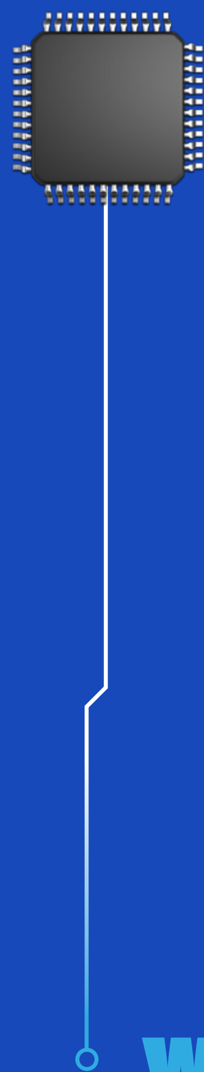
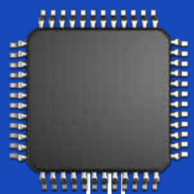


# WINNING THE FUTURE.

## A Blueprint for Sustained U.S. Leadership in Semiconductor Technology

April 2019

SIA SEMICONDUCTOR INDUSTRY ASSOCIATION



# WINNING THE FUTURE.

A Blueprint for Sustained U.S. Leadership in Semiconductor Technology

## SEMICONDUCTORS ARE VITAL TO AMERICA'S FUTURE

Semiconductors – the tiny chips that enable modern technologies – are critical to America's economy, job creation, technology leadership, and national security. **For 50 years, America has led the world in semiconductor innovation, driving transformative advances in nearly every modern technology, from computers to mobile phones to the Internet itself.** Today, semiconductors underpin the most exciting "must-win" technologies of the future, including artificial intelligence, quantum computing, and advanced wireless networks.

To secure America's leadership in these future technologies for the next 50 years, the United States must continue to lead the world in semiconductor research, design, and manufacturing.

## CHALLENGES TO CONTINUED U.S. LEADERSHIP IN SEMICONDUCTOR TECHNOLOGY

Technology challenges and ambitious steps by foreign governments put at risk continued semiconductor innovation and U.S. leadership in this sector. Technology advancements are pushing against barriers of physics, and breakthroughs to move beyond these limits are constrained by massive capital costs. Although U.S. companies still lead the world with nearly half of global market share, state-backed competition from abroad seeks to displace U.S. leadership.

## AMBITIOUS POLICY ACTION IS NEEDED TO SUSTAIN AND STRENGTHEN U.S. SEMICONDUCTOR LEADERSHIP

### 1 Invest in research

- Triple U.S. investments in semiconductor-specific research across federal scientific agencies from approximately $1.5 billion to $5 billion annually to advance new materials, designs, and architectures that will exponentially increase chip performance.
- Double U.S. research investments in semiconductor-related fields such as materials science, computer science, engineering, and applied mathematics across federal scientific agencies to spur leap-ahead innovations in semiconductor technology that will drive key technologies of the future, including artificial intelligence, quantum computing, and advanced wireless networks.

### 2 Incentivize domestic manufacturing

- Establish a manufacturing grant program to spur construction of new onshore advanced semiconductor manufacturing facilities in the U.S., including leading-edge logic foundries, advanced memory, and analog fabs to supply defense, critical infrastructure, and broader essential commercial needs.
- Provide tax incentives for semiconductor manufacturing, such as a refundable investment tax credit for the purchase of new semiconductor manufacturing equipment.

### 3 Attract and develop a skilled workforce

- Reform the high-skilled immigration system by eliminating counterproductive caps on green cards so qualified STEM graduates from U.S. colleges and universities, as well as STEM graduates from around the world, can contribute to U.S. leadership in the semiconductor industry and boost our economy.
- Increase U.S. investments in STEM education by 50 percent and implement a national STEM education initiative to double the number of American STEM graduates by 2029.

### 4 Ensure access to global markets and protect intellectual property

- Approve and modernize free trade agreements, including the United States-Mexico-Canada Agreement, that remove market barriers, protect IP, and enable fair competition.
- Increase resources for law enforcement and intelligence agencies to prevent and prosecute semiconductor intellectual property theft, including the misappropriation of trade secrets.

April 2019

Learn more and download the full report at **winthefuture.tech**

S I A
SEMICONDUCTOR INDUSTRY ASSOCIATION

## SEMICONDUCTORS: THE FOUNDATION OF MODERN TECHNOLOGY

Semiconductors form the foundation for nearly all modern technologies. They have transformed our lives and our economy for the better and are giving rise to the technologies that will shape our future. They have the unique distinction of being all around us, yet mostly unseen. They are embedded in the digital goods we depend on for communication, transportation, healthcare, business, national security, and countless other applications.

> *"Continual advancement of semiconductor technologies during the past 50 years in accordance with Moore's Law — which posits that the overall processing power of computers will double every two years — has been a key driver of the information technology revolution that underpins many U.S. economic and security advantages."*
>
> **Worldwide Threat Assessment of the U.S. Intelligence Community (May 2017)**

Semiconductors were invented in America, and the U.S. still leads the world in leading-edge semiconductor research, design, and manufacturing. **U.S. semiconductor companies commanded nearly half of the $469 billion global semiconductor market in 2018.**

Advancements in semiconductor technology have been measured by "Moore's Law," the observation that the number of transistors on an area of silicon will double roughly every 18 to 24 months. For more than 50 years, the ability of the semiconductor industry to maintain this rapid pace of innovation has propelled a technology revolution through massive increases in computing power at lower costs.

The industry has followed Moore's Law to levels once unimaginable, pushing the limits of material science, photonics, engineering, and design. Today's semiconductors have billions of transistors on a chip the size of a square centimeter, and circuits are measured at the nanoscale. Leading-edge semiconductors contain transistors **10,000 times thinner than a human hair**. As a result of dramatic advancements in semiconductor technology, consumers have benefitted from more innovative products at lower prices. This rapid pace of innovation has boosted America's economy, created U.S. jobs, and transformed our very way of life for the better.

To maintain our innovation trajectory for the next 50 years and win the competition for global leadership in the technologies of the future, the U.S. must lead the world in semiconductor innovation.

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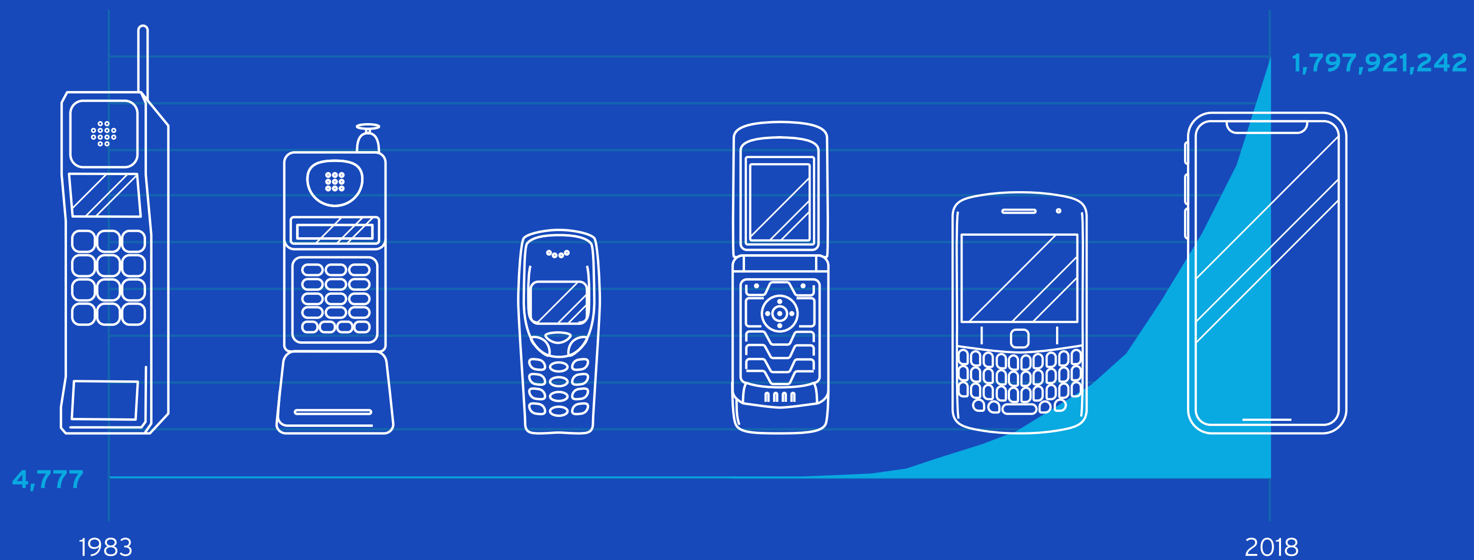
**The U.S. has a positive trade balance in semiconductors with virtually all our major trading partners, including China, and provided a net surplus of $4.5 billion to the overall trade balance in 2018.**

# DRIVING UNPARALLELED INNOVATION THROUGH MOORE'S LAW

THE AVERAGE NUMBER OF TRANSITORS ON A SINGLE SEMICONDUCTOR




Innovation has propelled a technology revolution through massive increases in computing power at lower costs. The first cellphones went on sale in the U.S. in 1983 for almost $4,000 each. Today, phones with exponentially higher computing power are affordable to most.

## CHALLENGES TO CONTINUED INNOVATION AND U.S. LEADERSHIP IN SEMICONDUCTOR TECHNOLOGY

The breathtaking pace of semiconductor innovation over decades is at risk from technology barriers and ambitious efforts by overseas competitors, bolstered by government investment.

The industry's ability to advance semiconductor technology is pushing against barriers of physics, and breakthroughs to move beyond these limits are constrained by massive capital costs.

In addition, while America leads the world with nearly half of global market share, overseas governments are seeking to displace U.S. leadership through huge government investments in both commercial manufacturing and scientific research. For example, the Chinese government has announced efforts to invest well over $100 billion over the next decade to catch up to the United States in semiconductor technology, artificial intelligence, and quantum computing. While China may not meet all its goals, the size and scale of its effort should not be ignored.

These challenges and others pose risks to American leadership in semiconductor design, research, and manufacturing and our position in the global race for the technologies that will define our future. Semiconductors enable the key "must-win" technologies of the future, including artificial intelligence to power self-driving cars and other autonomous systems, quantum computing to analyze massive volumes of data and enhance digital encryption, and advanced wireless networks to seamlessly connect people at unprecedented speeds. These core technologies will fuel future innovations in other fields essential to future economic growth, such as personalized healthcare, robotics, and intelligent products.

## SEMICONDUCTORS AND THE 'MUST-WIN' TECHNOLOGIES OF THE FUTURE

The future economy will be characterized by technologies that use sensors to collect immense amounts of data, networks to store and move the data, and advanced computers and systems to analyze and use the data in productive ways. **Semiconductors are core to each of these functions**, and we must make further advances in semiconductor technology to meet the needs of the technologies of the future.

## THE ROLE OF SEMICONDUCTORS IN HARNESSING THE TECHNOLOGIES OF THE FUTURE

### Artificial Intelligence

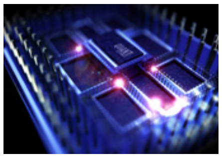
Artificial intelligence refers to technologies that imitate human learning and decision-making. AI has the potential to dramatically transform the economy. It will be critical to autonomous vehicles, machine learning, and countless "smart" devices and applications. Experts have estimated that **artificial intelligence could add $13 trillion to global economic output by 2030.**

Without advances in semiconductor process technology and chip design, AI could not have moved so rapidly from futuristic speculation to present-day reality. Indeed, semiconductors are critical in all three areas of a typical AI process flow: 1) data generation or data source through smartphones, automobiles, and multiple "Internet of Things" devices; 2) training the AI/deep learning algorithms using graphics processors, microprocessors, or other heavy performance-centric processors; and 3) AI inference in real-world uses.

*"The United States must drive technological breakthroughs in AI across the federal government, industry, and academia in order to promote scientific discovery, economic competitiveness, and national security."*

**- President Donald Trump, Executive Order on Maintaining American Leadership in Artificial Intelligence (Feb. 11, 2019)**

### Quantum Computing



Quantum computing promises to magnify the power of computers exponentially. **A quantum computer is 100 million times faster than a personal computer and thousands of times faster than existing supercomputers.** Achieving this level of computing power would transform entire industries and sectors of the economy.

The very development of quantum information sciences is closely linked with the semiconductor industry's research to overcome the computing power limitations of Moore's Law. Academic and government researchers have made advances in quantum computing in tandem, or in partnership, with the semiconductor industry.

Quantum computing requires sophisticated fabrication capabilities, specialized materials, and advanced technologies. Quantum hardware researchers believe that advances in quantum computing could help researchers working to answer difficult questions in the most widely used fields of AI and machine learning.

*"Quantum information science (QIS) applies the best understanding of the sub-atomic world – quantum theory – to generate new knowledge and technologies. Through developments in QIS, the United States can improve its industrial base, create jobs, and provide economic and national security benefits."*

**- National Science and Technology Council, "National Strategic Overview for Quantum Information Science" (September 2018)**

### Advanced Wireless Networks

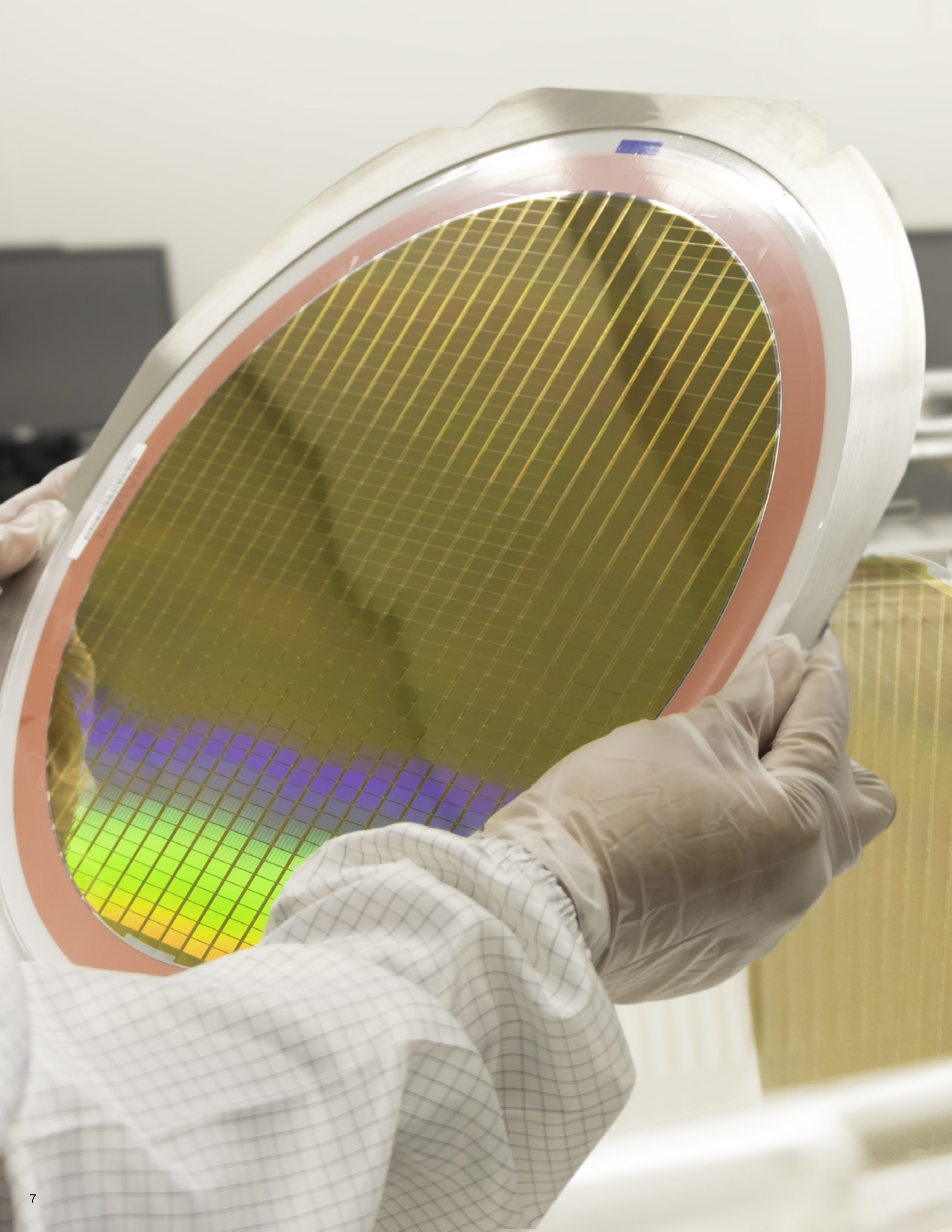
With promised low latency and ultra-high speeds up to 100 times faster than current networks, advanced wireless networks will be the foundation for the new economy and provide the backbone for the next generation of digital technologies, such as the Internet of Things, autonomous vehicles, and robotics – all paired with robust mobility.

Because of the huge promise of advanced network speeds and their entirely new architectures, the full potential of the underlying semiconductor hardware solutions has not yet been realized. **The nation that achieves advancements in semiconductor technology for next-generation wireless networks, such as 5G and beyond, will reap significant economic benefits.**

Leading in advanced wireless networks requires a national policy that augments the R&D efforts of the semiconductor industry, builds up the engineering and tech workforce, and supports both private and public R&D. NSF supports fundamental research in wireless data and advanced wireless networks. It also funds testbeds and research platforms for prototyping advanced wireless network systems using an array of research infrastructure programs at U.S. universities through the Platform for Advanced Wireless Research.

*"Wireless communications and associated data applications establish a foundation for high wage jobs and national prosperity."*

**- Presidential Memorandum on Developing a Sustainable Spectrum Strategy for America's Future (October 2018)**



# FOUR POLICIES TO ENSURE U.S. LEADERSHIP IN SEMICONDUCTOR TECHNOLOGY

The strategy to sustain and strengthen U.S. semiconductor leadership consists of three overarching policy initiatives:

1. **Invest in research** that will promote American semiconductor innovation.
2. **Incentivize domestic manufacturing innovation** to strengthen the defense industrial base, support economic growth, and improve supply chain security.
3. **Attract and develop a skilled workforce** that will ensure U.S. leadership in semiconductor research, design, and manufacturing and in the development and implementation of future growth technologies.
4. **Ensure access to global markets and protect intellectual property** so the U.S. semiconductor industry can compete, innovate, and grow in the future.

By implementing these policies, Congress and the Administration would be taking key steps to protect American leadership in semiconductor technology and win the global competition for the technologies of the future. Implementing these policies will help steer America toward a future of innovation leadership and economic growth, while also bolstering our national security.

# 1 INVEST IN SEMICONDUCTOR RESEARCH

To make breakthroughs in the key technologies expected to drive future economic growth and to maintain American leadership in the face of global competition, the U.S. needs to invest ambitiously in semiconductor research. Unfortunately, government investment in research has been declining or been flat for many years. In contrast, key competitors are dramatically increasing their research spending, including targeted investments in semiconductor research. **The U.S. risks losing its innovation edge and the global competition for technology leadership if under-investment persists.**

The U.S. semiconductor industry already invests heavily in its own research and development to stay competitive and maintain its technology leadership. Nearly one-fifth of U.S. semiconductor industry revenue is invested in R&D, amounting to approximately $36 billion in 2017, triple the amount invested 20 years ago.[1] This is among the highest shares of any industry, and the vast majority of this research is conducted in the U.S. The industry's investment is primarily targeted at applied research and product development, not the basic research needed for long-range, fundamental technology breakthroughs. To supplement this private-sector commitment, the U.S. needs to increase government investments at universities, national labs, and other entities to maintain our leadership in this critical industry.

The decades-long success of Moore's Law was driven by research investments in materials and chemicals sciences, computer science and applied math, electrical engineering, and fabrication technologies. Continued semiconductor innovation will require research in new materials, designs, and architectures through a whole-of-government approach and public/private partnerships to apply the best research from academia, industry, and government research centers. [2]

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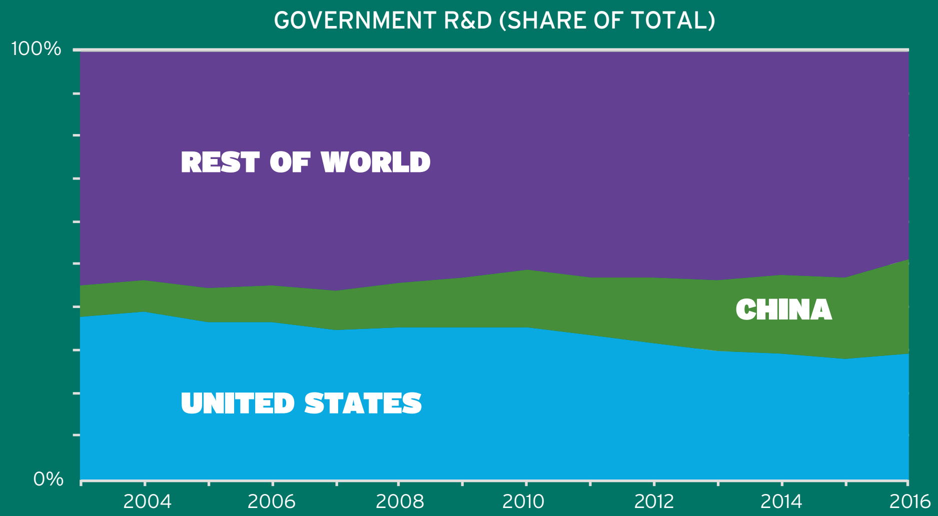
**The U.S. semiconductor industry annually invests approximately one-fifth of revenue in research and development, amounting to approximately $36 billion in 2017. This is among the highest R&D investment rates of any industry.**

## DECLINING GOVERNMENT SUPPORT FOR RESEARCH – A RISK TO AMERICAN LEADERSHIP

The federal scientific enterprise is a crown jewel of American society, yielding countless innovations that have contributed to U.S. economic strength and national security. Unfortunately, government investment in research has been declining in comparison to key competitors.




SOURCE: OECD Science Indicators, April 2019.

### RESEARCH POLICY RECOMMENDATIONS

We urge Congress and the Administration to:

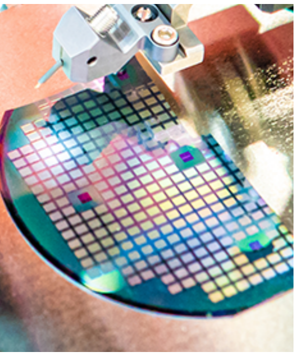
- **Triple U.S. investments in semiconductor research** across federal scientific agencies from approximately $1.5 billion to $5 billion annually to advance new materials, designs, and architectures that will exponentially increase chip performance. The federal government currently invests approximately $1.5 billion in research programs specifically focused on the semiconductor industry. These programs fund critical research in nanoelectronics, security, energy efficiency, and other important areas. To meet current technology challenges and keep up with global competition, funding of these semiconductor research programs should be tripled over the next 5 years.
- **Double U.S. research investments in semiconductor-related fields such as materials science, computer science, and applied mathematics** across federal scientific agencies to spur leap-ahead innovations in semiconductor technology that will drive key technologies of the future, including artificial intelligence, quantum computing, and advanced wireless networks. Semiconductor advances also benefit from programs addressing broader fields of scientific inquiry that span the range of the U.S. scientific enterprise. Research programs in areas such as materials science, computer science, applied mathematics, photonics, and chemistry are essential to future innovations in semiconductor technology. Funding for these programs should be doubled over the next 5 years.

Increased research funding alone, however, will not meet the challenges without increased engagement with industry. **The federal government plays an essential convening role and must drive public-private research partnerships that not only increase the general scientific research knowledge base, but also connect that knowledge to real-world applications.** Doing so is necessary to ensure scientific breakthroughs benefit society and sustain American leadership in semiconductor technology that is key to national security and industrial competitiveness.

### RESEARCH – DEVELOPING THE PIPELINE OF TALENT

In addition to providing the foundation for technological innovation, investments in research also support the "pipeline" of talent for the next generation of semiconductor innovators. Given the critical importance of developing a high-skilled, high-knowledge workforce that can continue advancement in semiconductor technology, research funding is an important component of facilitating an innovative workforce in the U.S.

# 2 INCENTIVIZE DOMESTIC MANUFACTURING



**Robust domestic semiconductor manufacturing is critical to America's economy, national security, supply chain resilience, and global leadership in the technologies of today and tomorrow.** The U.S. currently has commercial fabs in 18 states and semiconductors are our nation's fourth-largest export. Today, however, the U.S accounts for only 12 percent of global semiconductor manufacturing capacity, a decrease from 37 percent in 1990.

Depending on the type of fab, a new fab in the U.S. costs approximately **30 percent** more to build and operate over 10 years than one in Taiwan, South Korea, or Singapore, and **37-50 percent** more than one in China. As much as **40-70 percent** of that cost differential is directly attributed to government incentives. As a result, America has lost ground to overseas competitors that are investing significantly to win the race to build the next fab within their borders.

To be sure, global semiconductor value chains are – and should continue to be – critical to the semiconductor industry's success. The COVID-19 crisis and the shortage of chip supplies for the auto sector and other industries, however, have underscored the need to strike the right balance between a dependence on global supply chains and ensuring enough production occurs in the U.S., especially when it comes to components needed to drive key systems supporting our national security and digital infrastructure.

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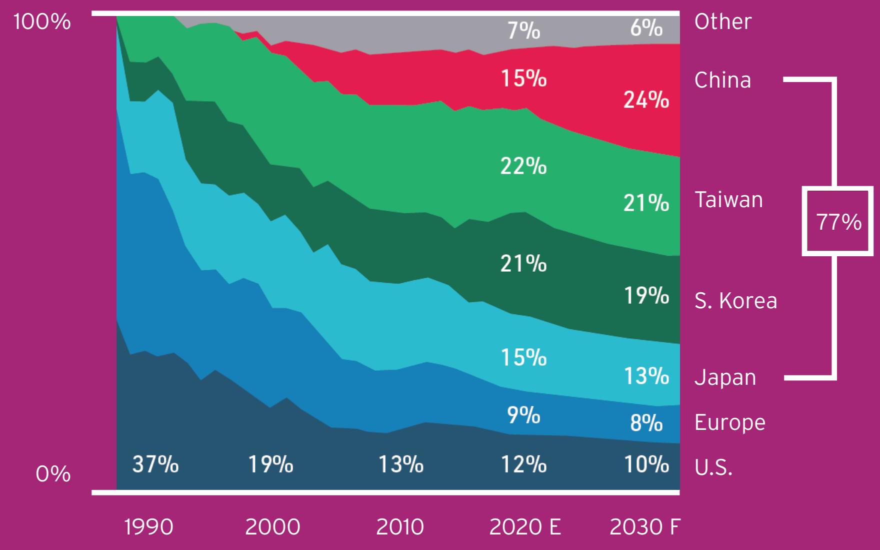
**With global manufacturing capacity projected to increase by 56 percent in the next decade, the U.S. has a strategic opportunity to reverse the decades-long trajectory of declining chip manufacturing in America, strengthen national security and make our supply chains more resilient, and make our country one of the most attractive places in the world to produce semiconductors.**

## AMERICA'S ERODING SHARE OF GLOBAL MANUFACTURING

Without bold U.S. government action to invest in domestic manufacturing incentives to make America more cost-competitive with other countries, by 2030, 77 percent of global fab capacity is projected to be located in Asia, with China accounting for the greatest growth.

SHARE OF GLOBAL CHIP MANUFACTURING BY LOCATION

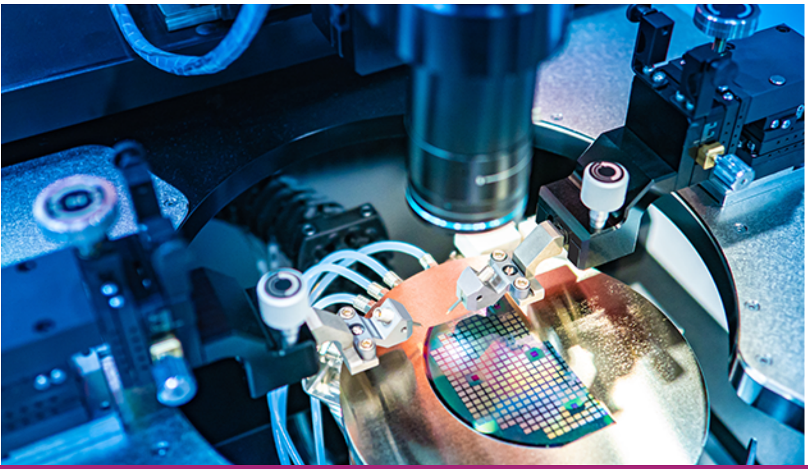



## MANUFACTURING POLICY RECOMMENDATIONS

To reduce the cost disadvantage facing semiconductor manufacturing in the U.S. and strengthen our economy and national security, we urge Congress and the administration to:

- **Establish a manufacturing grant program** to spur construction of new onshore advanced semiconductor manufacturing facilities in the U.S., including leading-edge logic foundries, advanced memory, and analog fabs to supply defense, critical infrastructure, and broader essential commercial needs.

- **Provide tax incentives for semiconductor manufacturing and research,** such as a refundable investment tax credit for the purchase of new semiconductor manufacturing equipment and research in advanced technology.



# 3 ATTRACT AND DEVELOP A SKILLED WORKFORCE

To maintain global semiconductor industry leadership and ensure America wins the worldwide race to develop and implement the technologies of the future, the U.S. needs a highly skilled workforce.

Leadership in semiconductor research, design, and manufacturing requires access to the best and brightest scientists and engineers from around the world. In the global race for talent, the U.S. educational system is failing to produce a sufficient number of American workers and students with the necessary STEM expertise to meet the needs of the semiconductor industry and other technology fields. As a result, allowing top minds from abroad to fill open jobs in the U.S. is critical to the U.S. semiconductor industry. **Every highly educated immigrant who stays and works in the U.S. creates nearly three additional American jobs,**[3] and many of America's most innovative companies — including several leading U.S. semiconductor companies — were founded and led by immigrants.

The U.S. is also falling behind its global competitors in most education benchmarks. China is producing many more bachelor's degrees in STEM fields. At the graduate level — which generates the expertise in materials science, physical chemistry, electrical engineering, and other fields of importance to the semiconductor industry — a large percentage of students in relevant fields at U.S. colleges and universities are from foreign countries. In electrical engineering and computer science graduate degree programs at U.S. colleges and universities, the NSF indicates that approximately 80 percent of students are from foreign countries, a rapidly increasing trend.

The U.S. needs a comprehensive long-term plan to attract young students — **particularly underrepresented women and minorities** — to science and engineering and expose them to work in labs, advanced manufacturing, and apprenticeships.

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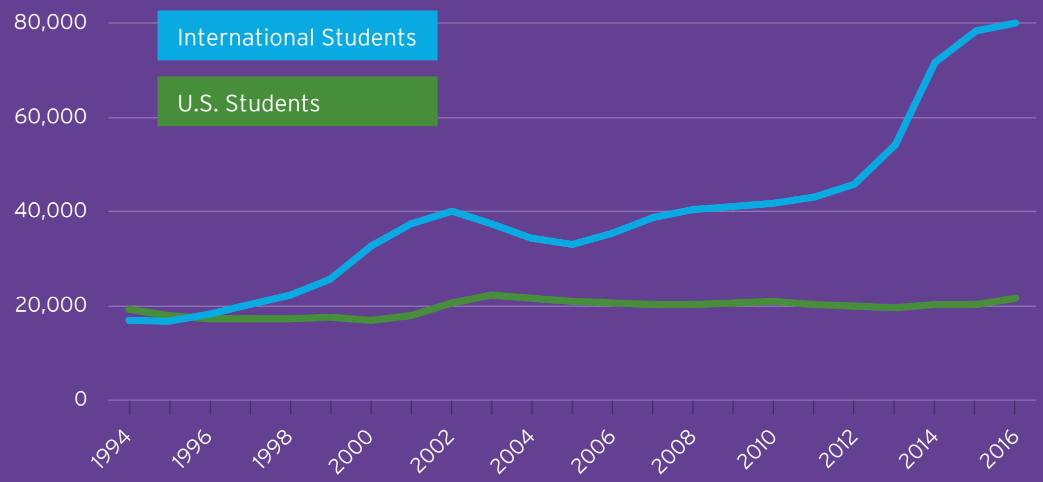
**The semiconductor industry directly employs nearly a quarter of a million workers in the U.S. and supports more than one million additional jobs in the U.S., with major manufacturing operations in 18 states.**

# AMERICA'S TALENT CHALLENGE

International students make up a growing share of science and engineering graduate students at U.S. institutions, outnumbering their American counterparts by a ratio of nearly four to one.

FULL-TIME U.S. GRADUATE STUDENTS IN ELECTRICAL ENGINEERING & COMPUTER SCIENCE

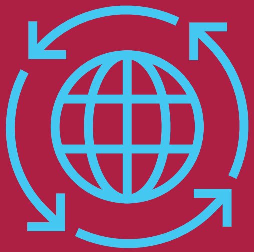



SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, Graduate Students and Postdoctorates in Science and Engineering Survey.

## WORKFORCE POLICY RECOMMENDATIONS

We urge Congress and the administration to:

- **Reform the high-skilled immigration system by eliminating counterproductive caps on green cards** so qualified STEM graduates from U.S. colleges and universities, as well as STEM graduates from around the world, can work, innovate, and contribute to U.S. leadership in the semiconductor industry and boost our economy. Foreign nationals in STEM fields, particularly those with advanced degrees, should be automatically eligible to work in the U.S. and contribute to our economy.
- **Increase U.S. investments in STEM education by 50 percent and implement a national STEM education initiative** to double the number of American STEM graduates by 2029. Policymakers should support apprenticeships and training programs and work with industry and academia to develop curricula to match the needs of growing technologies that are critical to the future of the semiconductor industry, such as artificial intelligence, quantum computing, and advanced wireless networks.



# 4 ENSURE ACCESS TO GLOBAL MARKETS AND PROTECT INTELLECTUAL PROPERTY

Free and fair access to global markets is essential to the industry's success. **Semiconductors are America's fourth-largest export, contributing positively to America's trade balance for the past 20 years.** More than 80 percent of revenues of U.S. semiconductor companies are from sales overseas. Revenue from global sales sustains the 1.25 million semiconductor-supported jobs in the U.S., and is vital to supporting the high level of research and development necessary to remain competitive. Additionally, most of this R&D is conducted in the United States. The semiconductor industry relies on a complex and global supply chain for raw materials, equipment, R&D, technology, human talent, testing, and distribution.[4] As a result, continued access to global markets and supply chains is critical for continued U.S. industry leadership.

All phases of the semiconductor value chain — research, design, manufacturing, assembly, and packaging — occur in a globally integrated network. The semiconductor industry in the U.S. has leveraged this global network to maintain its competitiveness, and it is a key aspect of the industry's success.

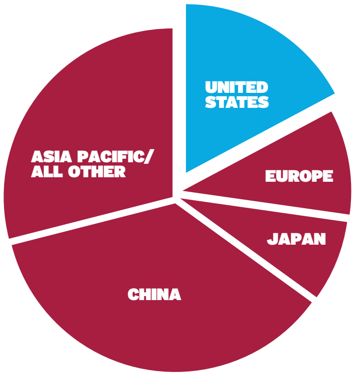
Today, the global semiconductor ecosystem is under threat from government policies that seek to localize supply chains and build state-backed national champions to compete abroad. These policies employ massive state subsidies, top-down approaches, centrally planned industrial policies, and other non-market efforts, including forced technology transfer and intellectual property theft. They also have the potential to disrupt markets and harm innovation. While China stands out today, there are fears this "supply-chain localization" trend will spread to other nations. **America's global leadership of the semiconductor industry can be maintained only by promoting access to global markets and ensuring fair competition.** In addition, all nations have an interest in maintaining this global value chain. The U.S. government should work with like-minded nations to promote effective trade policies to sustain this critical aspect of our industry.

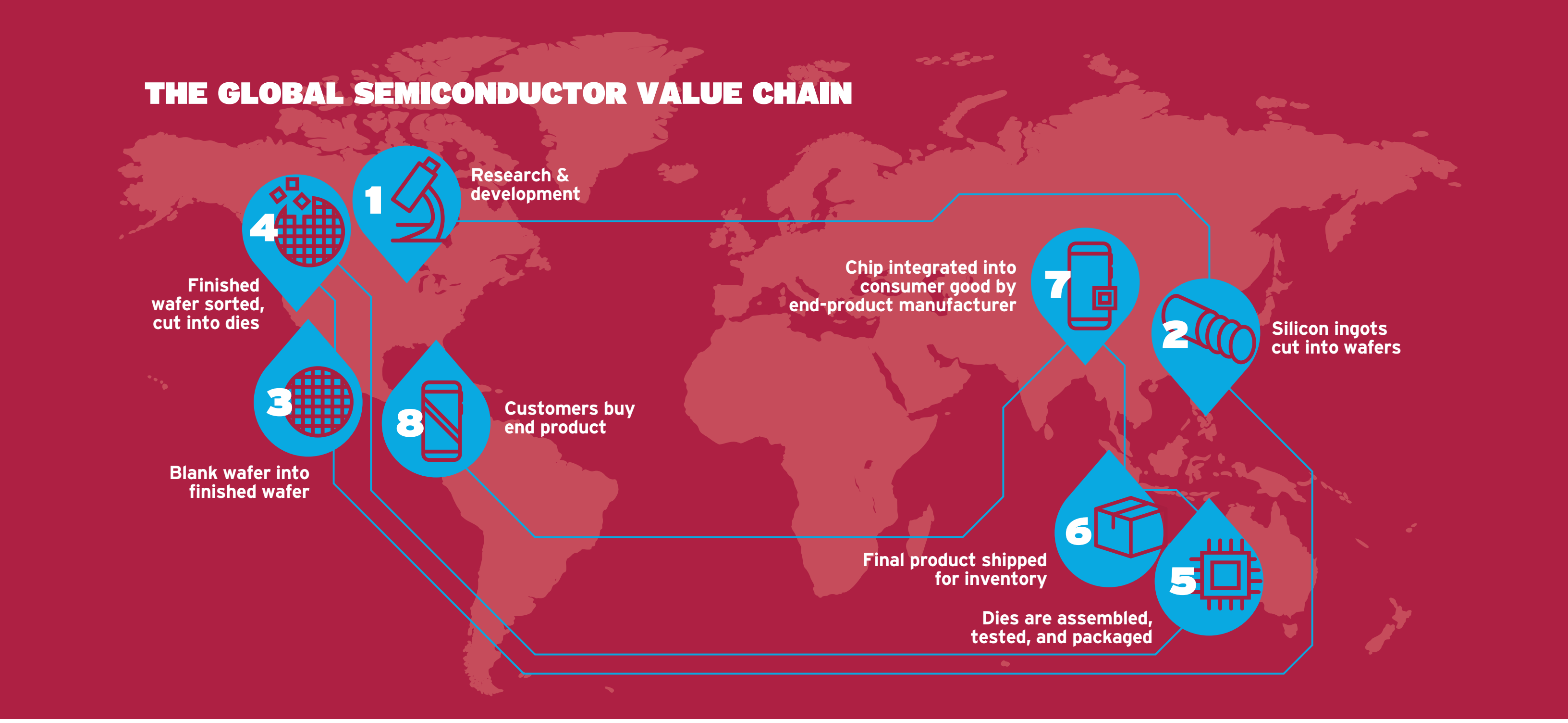
Open markets and fair trade require strong intellectual property protection and enforcement. Intellectual property is the lifeblood of the semiconductor industry, and enforcing intellectual property rights is essential to the industry's global competitiveness. The industry's high level of investment in research and development results in valuable intellectual property (patents, trade secrets, source code, etc.), and protection of this intellectual property is critical to the industry's competitive position in the world.

## THE IMPORTANCE OF FREE AND OPEN MARKETS

**OVERSEAS MARKETS ACCOUNT FOR OVER 80% OF SALES FOR U.S. SEMICONDUCTOR COMPANIES**

SOURCE: World Semiconductor Trade Statistics and SIA






## TRADE POLICY RECOMMENDATIONS

We urge Congress and the administration to:

- **Approve and modernize free trade agreements,** including the United States-Mexico-Canada Agreement, that remove market barriers, protect IP, and enable fair competition. U.S. policymakers should expand access to global markets and combat discriminatory and market-distorting policies by approving new and updating existing free trade agreements. Modern U.S. trade agreements should:
    - Strengthen safeguards and increase penalties to protect trade secrets and other forms of intellectual property.
    - Ensure access to global markets for the most innovative and effective encryption products by eliminating technical barriers to trade.
    - Ensure state-owned or subsidized enterprises compete fairly and transparently based on market considerations, by removing government subsidies that are illegal or lead to adverse effects.
    - Eliminate duties on semiconductor-rich products, applications and electronic transmissions.
    - Prevent forced localization of digital infrastructure and local content requirements.
    - Prohibit forced technology transfer.
    - Simplify and harmonize customs and trade procedures.

  Specifically, we urge approval of the United States-Mexico-Canada Agreement, which includes many new and higher-standard trade disciplines that will strengthen the digital economy and the global semiconductor supply chain.

- **Increase resources for law enforcement and intelligence agencies** to prevent and prosecute semiconductor intellectual property theft, including the misappropriation of trade secrets. Robust intellectual property protection is essential to preserving incentives for innovation.

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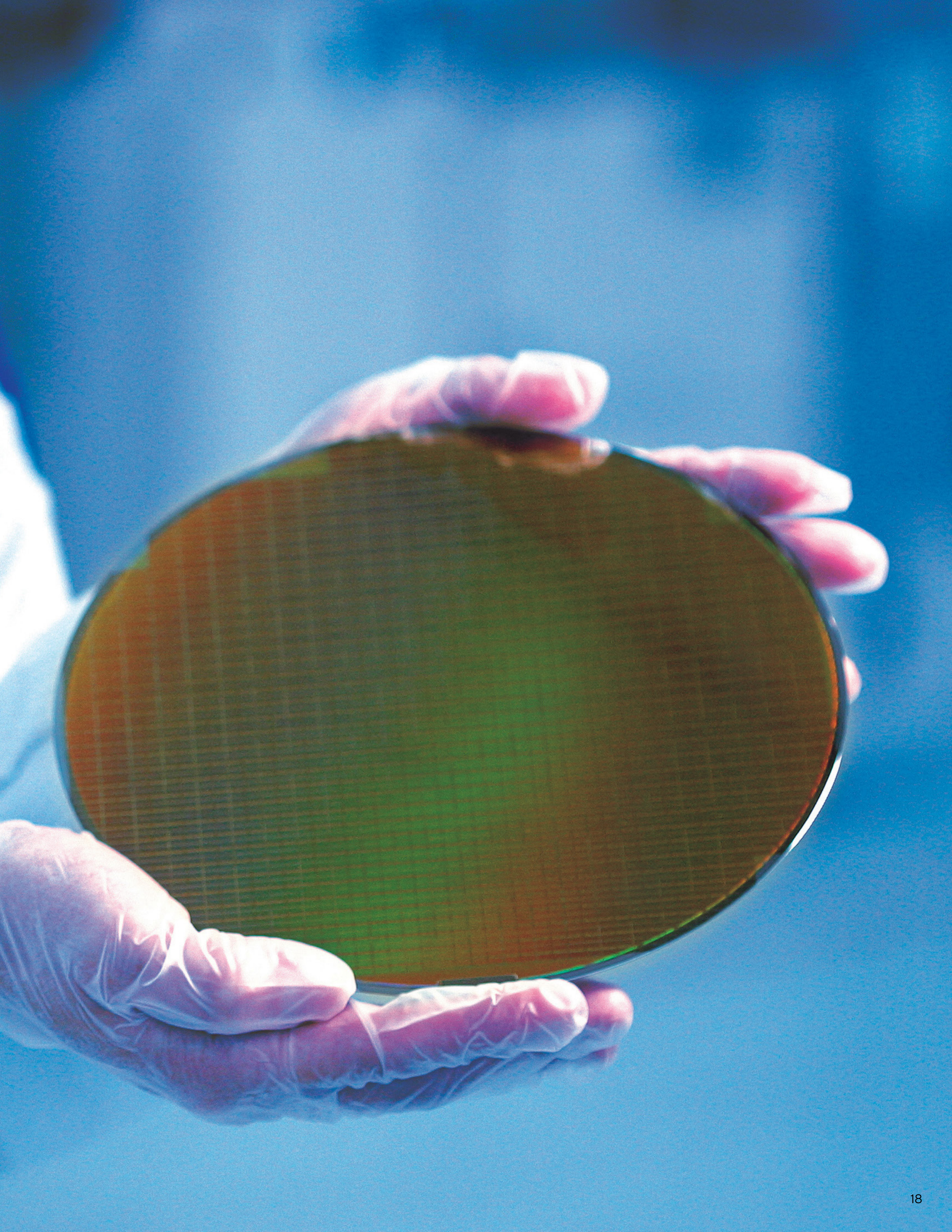
**Semiconductors are America's fourth-largest export after aircraft, refined oil, and crude oil.**

# CONCLUSION

Semiconductors are a key enabling technology that shapes our nation's economy, job creation, technology leadership, and national security. To maintain America's position as the global leader in semiconductor technology, the federal government must establish policies that invest in our innovation base, manufacturing footprint, human talent, and ability to compete globally.

When the U.S. has faced challenges to its leadership in semiconductor technology in the past, it rose to the moment through cooperation and collaboration. In the 1980s, government and industry partnered to form SEMATECH, a far-sighted collaborative effort to maintain U.S. semiconductor industry leadership. SEMATECH is widely regarded as having driven the technological innovations of that era by making strategic research investments and building the semiconductor workforce.[5] The effort was further advanced by the opening of global markets and supply chains, leading to the unparalleled growth and innovation that we have today.

The U.S. now faces a similar challenge to its industry leadership, and government, academia, and industry must again work together to overcome it. The obstacles we face today are different than those of the past, so this moment calls for strategic thinking and fresh solutions to achieve our common goal of continued U.S. semiconductor leadership.



# ENDNOTES


1 SIA Factbook https://www.semiconductors.org/resources/2018-sia-factbook/ (2018)

2 More detail on the research agenda for the semiconductor industry is available at "Semiconductor Research Opportunities: An Industry Vision and Guide" (March 2017). https://www.semiconductors.org/wp-content/uploads/2018/06/SIA-SRC-Vision-Report-3.30.17.pdf and Office of Science, Department of Energy, "Basic Research Needs for Microelectronics" (February 2019), https://science.energy.gov/~/media/bes/pdf/reports/2018/Microelectronics_Brochure.pdf

3 Help Wanted: The Role of Foreign Workers in the Innovation Economy. http://www.renewoureconomy.org/sites/all/themes/pnae/stem-report.pdf

4 Beyond Borders – The Global Semiconductor Value Chain: How an Interconnected Industry Promotes Innovation and Growth. https://www.semiconductors.org/wp-content/uploads/2018/06/SIA-Beyond-Borders-Report-FINAL-June-7.pdf

5 For more information about the role of SEMATECH in the 1980s, please see "Rising to the Challenge: U.S. Innovation Policy for the Global Economy," National Research Council of the National Academies, National Academies Press, 2012, pages 324-353. https://www.nap.edu/catalog/13386/rising-to-the-challenge-us-innovation-policy-for-the-global

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