Testimony of the
Semiconductor Industry Association (SIA)
Before the
Senate Committee on Environment & Public Works
A Legislative Hearing to Examine a Discussion Draft
“S.__ the Toxic Substances Control Act Fee Reauthorization and Improvement Act of 2026”

March 4, 2026

Chair Capito, Ranking Member Whitehouse, and Members of the Committee:

Thank you for the opportunity to testify at this important hearing. I’m David Isaacs, Vice President of Government Affairs for the Semiconductor Industry Association (SIA).[1] SIA is the voice of the U.S. semiconductor industry, a key driver of America’s economic strength, national security, and global competitiveness. SIA represents 99% of the U.S. semiconductor industry by revenue and nearly two-thirds of non-U.S. chip firms. The semiconductor was invented in the United States more than 65 years ago, and today, the U.S. industry remains a global leader in semiconductor technology and innovation.

Semiconductors drive America’s innovation and manufacturing leadership and play a fundamental role in the artificial intelligence (AI) revolution that is transforming the economy. These devices are the brains of modern electronics, enabling advances in medical devices and health care, communications, computing, defense and aerospace, transportation and infrastructure, energy, and more. Critically, chips underpin advances in the “must-win” technologies of the future, including AI, quantum computing, and advanced wireless networks. A globally competitive U.S. semiconductor industry will allow us to contest global challenges, boost our economy, enhance national security, and lead the technology race of the 21st century.

The semiconductor industry in the U.S. is a global leader in semiconductor research, design, and manufacturing. U.S. headquartered companies account for over 53% of global market share, with sales totaling $425 billion in 2025. The semiconductor industry directly employs 345,000 people in the U.S. and supports nearly 2 million additional U.S. jobs. Semiconductors are America’s sixth largest export, with approximately $56.8 billion in exports in 2024 (the latest full year of available data).

I. Semiconductor Manufacturing in the U.S.

The U.S. semiconductor industry is experiencing a revitalization of manufacturing throughout the supply chain. While the U.S. commanded 37 percent of global fabrication capacity in 1990, our share of global capacity declined to 10 percent by 2022.[2] Fortunately, this decades-long decline is beginning to reverse. Starting during the first Trump Administration, the United States took a critical step toward an investment-driven approach to revitalize a robust semiconductor ecosystem in the U.S., and those investments are now beginning to pay off. The industry has announced over 140 projects and $640 billion in investments throughout the country in all parts of the supply chain, from semiconductor manufacturing and packaging to semiconductor

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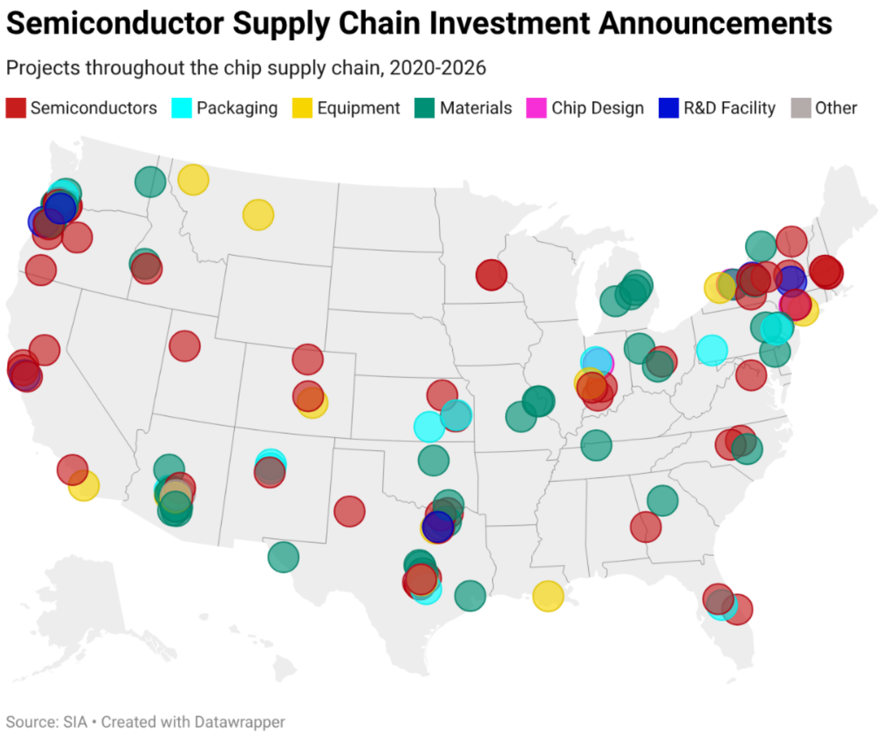
[1] nformation about SIA is available at www.semiconductors.org.

[2] SIA and BCG, “Strengthening the Global Semiconductor Supply Chain in an Uncertain Era”, April 2021. https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-ChainApril-2021_1.pdf.

manufacturing equipment and key material inputs (Figure 1). These investments contribute to growth in our economy, strengthen our national security, and make global supply chains more resilient. These announced projects are expected to create and support over 500,000 American jobs — 70,000 facility jobs in the semiconductor ecosystem; 122,000 construction jobs; and support over 320,000 additional jobs throughout the U.S. economy.[3]

Figure 1



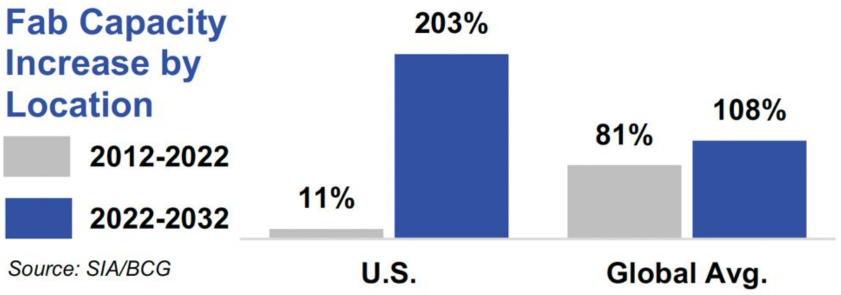
Semiconductor Supply Chain Investment Announcements

Projects throughout the chip supply chain, 2020-2026

Source: SIA • Created with Datawrapper

These investments will result in a projected increase in U.S. semiconductor manufacturing capacity of 203 percent by 2032, a tripling of U.S. capacity. By comparison, between 2012 and 2022, U.S. fab capacity increased by only 11 percent. (Figure 2).

Figure 2



Fab Capacity Increase by Location

Source: SIA/BCG

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[3] Semiconductor Industry Association, “America’s Chip Resurgence: Over $640 Billion in Semiconductor Supply Chain Investments,” updated February 2026 at https://www.semiconductors.org/chip-supply-chain-investments/.

As part of America's chip resurgence, chipmakers are onshoring new, advanced manufacturing processes. Accordingly, U.S. capacity for advanced logic will grow substantially to 28% by 2032, including new capabilities at the leading edge.[4] The U.S. share of advanced memory manufacturing will also grow from around 2% today to approximately 12% by 2035.[5] Critical to these investments will be the ability of semiconductor manufacturers to use innovative materials and chemistries in their U.S. fabs. New chemicals are necessary to keep pace with each successive technology node, enabling the manufacturing of devices that are smaller, more complex, and require extreme precision to build and manipulate individual atoms and molecules.

II. Brief Overview of the Semiconductor Manufacturing Process

Semiconductor fabrication is a highly complex manufacturing process resulting in device features measured at the nanometer length scale. The process involves advanced equipment and specialized material inputs. Sophisticated fabrication facilities ("fabs") require high levels of capital investment (as much as $20-25 billion for a leading-edge fab, spanning construction costs and manufacturing equipment investments) and significant R&D investments (the U.S. industry, on average, invests 20% of revenue back into research). Fab equipment operates under carefully controlled conditions to build chips with ever-increasing performance and features that in turn enable improvements in AI and virtually all sectors of the economy.[6]

The fabrication of a semiconductor device involves well over 1,000 precise steps, each requiring a unique set of specialized equipment (ranging in cost from ~$5M to >$300M) and material inputs. If any one of those steps fails, the chip will not function. In addition to chemicals directly used in the manufacturing process, a variety of materials and chemistries are present in the complex semiconductor manufacturing equipment and overall fab infrastructure.

The fabrication process entails a repetitive patterning process in which materials are selectively deposited, modified, or removed from a wafer surface, to produce highly intricate structures that are the building blocks of transistors which then become integrated circuits. Generally, the process involves the creation of 8 to 20, and up to hundreds of, patterned layers on (and into) the wafer to form interconnected, electrically active regions on the semiconductor wafer. Several of the key process steps in creating a semiconductor employ the use of specialized chemicals (Figure 3),[7] and in fact, manufacturing equipment is typically designed around the chemicals they must handle for that step.

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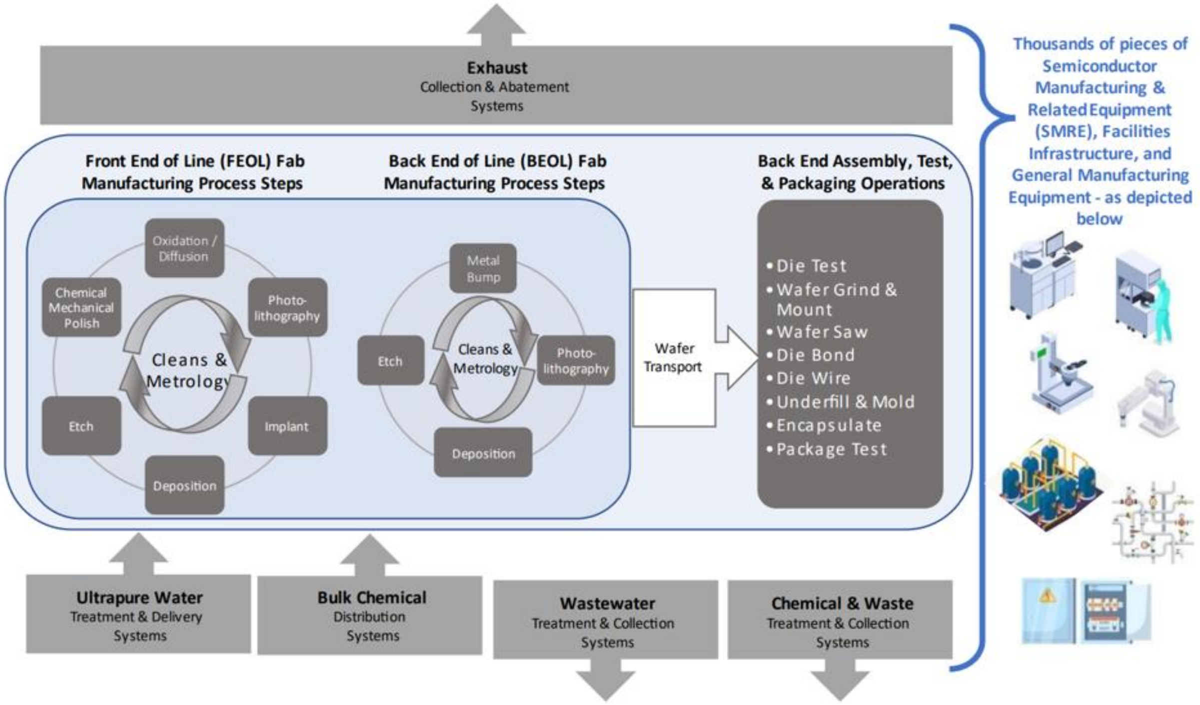
[4] Semiconductor Industry Association / Boston Consulting Group, "Emerging Resilience in the Semiconductor Supply Chain," May 2024. https://www.semiconductors.org/wp-content/uploads/2024/05/Report_Emerging-Resilience-inthe-Semiconductor-Supply-Chain.pdf.

[5] Estimates per SIA's discussions with member companies.

[6] Nanotechnology is the science, engineering, and technology conducted at the nanoscale, a range from 1 to 100 nanometers (nm). One nanometer is a billionth of a meter, or 10-9 of a meter. See http://www.nano.gov/nanotech-101. Current leading-edge chips have features of 2 nanometers (nm).

[7] Semiconductor Industry Association, Semiconductors 101 Frequently Asked Questions, https://www.semiconductors.org/semiconductors-101/frequently-asked-questions/
Semiconductor Industry Association / Semiconductor PFAS Consortium, "The Chemistry of Semiconductors Episode 2: Manufacturing the Miraculous," https://www.youtube.com/watch?v=H1kMEffPV6s

Figure 3: General Overview of Semiconductor Manufacturing Process Steps



Front-End Fabrication

- **Thermal Oxidation:** Wafers are first pre-cleaned using high-purity deionized water and low-particulate chemicals to ensure high-yield production. The silicon wafers are then heated to approximately 1000°C in an oxidation furnace and exposed to ultra-pure oxygen (dry oxidation) or water vapor (wet oxidation). Under carefully controlled conditions, a silicon dioxide insulator film of uniform thickness forms on the wafer surface.
- **Photolithography:** Photolithography defines where to add or remove materials in subsequent fabrication steps, creating extremely small patterns down to just a few nanometers in size with precise control of shape, size, and placement. First, a light-sensitive photoresist film is spin-coated onto the wafer, giving it characteristics similar to photographic film. A stepper or scanner (using deep ultraviolet or extreme ultraviolet light) aligns the wafer to a glass photomask and projects intense light through the mask or reticle, exposing the photoresist with the pattern. Exposed sections are then chemically removed, and the remaining photoresist is baked to harden it—leaving an intricate pattern on the surface for further processing.
- **Etching:** The wafer is then exposed to a chemical wet solution or plasma so that areas not covered by the hardened photoresist are etched away. Wet etching uses solutions of acids such as sulfuric, hydrochloric, phosphoric, and hydrofluoric, as well as bases such as ammonium hydroxide, or oxidizers such as hydrogen peroxide. The most commonly used form is plasma etch, in which source gases—typically fluorinated gases (F-gases) such as hydrofluorocarbons and perfluorocarbons—are excited using radio frequency (RF) energy to create a plasma that releases ions, electrons, and chemically reactive neutral molecular species including fluorine radicals. The remaining photoresist is then

removed using either wet or plasma chemistry, and the wafer is optically inspected to confirm correct image transfer before proceeding.

- **Doping:** Silicon is not naturally conductive. To make it semiconducting, atoms with one less valence electron than silicon (such as boron) or one more electron than silicon (such as phosphorus, arsenic, aluminum, antimony, gallium, or indium) are driven into the exposed silicon through ion implantation at high energy or through diffusion at high temperature. These dopant atoms create p-type or n-type regions that add or remove the right number of electrons within the pure silicon, establishing the flow paths for electrons in the transistors.
- **Deposition:** Full-surface or selective-surface deposition steps add precision layers of new substances to the wafer surface—from atomic to micron thicknesses—providing conducting or insulating building blocks for further device development. Deposition chemicals include silane, diborane, phosphine, tetraethylorthosilicate (TEOS), and ozone (O_3). Process chambers may be cleaned with gases such as nitrogen trifluoride (NF_3), SF_6, CF_4, C_2F_6, and C_3F_8.

Note: These steps are repeated many times until the last "front-end" layer is completed and all active devices have been formed.

Back-End Fabrication

- **Metallization:** Prior processing steps prepare the device for metallization, which creates the electrical interconnections between all transistors on the wafer. Following completion of the front end, individual devices are interconnected on the "back end" using a series of alternating metal depositions and dielectric films, each with their respective patterning. Barrier layers of cobalt, nickel, tungsten, titanium, or tantalum are deposited first, followed by aluminum or copper interconnects. Metals may be sputtered from solid targets, deposited via chemical vapor deposition using gaseous or liquid precursors, or—in the case of copper—electroplated from a copper solution. All of these processes are conducted within enclosed mini-environments for absolute cleanliness and chemical control.
- **Chemical Mechanical Planarization (CMP):** Between many deposition and metallization layers throughout the back-end process, chemical mechanical planarization (CMP) uses chemical and physical forces to create a microscopically flat surface for each successive layer of circuit features. A polishing pad with a liquid chemical called a “slurry” polishes the wafer surface until the desired nanometer topography is achieved on the uppermost exposed layer. Slurry is a suspension of nanosized silica, polymer, or metal particles dispersed in an aqueous solution containing oxidizers, acids, and corrosion inhibitors.
- **Passivation:** After the last metal layer is patterned, a final insulating layer (passivation) is deposited to protect the circuit from humidity, chemicals, and damage. Openings are etched in this film to allow access to the top metal layer by electrical probes and subsequent wire bonds.

These process steps are repeated hundreds of times on each semiconductor wafer.

- **Electrical Test:** An automatic, computer-driven test system checks the functionality of each chip on the wafer. Chips that do not pass are marked for automatic rejection. For simpler devices, a mechanical probe is used.

- **Assembly:** Each wafer contains many individual devices called die—a single 12-inch wafer can yield anywhere from a few dozen to tens of thousands of them. The wafer is thinned by polishing the backside, and tape is applied to hold the die in place during sawing. A diamond saw then slices the wafer into individual chips ranging from 1×1 mm to 10×10 mm or larger. Rejected chips are discarded, and the remaining chips are visually inspected under a high-power microscope.

Packaging: Semiconductor die are packaged in a variety of package types from leadframe to advanced ball grid arrays, to flip chip. In simple products, each chip is assembled into an appropriate package that provides contact leads. A wire bonding machine attaches wires—a fraction of the width of a human hair—or solder spheres are added to facilitate electrical connection. To protect against humidity, chemicals, and vibration, connections are enclosed with encapsulants such as underfill, coatings, or mold compounds. Certain high-performance applications use ceramic packages. In advanced packaging (a technology being pursued by multiple U.S. semiconductor manufacturers), multiple chips are arranged in three dimensions in a single package. This increases speed, lowers power consumption, and allows for devices with different functions to be included in the package. Upon completion, the packaged device is transferred to dispense packing (tape and reel, tube, or tray) to protect it during storage and shipping to the electronics assembler, where it is placed onto a circuit board alongside the other components necessary to make a functioning piece of hardware. The supply chain required to fabricate chips is a globally integrated, complex network of thousands of upstream suppliers that provide fabs with hundreds of chemical, gas, and material inputs, each with precise requirements and their own sophisticated supply chains.[8] The upstream semiconductor ecosystem requires raw materials and equipment components with precise purity levels or specifications to deposit materials and build features at a near-atomic level. For example, ultrapure semiconductor-grade polysilicon is typically produced at purity levels greater than 11 nines (99.999999999%), which is an impurity level less than 10 parts per trillion (equivalent to one grain of sand in sixteen Olympic-size swimming pools).[9] Likewise, the mirrors used to reflect extreme ultraviolet (EUV) light in an EUV machine are the most accurate, flattest mirrors in the world. Scaled up to the size of Germany, the largest unevenness would be just a tenth of a millimeter.[10]

III. Chemical Use and Controls in the Semiconductor Industry

Semiconductor fabrication employs advancements in engineering, physics, materials science, computer science, and chemistry, all working together to produce devices of ever-increasing complexity and sophistication. To manufacture at the nanoscale, semiconductor fabrication depends in part on a range of materials, gases, and chemicals with unique functional and performance attributes, working in concert with specialized fab equipment. The industry also uses certain bulk chemicals that are widely used and well-understood in industrial operations. The use of chemicals in the fab are differentiated from other industrial uses because the semiconductor industry generally uses low volumes of chemicals coupled with extensive and often redundant controls to minimize exposure to workers and releases to the environment.

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[8] McKinsey, “Creating a Thriving Chemical Semiconductor Supply Chain in America,” March 25, 2025. https://www.mckinsey.com/industries/chemicals/our-insights/creating-a-thriving-chemical-semiconductor-supply-chain-in-america.

[9] Hemlock Semiconductor, Wacker Polysilicon North America, and REC Silicon comments to the U.S. Department of Commerce, https://www.regulations.gov/comment/DOC-2022-0001-0121.

[10] Zeiss, “EUV Lithography,” Oct. 2021. https://www.zeiss.com/semiconductor-manufacturing-technology/smt-magazine/euvlithography-as-an-european-joint-project.html.

A. Use of Chemicals in Semiconductor Manufacturing

As circuit features get ever smaller and new designs and architectures are developed to provide greater performance, the semiconductor industry will continue to require the precise use of chemicals with specific properties. The continued ability of the industry to innovate and produce ever smaller, faster, more energy efficient and capable integrated circuits will depend, in part, on our industry's access to chemicals with specific functionality. Chemicals are selected based on their unique properties and functionality, and the advanced manufacturing tools are designed to operate using these specific chemicals. There are typically no "drop-in" replacements for many of the chemicals currently in use in any given manufacturing process, and it is typically very difficult or even impossible to replace the critical chemicals once they have been implemented in the manufacturing process.

Semiconductor fabrication requires chemicals across a range of consumption volumes, each tier presenting distinct supply chain characteristics. At one end are bulk chemicals purified to meet semiconductor requirements— acids, bases, solvents, and oxidizers — delivered by tanker and stored in large on-site tanks or delivered in tote tanks. Fabs operate 24 hours a day, 7 days a week, and use chemicals continuously, requiring dedicated supply infrastructure and waste treatment systems. At the other end are ultra-specialty chemicals consumed in quantities measured in liters or milliliters per batch. Despite their low volumes, these substances often represent a disproportionate share of chemical spending due to the difficulty of producing them with the required performance characteristics at the required purity and specification. Between these sits a broad middle tier of required substances — needed in slightly greater quantities, yet with significant purity requirements, and these are generally available from multiple suppliers. Large scale semiconductor manufacturing requires access to all these tiers of differing substances simultaneously.

B. Chemical Controls in Semiconductor Manufacturing

Process chemicals are utilized under highly controlled operational conditions. In order to ensure quality and consistency in the production process, chemicals and materials used in semiconductor manufacturing are subject to significant and often redundant controls and safety measures. The highly controlled systems in a fab include enclosed processes, automation, and chemical delivery systems. The entire process is conducted in a tightly controlled clean room environment, where there are specific controls on temperature, humidity, and air purity. In the semiconductor manufacturing process, uncontrolled particles, chemical vapors, and gases are unacceptable from a production and quality standpoint. Highly specialized manufacturing tools and processes deliver exactly the right amount of chemicals, in exactly the right place, at exactly the right time. These conditions are likely to give rise to substantially reduced risk and exposure scenarios compared with those in other industries.

The hierarchy of controls, including engineering and administrative controls – as well as personal protective equipment, are fundamental to the manufacturing process and worker safety. Semiconductor process equipment is located in the clean room where stringent contamination control is maintained as a requirement for production, which also ensures no chemical releases. Some features of the manufacturing process include:

- Modern high-volume manufacturing fabs use enclosed, interlocked, ventilated, and automated manufacturing equipment ("tools") which separate employees from the product wafers and process chemicals.

- Hazardous gases and chemicals are transferred to process tools in transfer lines that are typically double contained as well as being equipped with leak detection.
- Chemicals are stored and delivered into the manufacturing area using automated chemical delivery systems that prevent personnel exposure and ensure limited human interface.
- Tools are emptied of chemicals and purged prior to maintenance, and maintenance occurs at room temperature under local exhaust ventilation

Contemporary equipment is also designed and fabricated to meet the requirements of industry safety guidelines, including SEMI S2 – Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment and SEMI S6 – Environmental, Health, and Safety Guideline for Exhaust Ventilation of Semiconductor Manufacturing Equipment. The SEMI S2 guidelines specify that chemical emission to the workplace environment during normal equipment operation must result in ambient air concentrations that are less than 1% of the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) or permissible exposure limit (PEL) during normal equipment operation. ACGIH TLVs are consistently much lower than OSHA occupational exposure limits (OELs). The semiconductor industry is committed to adopting measures to ensure exposure is reduced to well below OSHA levels or other regulatory requirements. Chemical emissions do not exceed 25% of the TLV or PEL in the anticipated worst-case breathing zone during equipment failures and maintenance activities. The SEMI S2 guidelines also require a third-party validator to certify the tool's compliance.

Semiconductor fabs control environmental releases by implementing strict controls including wastewater collection and treatment, waste management systems, and air emissions abatement.[11] Fab wastewater drain lines convey waste aqueous chemistries and process wastewater through pre-treatment, equalization and elementary neutralization before discharging in a combined wastewater effluent. Depending on local and federal pretreatment rules, metals, acids, fluorides, and chemical mechanical planarization wastes may be carried in segregated drain lines to treatment systems where contaminants are removed before aqueous effluent is discharged to industrial wastewater for further treatment. Organic wastes are collected in a segregated drain and collection system, with waste shipped offsite for recycling or disposal, typically via fuel blending or hazardous waste incineration. Fab exhaust systems remove chemical vapors and heat from process tools. Acids and bases are routed to centralized scrubbers, while volatile organic compounds are abated via centralized thermal, catalytic, or plasma oxidizers which may be equipped to concentrate contaminants prior to abatement. Exhaust emissions from certain processes are treated using point of use abatement systems which discharge to the appropriate centralized exhaust system for further treatment.

The extensive controls in a fab result in high levels of protection of both the environment and fab workers, helping the U.S. semiconductor industry to achieve one of the best environmental, health and safety records among American industries.

IV. SIA Policy Recommendations on the Approval of New Chemicals

SIA looks forward to working with this committee, Congress as a whole, and other stakeholders in support of legislative reforms to enhance the new chemicals authorization process. Our goal is to help structure a process governing the review and approval of new chemicals in a manner

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[11] Semiconductor PFAS Consortium, *Background on Semiconductor Manufacturing and PFAS*, https://www.semiconductors.org/background-on-semiconductor-manufacturing-and-pfas/.

that protects human health and the environment while facilitating the ability of the semiconductor industry operate efficiently and to continue to innovate in the U.S.[12]

Given the important role of chemicals with specialized properties and performance attributes in contributing to ongoing innovations in our industry, along with the carefully controlled conditions of use in our operations and the low volumes of chemicals under consideration, the industry needs an effective and efficient system for EPA review and approval of new chemicals that ensures protection of human health and the environment . To be effective, the review of new chemicals must employ a risk-based approach that takes into account factors such as the specific conditions of use and actual exposure scenarios present in our industry – not simply the inherent hazards of various chemicals and hypothetical exposure scenarios in the absence of industry controls and practices. EPA reviewers must assess chemical risks based on the actual conditions of use in specific industries. The new chemicals approval process should not employ a "one-size-fits-all" model but instead employ a differentiated approach tailored to address the specific conditions of use and controls implemented in a particular industry.

To achieve this goal, SIA's priorities for legislation to reauthorize funding for the new chemicals program include the following:

- Reauthorize TSCA fees to ensure EPA has the requisite resources and staffing to engage in an appropriate review of chemicals to ensure protection of health and the environment while making timely risk-based decisions.
- Ensure risk analyses are based on real-world, reasonably foreseeable conditions of use that allow for market entry for new chemistries under limited, specified conditions.
- Provide a pathway for authorizing low-volume chemicals used in tightly controlled environments (such as a semiconductor cleanroom) for critical sectors of the U.S. economy, including the semiconductor manufacturing industry.
- Call for transparent, objective, risk-based regulatory requirements for new chemicals.
- When chemical testing is needed, provide for tiered testing which is appropriate for the category of chemistries under review and the information needed for risk-management decision making.
- Enable data sharing and reciprocity with government agencies in allied/partner countries (e.g., EU, Korea, Japan, Taiwan) when authorization already exists for identical chemicals with the same conditions of use.

Congress should work to ensure the chemical review process is protective of health and the environment while also providing a reasonable degree of regulatory certainty for the manufacturers and users of chemicals. The system should also take into account the globally competitive landscape facing the semiconductor industry.

A. Need for Certainty in the Process

Semiconductor manufacturers and their suppliers depend on reliable approval pathways to translate new chemistries into commercial applications that enable semiconductor innovation. Before even initiating the new chemicals review process, suppliers and semiconductor

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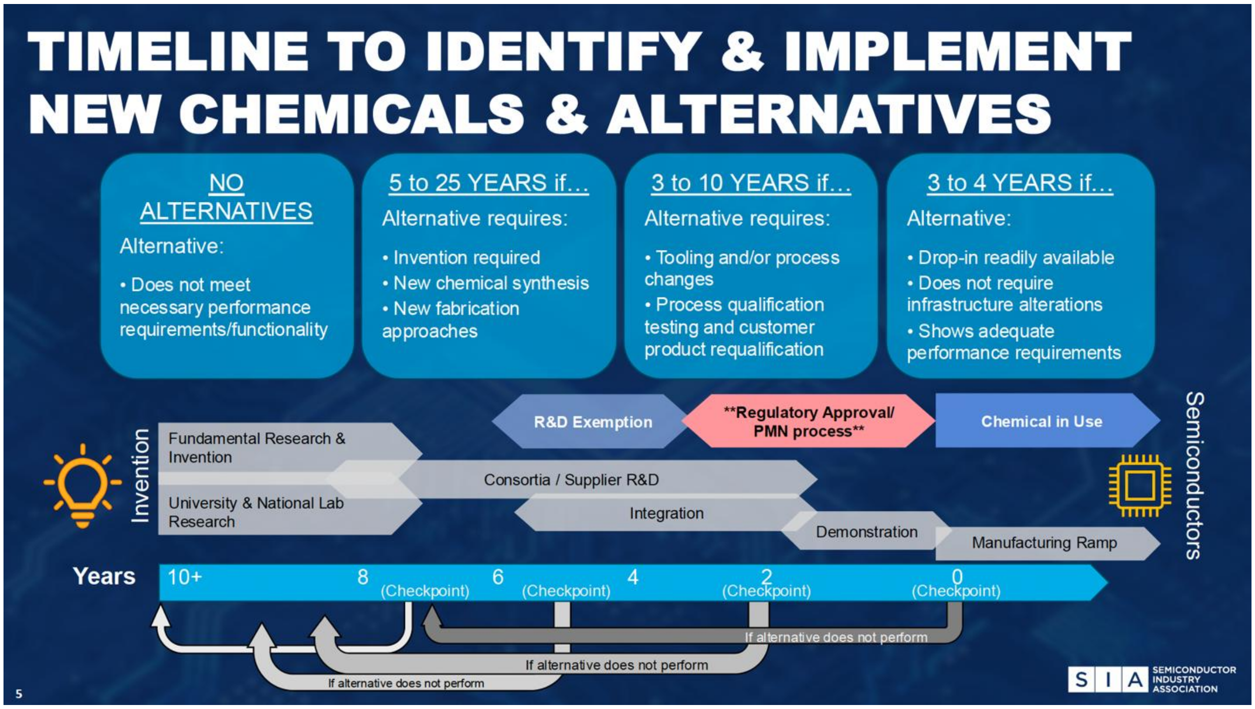
[12] It is important to note that semiconductor manufacturers are not the entity responsible for securing the approval of new chemicals. Rather, the chemical suppliers to our industry must obtain the necessary approvals for new chemicals. These suppliers are key partners in the ability of the semiconductor industry to operate and innovate, and semiconductor manufacturers have a strong interest in enabling these suppliers to have certainty in the requirements and timing for EPA approval of new chemicals for our industry.

manufacturers often will have already committed years or decades of research time and investment (Figure 4). For this R&D to pay off, a predictable, timely approvals process is needed. Uncertainty or delays in the process could slow the ramp of new process technologies, or disincentivize the onshoring of that technology altogether if the requisite materials will reliably be available in another jurisdiction. Additionally, a predictable and effective new chemicals review process at EPA is necessary to allow for supply chain continuity. From time to time, suppliers may withdraw certain essential substances from the market, meaning that semiconductor manufacturers may need to source alternatives that meet the same performance requirements, which may necessitate EPA approval. Finally, chipmakers and their suppliers may work to develop new substances that have improved risk profiles, and the approvals process should encourage bringing those safer alternatives to high-volume manufacturing.

Figure 4



TIMELINE TO IDENTIFY & IMPLEMENT NEW CHEMICALS & ALTERNATIVES

NO ALTERNATIVES

Alternative:

- Does not meet necessary performance requirements/functionality

5 to 25 YEARS if…

Alternative requires:

- Invention required
- New chemical synthesis
- New fabrication approaches

3 to 10 YEARS if…

Alternative requires:

- Tooling and/or process changes
- Process qualification testing and customer product requalification

3 to 4 YEARS if…

Alternative:

- Drop-in readily available
- Does not require infrastructure alterations
- Shows adequate performance requirements

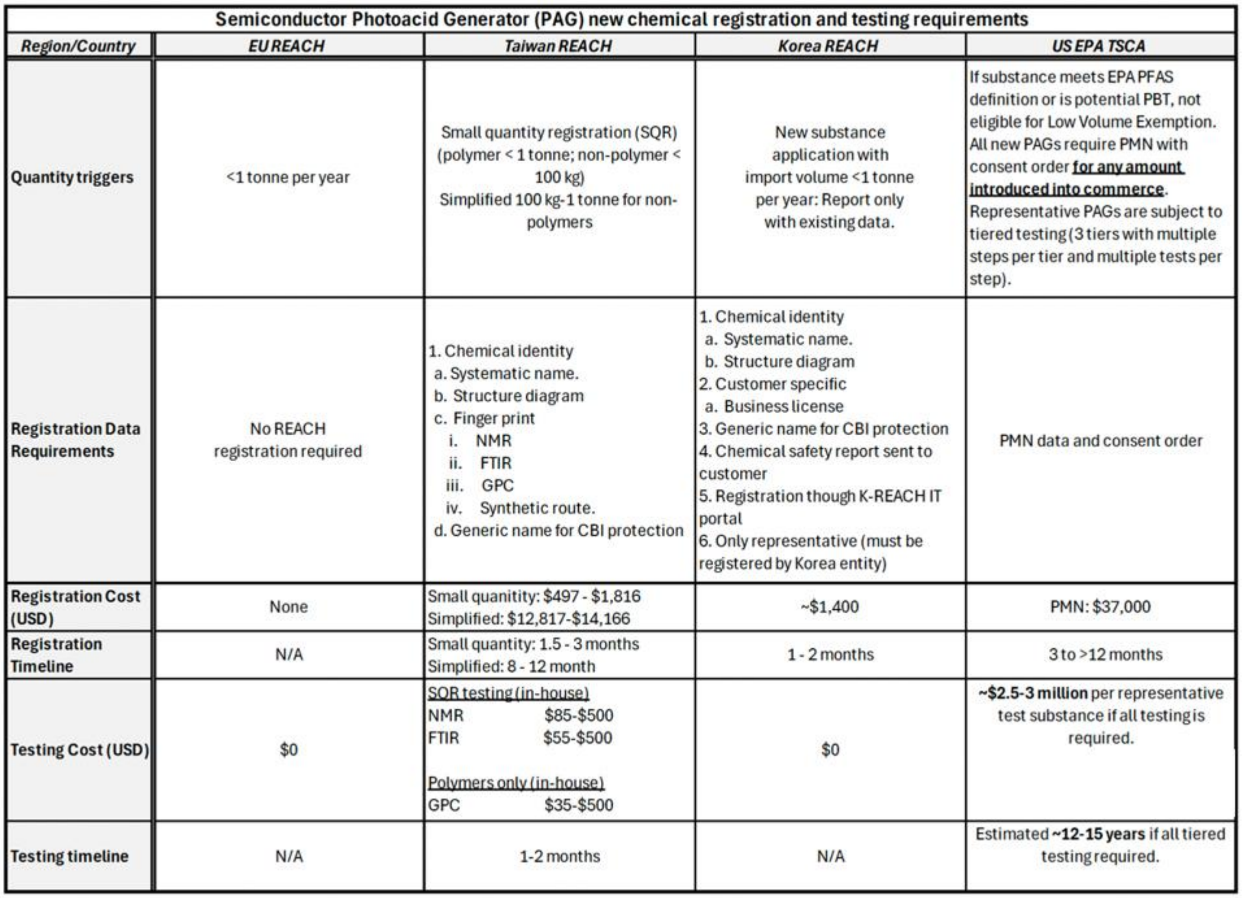
B. Need to Consider the Competitive Global Landscape

Continuous chemical innovation is the engine of manufacturing and advanced product development in the semiconductor industry. Product life cycles typically are short with a new set of specialized chemicals developed to enable production of each new product generation. For the United States to remain competitive in semiconductor manufacturing, our companies must have timely access to the most advanced and innovative materials.

While a number of factors contribute to market leadership and investment decisions, the regulatory process for approving new chemicals and the ability to introduce new technologies in a timely and efficient manner is one relevant factor. In this regard, some aspects of the U.S. regulatory process governing chemicals can be more time consuming, less certain, and more expensive than our global competitors.

Working with key chemical suppliers of the specialized formulations necessary for our companies to produce cutting-edge technologies, SIA reviewed the approval and registration processes in the U.S., Europe, Taiwan, and Korea for commercial uses of one type of essential chemical used in low volumes in semiconductor fabrication: photoacid generators (PAGs) (Figure 5).[13] Along with our suppliers, we compared the approval/registration processes, estimated costs, and timelines in each jurisdiction, and the results indicate that the U.S. chemical approval process for these low volume substances is generally more time consuming and expensive than in competitor regions. For example, in Europe the REACH authorization process provides data and dossier submission requirements calibrated by tonnage threshold limits, which effectively exempts chemicals used in certain low volumes from lengthy premarket review procedures.[14]

Figure 5



Semiconductor Photoacid Generator (PAG) new chemical registration and testing requirements

Region/Country	*EU REACH*	*Taiwan REACH*	*Korea REACH*	*US EPA TSCA*
Quantity triggers	<1 tonne per year	Small quantity registration (SQR) (polymer < 1 tonne; non-polymer < 100 kg) Simplified 100 kg-1 tonne for non-polymers	New substance application with import volume <1 tonne per year: Report only with existing data.	If substance meets EPA PFAS definition or is potential PBT, not eligible for Low Volume Exemption. All new PAGs require PMN with consent order **for any amount introduced into commerce**. Representative PAGs are subject to tiered testing (3 tiers with multiple steps per tier and multiple tests per step).
Registration Data Requirements	No REACH registration required	1. Chemical identity a. Systematic name. b. Structure diagram c. Finger print i. NMR ii. FTIR iii. GPC iv. Synthetic route. d. Generic name for CBI protection	1. Chemical identity a. Systematic name. b. Structure diagram 2. Customer specific a. Business license 3. Generic name for CBI protection 4. Chemical safety report sent to customer 5. Registration though K-REACH IT portal 6. Only representative (must be registered by Korea entity)	PMN data and consent order
Registration Cost (USD)	None	Small quanitity: $497 - $1,816 Simplified: $12,817-$14,166	~$1,400	PMN: $37,000
Registration Timeline	N/A	Small quantity: 1.5 - 3 months Simplified: 8 - 12 month	1 - 2 months	3 to >12 months
Testing Cost (USD)	$0	SOR testing (in-house) NMR $85-$500 FTIR $55-$500 Polymers only (in-house) GPC $35-$500	$0	**~$2.5-3 million** per representative test substance if all testing is required.
Testing timeline	N/A	1-2 months	N/A	Estimated **~12-15 years** if all tiered testing required.

Suppliers also provided commentary on their experience:

- **Supplier A:** “The general timeline and cost of new chem approval for other countries are faster/cheaper than the US. This greatly reduces potential innovation and

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[13] PAGs are a vital component of many semiconductor photolithography formulations, especially chemically amplified resists. The availability of new PAGs is key to driving innovation in our industry, and the approval process for these substances may be illustrative of the process for other types of essential chemicals.

[14] Entities do not need to register substances with ECHA if the manufacture or import of a substance is in an amount less than one metric ton per year. See: https://environment.ec.europa.eu/topics/chemicals/reach-regulation_en#implementation.

competitiveness of US suppliers as there's little incentive when compared to the non-US market"

- **Supplier B:** "Registering . . . chemicals in the United States requires significant time and cost. Material suppliers like (Supplier B) face difficult decisions on whether to apply for PMN before securing business with customers or withdraw from the material selection competition. This opportunity loss also applies to device manufacturers, who may delay launching devices to the market due to extended PMN review times."
- **Supplier C:** Ballooning cost and delays in EPA testing have had a "chilling effect on bringing new materials to market in the US" and an "uncompetitive situation with the rest of the world".
- **Supplier D:** "The . . . registration and new chemical testing costs portion is accurate to a similar experience we shared where just by virtue of timelines and costs of potential testing . . . essentially shuts down the market for a product, much to our business's chagrin (to be fair this is likely preferred by EPA given the scrutiny of a chemistry like PFAS in this current industrial and regulatory climate). The [PAG] consortium negotiated Consent Order templates do speed up the process for PMN approval, however, with EPA's requests for expanded testing and no realistic idea of when it will be completed it can be daunting for a company to keep up with these demands and maintain a competitive position in industry."
- **Supplier E:** "Recently, we approved 3 new substances in Taiwan through the small quantity registration, <100kg/y for PAG and <1t/y for polymer. Our new PAG was PFAS, but there was no negative impact on the approval. It took about ~3 months and ~$20k for each substance."

Congress should consider the global landscape in considering improvements to the new chemicals review process to ensure the continued buildout of the semiconductor supply chain, innovation, and advanced manufacturing in the U.S.

Conclusion

The semiconductor industry is essential to America's economic growth, technology leadership, and national security. Accordingly, an effective regulatory system that provides for protection of the environment and health while also advancing the appropriate review and approval of new chemicals used in the semiconductor industry is one part of a holistic policy approach to winning the chip race. To compete effectively and advance American technology leadership, while also securing the U.S. semiconductor supply chain, Congress and the Administration should adopt a holistic policy agenda to make the United States an attractive destination for investment in semiconductor research, design, and manufacturing.[15] Reform of TSCA is just one part of such a comprehensive competitiveness agenda.

SIA is eager to work with the Administration and Congress to ensure America's leadership in semiconductor technology remains unchallenged. Thank you for the opportunity to submit this testimony on behalf of the U.S. semiconductor industry. For more information, please contact David Isaacs at disaacs@semiconductors.org.

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[15] See "Winning the Chip Race: American Semiconductor Innovation and Competitiveness under the Trump Administration & the 119th Congress," available at https://www.semiconductors.org/winning-the-chip-race/.