Pearson published the study in 1955.

Considering the importance of sophisticated semiconductors to the operation of a broad variety of potentially game-changing technologies, the production of cutting-edge computer chips has emerged as a contentious arena for international competitiveness in the 21st century. Despite the fact that they are quite important, semiconductors are one of the few industries in which the Chinese economy is dependent on the economies of other countries, rather than the other way around.

The technological industries of both nations have benefited from their reciprocal dependency on one another. Chips made in the United States are used by every major Chinese technology business. Tencent and Alibaba would not be the powerhouses they are now if they had relied on Chinese microprocessors during their formative years or if they had designed and produced their own. In the meanwhile, a great number of American businesses have reaped the benefits of Chinese consumers, markets, and inventions. The widespread adoption of information technology was aided by the economies of scale and cost reductions made possible by the production of systems and devices located in China and Asia more generally. Despite the heated rhetoric on both sides of the Pacific, American semiconductor companies and their Chinese counterparts are now collaborating on the design of hundreds, if not thousands, of products and cooperative efforts to create new technologies. As a result, they are investigating the possibility of imposing new restrictions on imports of Chinese hardware and exports of both cutting-edge semiconductors and the equipment that is required to manufacture them.

But the means by which to accomplish this independence, as well as the question of whether or not doing so really makes sense, are both fraught with a great deal of ambiguity. The Chinese and global semiconductor industries are both in a state of flux, and U.S. officials need to first get a clear picture of the state of these industries before they can begin to consider the policy options available to them in this regard. Beijing's

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strategy for achieving its goal of establishing a domestic chip-making industry also needs to be examined. Even while it has made significant strides forward, the majority of China's semiconductor sector is still behind its international rivals, and the country's attempts to catch up confront significant challenges on the economic front.

Statement of the Problem

China has fallen far short of its ambitions to become technologically independent and a world leader in the semiconductor industry. China's manufacturing industry is at least two generations behind the times and heavily dependent on foreign suppliers of industrial equipment. Though the design side of the business can make competitive chips anywhere in the globe, the cutting edge must import most of its components from outside. There is little hope of China catching up to the cutting edge of semiconductor production anytime soon, and this pace is projected to be severely slowed by the effort from many national governments to tighten export controls on critical technologies. While the aforementioned technological constraints do exist, many bottlenecks in the business may often be addressed by a variety of transnational changes due to the sector's complexity. In 2020 (Hodiak),

Policy alternatives for tackling strategic rivalry between the US and China have been hotly disputed, and they include decoupling and reversing the integration of the supply chain. However, another viewpoint is that cooperative action and coordination between allies and equal partners is the optimal way to address economic and security concerns that affect all parties involved. Instead, China will continue to use a mix of indigenous development, international talent recruiting programmes, joint ventures, intellectual property theft, vertical integration, and other tactics to reach industrial calls into production in the semiconductor industry. Forthcoming (Hodiak, 2020).

The cold hard truth is that China can't meet global demand for semiconductors or equipment used to make them. Still, it has a long way to go before it can rely only on its own production of semiconductors; it now exports over $100 billion worth of chips while importing more than $300 billion. Meanwhile, HSBC Holdings Plc estimates that 28% of the semiconductor production equipment used by chipmakers is made in China. China has established a number of chip foundries and production lines, all of which need the import of various pieces of machinery.

Although the country has made strides, notably in the simpler stages of the multi-stage chipmaking process, the more complicated procedures are still decades away. When compared to industry heavyweights like Taiwan Semiconductor Manufacturing Co. and Samsung Electronics Co., Shanghai-based firms like Semiconductor Manufacturing International Corp. are many generations behind. China hasn't been able to enter into the cutting edge, and until 2015, the Chinese business produced much older technology. With the development of new chip designs and the worldwide need for more sophisticated semiconductors, China is chasing changing objectives.

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Take lithography, a crucial technique in the creation of chips, in which light is used to transfer circuit layouts to a film, which is then utilised to create individual microprocessors. Extreme ultraviolet lithography tools can take over a decade to create, and the price of this precise equipment continues to rise. Due to the high cost of entry and the high knowledge requirements, the industry has shrunk to just three major companies. Beijing has made repeated attempts to become semiconductor independent by offering subsidies and incentives, like as tax exemptions that last decades. The pursuit of independence is still a priority. In spite of this, major initiatives have failed.

HSBC also points out that Chinese chip-making equipment is inferior to that of international market leaders. Additionally, they are less accurate and more costly to maintain. The cost of ownership of expensive machinery and tools quickly rises above and above the initial purchase price. China will not be able to produce chips for local use or export even if it makes significant strides in chip design and technology. Due to its incapacity to produce this machinery and the monopoly foreign companies have on the market, the country will continue to rely on the international supply chain for the foreseeable future.

Objective of the Study

- To Enable Data-Driven And Targeted Workforce Policies, Federal Agencies Should Improve Their Semiconductor Industry-Related Data Collection.

Research Question

- How strong semiconductor industry growth set to continue as artificial intelligence adds to demand?

RESEARCH METHODOLOGY

The fields of communication, consumer electronics, and automotive, together with the field of industry, all appear to have bright future possibilities for semiconductors. It is anticipated that the worldwide semiconductor sector would increase at a compound annual growth rate of 7.7% between the years 2021 and 2026, ultimately reaching $778 billion. The desire for more advanced safety features in autos and the proliferation of internet-connected items are driving up the price of semiconductors, which are in short supply. This demand is also driving up the price of other goods that are linked to the internet. Since the year 2000, the analyst's company, which specialises in market research and management consulting, has produced more than 600 market intelligence studies and provided services to more than 1,000 clients located all over the world. In order to finish each research, the analytic team works practically constantly for the better part of four months.

Estimates of market share and size are derived on in-depth research as well as interviews conducted with key companies located across the supply chain. As a consequence of this, the analyst compiles a substantial quantity of information derived from a wide range

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of sources, verifies the accuracy of the data, and then performs an exhaustive analysis. Following the compilation of the data, results, and insights, the analyst will present the findings in a concise report in order to contribute to the process of making strategic decisions. (Andrea, 2021).

Research Design

Two growing subjects that have a direct influence on the dynamics of the semiconductor business are semiconductors for artificial intelligence and autonomous driving. Other well-known semiconductor manufacturers include SK Hynix and NXP Semiconductors, in addition to Broadcom and Micron. These two companies, along with Samsung Electronics and Intel, are all included here.

Because of the growing need for memory integrated circuits in portable media devices like smartphones, tablet PCs, and other handheld electronic gadgets, the market for integrated circuits will continue to be the most lucrative. It is anticipated that advanced driver assistance systems in vehicles and consumer desire for Internet of Things–enabled devices will both contribute to the expansion of the sensor market over the course of the forecast period.

The expansion of consumer interest in wireless communication technologies will ensure that the major end use will continue to be communication. The automotive category is expected to witness the largest increase over the course of the projection period. This is expected to be the case because the market has recovered from the effects of COVID-19 and because more electronic components are being integrated into vehicles.

During the time period covered by this prediction, the greatest market for IoT (internet of things) and electronic content in automobiles will continue to be China, Taiwan, and India, along with other nations located in the APAC region. It is anticipated that the markets for automotive electronics and industrial electronics would have the greatest growth in North America throughout the period covered by the projection.

Analysis

There are three different qualitative literature review approaches. These methods include identifying, categorising, and assessing the scientific advancements made during the fourth industrial revolution from the standpoint of OR&DS for the fabrication of semiconductors. The researchers utilised a two-step screening strategy in order to locate studies that were pertinent to their inquiry: The scope of the literature review was restricted as a first phase of the study by concentrating on publications that included phrases like "wafer," "integrated circuit," or "chip" in their names or keywords.

The Scopus database was utilised by the researchers to serve in the capacity of a search engine. The scope of the research has been narrowed as a result of the fact that national manufacturing policies have been in effect since 2011. According to the findings of the search, the evaluation was limited to considering only those articles in the subject of decision science that were written in English. Utilizing the Google scholar search engine

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to perform a comprehensive fact-check on all of the mentioned sources is the second stage. In the study, the keywords that were indexed were grouped so that additional research could be conducted on them. The indexed keywords for every article are arranged alphabetically under a single category. Eliminating all of the terms that had a similar meaning but were unconnected to the OR&DS file led to the creation of a new title for each of the phrases that were left standing. Using the results of the categorization, decision support matrices are constructed in order to illustrate the connections between the keywords. Researchers gave journal papers published in the most recent few months more weight than older studies and eliminated publications from consideration if their methodology was too similar to that of earlier research.

Intelligence pertaining to the development of semiconductor products and their manufacture for use in industry. The additional responsibilities for the subsequent step toward smart manufacturing are seldom ever discussed in an analytical framework in the relevant literature. In the lines that follow, we will discuss some of the elements of this chain that are considered to be the most significant.

CONCLUSION

In this study, we covered the most recent studies that have been conducted on SMOxs as well as their potential use as gas sensors. The chemical, physical, optical, and electrical properties of these materials have already sparked the interest of researchers in the use of these substances as gas sensors with a detection range of ppb levels and below. The SMOxs that were synthesised in a variety of morphologies, sizes, crystal and microstructures have shown that they are more capable of detecting a variety of gases, such as H2, NO2, CO, NH3, O2, VOCs, NO, SO2, and H2S, with good sensitivity, selectivity, and stability across a wide temperature range. This was demonstrated by the fact that the SMOxs were able to detect these gases. Because of the induced features, there is a large rise in the specific surface area, electron transport rate, permeability, and number of active reaction sites. Additionally, there is an increase in the total number of active reaction sites. Because of this, sensors that are dependable and able to function at temperatures ranging from room temperature to 500 degrees Celsius have made it possible to identify gases more precisely and accurately than ever before.

Another technique that might lead to enhanced gas sensing materials is the construction of heterojunctions and combinations with other functional materials. Constructing heterojunctions reverses the flow of electrons at the contact surfaces of the two different materials, which results in an increase in sensitivity. When it comes to having excellent sensor properties, having a high SMOxs resistance might be a disadvantage. It is hypothesised that combining SMOxs with other functional materials may circumvent this limitation and provide robust gas responsiveness at lower temperatures as a consequence of synergistic effects and defect structures. Despite all of the progress that has been made, further research and development is still required in order to achieve a high level of selectivity, sensitivity, and operating temperature for each key gas. One of the most challenging obstacles is maintaining selectivity in the presence of several gas

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species. In spite of the fact that the SMOxsensing materials have been adapted to the target gas, they continue to respond to other species, even though the concentration of these other species is lower. The development of novel MOx composites, the simplification of the production of nanostructured sensors, and the compositional cooperation of nanostructures and components are all possible areas that could be the focus of attention in order to make it possible for these technologies to be utilised in a practical setting.

According to Cornyn, companies based in the United States hold nearly half of the global market share for these types of microchips. However, despite the fact that the United States was once home to a quarter of the world's chip manufacturing facilities, it now only accounts for 12% of global manufacturing. China, on the other hand, produces 16% of the world's supply of microchips. When Cornyn found out that "Asia will possess 83 percent of the world semiconductor output by the year 2030," he became more worried. There is a consensus among the senators that the United States is already playing catch-up with regard to 5G technology because of their readiness to invest in domestic technologies. Warner argued that the United States was lagging behind in both the development and adoption of legislation to control a critical technology, and he compared this situation to the launch of Sputnik. During his remarks at the CSIS event, Senator Warner made the following observation: "Even if the process didn't originate in the United States, we've been defining its standards for a very long time now. When it came to 5G, China was the first country in many ways to saturate the zones in these international institutions in order to define the standards. This will be accomplished by developing the capacity to produce semiconductors as well as a marketing strategy. This train's first stop may be in the semiconductors industry, but Warner also said that the similar funding system might be developed to assist US businesses in 5G, artificial intelligence, quantum computing, hypersonic, and maybe other industries as well.

This amendment, in conjunction with $10 billion in additional federal funding from the Commerce Department, offers incentives for state and local governments to equal the level of investment by the federal government. Following the year 2024, tax credits for increasing industrial capacity will be eliminated gradually, and the incentives will come to an end the following year, in 2027. A worldwide standard-setting Organization will also be supported by the CHIPs law through the establishment of a fund in the amount of 750 million dollars. According to Warner, the reason why it is referred to as "industrial policy" is because its implementation serves to advance the objectives of a nation-state. (The year 2020, Atherton)

Alibaba has demonstrated, with the launch of the Yitian 710, that the desire for international talent in China is not going away anytime soon. Alibaba will continue to collaborate closely with long-standing foreign vendors such as Intel, Arm, Nvidia Corporation, and Advanced Micro Devices Inc. AMD. In 2019, T-Hanguang Head introduced its 800 chip, which is designed for artificial intelligence. It also possesses a second gadget known as the Xuan Tie 910, which may be used for things like self-driving

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cars and a variety of other applications. In the month of November, Tencent Holdings announced the release of three new processors, one each for intelligent machines, cloud computing, and video. The Chinese government aims to invest $150 billion in the growth of its chip sector from 2014 through 2030. This amount is a fraction of what the most powerful firms in the world spend each year on research and development. Over the next three years, TSMC plans to invest a total of one hundred billion dollars in both research and production. In order to advance their manufacturing capabilities, TSMC and other Taiwanese companies have begun recruiting Chinese engineers. If Taiwan does not decrease the number of job posts, Chinese President Xi Jinping has threatened to attack the island.

Officials refute the notion that China is attempting to cut itself off from the rest of the world economy by encouraging smartphone and other manufacturers to use Chinese suppliers, regardless of the fact that these suppliers are more expensive. During the Asia-Pacific meeting that took place in Malaysia in November, Chinese President Xi Jinping delivered a speech via video link in which he stated that "we would never go back in history by seeking to disconnect." The semiconductor industry's most recent disagreement revolves over photolithography, a technique that uses ultraviolet light to etch nanoscale circuits into silicon. Photolithography is at the centre of the controversy. Even while China's SMIC is just one-third as accurate as the technology used in the United States, the precision of 14 nanometers is a major increase. TSMC, a semiconductor manufacturer based in Taiwan, intends to improve its precision to 2 nanometers in the near future. In order to stay current, SMIC intends to purchase the most recent equipment offered by ASML; however, the Dutch government has not yet granted its authorisation. (Press, 2021).

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