April 5, 2021

The Honorable Gina Raimondo
Secretary
U.S. Department of Commerce
1401 Constitution Avenue, NW
Washington, DC 20230

Re: Risks in the Semiconductor Manufacturing and Advanced Packaging Supply Chain; 86 FR 14308; Docket No. BIS-2021-0011

Dear Secretary Raimondo:

The American Chemistry Council (ACC) represents a diverse set of companies engaged in the business of chemistry, an innovative, $565 billion enterprise. We work to solve some of the biggest challenges facing our nation and our world. Our mission is to deliver value to our members through advocacy, using best-in-class member engagement, political advocacy, communications and scientific research. We are committed to fostering progress in our economy, environment and society.

The business of chemistry:

- Drives innovations that enable a more sustainable future.
- Provides 544,000 skilled good paying jobs—plus over 3.9 million related jobs—that support families and communities.
- Enhances safety through our diverse set of products and investments in R&D.

Every year, the chemistry industry invests tens of millions of dollars to ensure that the products making modern living possible are safe for our communities and the environment. In addition to research initiatives, ACC programs focus on anticipating and preventing accidents, as well as educating the public about how to use our products safely. Chemistry makes it possible to satisfy a growing world population. Our products protect our food supply, air and water, ensure safe living conditions and provide access to efficient and affordable energy sources and lifesaving medical treatments in communities around the globe. To enable these ongoing innovations, we advocate for public policies that support the creation of groundbreaking products to improve lives, protect our environment, and enhance the economic vitality of communities.

Free and Open Trade Strengthens Supply Chain Resiliency

Over the past four years, our industry has witnessed firsthand how trade policy uncertainty and the levying of high and broad tariffs on our imports and exports has disrupted the chemical value chain and the industries that rely on the business of chemistry. As a general matter, ACC advocates for the elimination and reduction of tariff and non-tariff barriers wherever possible. Reducing trade barriers is a better way to support production in the U.S. as opposed to the wielding of blunt trade instruments, which only increase uncertainty and costs and weaken competitiveness. We are also mindful that enabling greater U.S. production may require additional incentives from the U.S. and state governments. These incentives should be constructed in a way that does not distort trade and investment. As we have learned, when the United States implements trade actions such as tariffs, U.S. trading partners respond in kind, often retaliating against competitive U.S. exports, including chemicals.

We encourage the Administration to focus on what makes the U.S. chemical industry competitive. Factors of competitiveness include:

- Abundant sources of natural gas and natural gas liquids, the primary feedstocks and energy sources for manufacturing chemicals in the United States;
- Low cost imported intermediate inputs into manufacturing of chemicals;
- High skilled labor, including through immigration;
- Strong protection of intellectual property rights, including trade secrets;
- World class ecosystem for industry-university-government collaborative research & development and innovation; and
- High standard protections for human health, safety, and the environment.

By enhancing our competitiveness in the above areas, U.S. chemical manufacturers will be in a stronger position to produce more in the United States. Demand for the products of chemistry will increase in the U.S. over time but even more so in the rest of the world. In that regard, it is critical that the U.S. strategy on supply chain resilience prioritize opening new markets. Commercially meaningful new market access allows our companies to take advantage of economies of scale, thereby manufacturing more important chemistries at home in the United States and exporting more of those chemistries to the world. Enhancing our competitiveness will beget more competitiveness in the long run – and therefore greater supply chain resiliency. And where U.S. trading partners are not playing by the rules and tilting the playing field in the favor of their domestic companies, we urge the Administration to enforce U.S. trade agreements and U.S. trade remedies laws.

Chemistry Is Core to Semiconductor Manufacturing

U.S. chemical manufacturers have supplied important chemistries to the semiconductor industry since its inception. In 2019, the business of chemistry in the United States supported 379,000 workers in the semiconductor and electronic component industry, $44 billion in payroll, and $53.4 billion in value-added (see 2020 Guide to the Business of Chemistry, Table 1.2).

Electronic chemicals are essential in the manufacture of semiconductors, printed circuit boards, and other microelectronic devices. Among them are cleaners, developers, dopants, encapsulants, etchants, flame retardants, photoresists, specialty polymers, plating solutions, and strippers. In addition, chemical products can be used as key materials in various pipes, tubing, fittings, membranes, coatings, and moldings that are used in the semiconductor manufacturing process. This business serves major markets such as computers, telecommunications equipment, automotive, and medical devices. Long-term growth prospects are driven by the increasing proliferation of electronics in contemporary life. Key economic factors include increasingly global customers, high technological barriers to entry, device miniaturization, and shortening product life cycles.

A wide range of chemistries enable the manufacture of the silicon wafers, doping to impart innovative characteristics (e.g., conductivity), polishing and cleaning of the wafers, and further preparation of the wafers. These chemistries include:

- Semiconductor substrates derived from crystalline silica;
- Atmospheric gases (e.g., nitrogen, argon, oxygen, helium, and hydrogen);

- Specialty gases (e.g., nitrogen trifluoride (NF_3), tungsten hexafluoride (WF_6), germane (GeH_4) and nitrous oxide (N_2O));
- Fluoropolymers (see below);
- Photoresists and photoresist ancillaries;
- Chemical mechanical planarization (CMP) slurries and pads; and
- Deposition, dielectric, and other electronic materials.

Minimizing contamination is a central discipline of semiconductor manufacturing. The needs for higher data transmission rates and improved signal integrity require smaller integrated circuits and contaminant-free manufacturing processes. Fluoropolymers are a key material for avoiding contaminants in semiconductor manufacturing because they exhibit a unique combination of properties, including resistance to chemical, thermal, and physical degradation that can withstand the semiconductor manufacturing process. Fluoropolymers are critical components of fab equipment (fittings, valves, wafer carriers), consumables (high purity air filters, lubricants), and chemical storage and transport equipment (tanks and pipes). They, and other products such as certain peroxides and fluorogases, can be used as etchants in the semiconductor manufacturing process. They are also used in powder coatings on duct work to protect against corrosion and heat.

In addition to their superior performance characteristics, fluoropolymers have well-established safety profiles and do not present a significant concern for human health or the environment. Because of their unique combination of physical and chemical properties, fluoropolymers meet criteria developed to identify polymers of low concern for potential risk to human health or the environment. These criteria were developed by chemical regulatory experts working collaboratively under the auspices of the Organization for Economic Cooperation and Development. Fluoropolymers are not water soluble and as a result are not found in sources of drinking water. Importantly, fluoropolymers are not PFOA or PFOS or other long-chain PFAS, nor can they transform to those substances in the environment.

Increased Semiconductor Manufacturing in the U.S. Would Provide New Supply Opportunities for U.S. Chemical Manufacturers

Many of these materials are specialty chemicals manufactured to specific grades and purities and in low volumes, often for multiple downstream sectors, including the semiconductor industry. If U.S. and global semiconductor manufacturers decided to build new fabs or refurbish and upgrade existing fabs in the United States, demand for these chemistries could increase significantly, perhaps at the expense of other industries that also rely on these materials. Furthermore, demand for semiconductors across the world is estimated to increase exponentially as businesses and consumers adopt new technologies that require greater processing power and connectivity to the Internet through 5G and other networks (e.g., autonomous vehicles, sensors, and connected and wearable devices). Specialty chemicals are an important part of the semiconductor supply chain and efforts by the U.S. Government to increase domestic semiconductor production should account for follow-on impacts to other industry sectors and the entire supply chain for each affected chemistry.

U.S. Tariffs Limit the Supply of Important Inputs for the Manufacturing of Chemistries Relevant to Semiconductors

A straightforward way to incentivize U.S. production of chemicals relevant to semiconductors is to provide relief from tariffs. ACC encourages the Department of Commerce to work with the Office of the U.S. Trade Representative (USTR) to identify the relevant intermediate inputs exposed to most-favored-nation customs duties and additional tariffs under Section 301 of the Trade Act of 1974. Quick Congressional renewal of the Miscellaneous Tariff Bill may provide temporary suspension or reduction of the MFN duties imposed on imports of intermediate inputs. Furthermore, if they are also subject to additional tariffs under Section 301, USTR may be in a position to exclude these intermediate inputs from the China Section 301 tariffs. Avoiding the payment of MFN duties and additional tariffs of up to 25 percent under Section 301 will help U.S. chemical manufacturers respond quickly to increased demand, instead of paying tariffs on inputs.

Incentives May be Necessary to Ramp Up Production of Chemical Inputs for Semiconductor Manufacturing

The business case for new production of these chemistries is unclear. The U.S. government and state governments could help solidify that business case by considering additional ways beyond tariff relief for incentivizing chemical manufacturers to increase production or build new facilities. Such incentives could include:

- Tax credits and abatements;
- Expedited permitting for plant construction or upgrading;
- Programs to educate the workforce in response to industry needs;
- Facilitation of high skilled immigration;
- Access to worker training/retraining programs;
- Public-private partnerships for research and development of new materials and technologies; and
- Potential cost-shared grants to support domestic capital investments for key upstream materials, including chemical inputs, as well as infrastructure; and
- Relief/insurance for domestic supply chain disruptions, e.g., hurricanes, wildfires, and winter storms.

U.S. Regulation Also Impacts Chemicals Relevant to Semiconductors

As the Department of Commerce reviews risks to the semiconductor supply chain, it will be important to explore with the U.S. Environmental Protection Agency (EPA) the impact of ongoing assessments on chemicals relevant to semiconductor manufacturing, performance and safety, including with respect to the chemistries described below.

N-Methylpyrrolidone (NMP)

In 2016[1], EPA undertook a risk evaluation on N-Methylpyrrolidone (NMP), as required under the Toxic Substances Control Act (TSCA), which the Congress modernized and passed in 2016. In the highly-controlled semiconductor manufacturing process, the semiconductor industry uses NMP in manufacturing for three main purposes:

1. Dedicated solvent in certain photolithography formulations, including photoresists, Bottom Anti-Reflective Coatings (BARC) and polyimides;
2. Solvent pre-wet of wafers prior to application of spin on polymer; and
3. Component of photoresist stripper formulations.

In addition to the main uses of NMP, this chemical may also be used in similar photolithography applications such as mask making and related manufacturing processes that involve the attachment of the

[1] The risk evaluation was initiated in 2016, the draft was issued in 2019 and finalized 2020. Details on dates can be found here: https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/risk-evaluation-n-methylpyrrolidone-nmp-0

chip to chip packaging. Small quantities of NMP are used in analytical laboratories such as failure analysis labs for organic surface deconstruction to inspect device features. Lab use occurs in exhaust hoods with appropriate personal protective equipment such as gloves and eye protection. It is important to emphasize that there is no NMP left in the final product, which is a finished wafer that is then cut into individual semiconductor devices for assembly, test, and packaging. For further information about NMP, see the Semiconductor Industry Association's public comments as submitted to EPA on March 15, 2017.

Upon conclusion of its risk evaluation, EPA found potential risk for 26 out of 37 of its conditions of use, including domestic manufacture, import, and its use in semiconductor manufacturing. It is now considering possible risk management measures, which could restrict the availability of this chemistry so ensuring any potential management measures appropriately consider safety and uses for semiconductor manufacture will be important.

Octamethylcyclotetra-siloxane (D4)

Similarly, the EPA is conducting a risk evaluation[2] on Octamethylcyclotetra-siloxane (D4), which is used as a dielectric material in semiconductor manufacturing. The semiconductor industry uses D4 in totally enclosed radio frequency (RF) plasma enhanced chemical vapor deposition (PECVD) processes to deposit a very thin dielectric layer (measured in nm) on the wafer surface (an article). This specific CVD process is a radio frequency plasma-enhanced CVD (RF PECVD) process, which results in a high level of material conversion and rearrangement of OMCTS into a very thin layer of a distinctly different material than OMCTS, called SiCOH. The term "SiCOH" describes the elements present in the thin dielectric layer (it does not represent the stoichiometry). The SiCOH film structures (composed of Si, C, O and H atoms) are extensively cross-linked with little relation to the molecular composition of the D4 precursor. It can best be described as an inorganic porous glass like structure, it also may be characterized as an organosilicate glass. To be clear: the resulting SiCOH dielectric layer does not include any D4 impurities (also please note that the resulting transistors in the semiconductor chip would not be functional with D4 impurities included).

The D4 that is fed into the PECVD tool is destroyed within the tool plasma, and any potential remaining D4 in the process exhaust is believed to be destroyed via point of use abatement at the process tool. There are no known emissions of D4 to the environment. D4 is not present in the wafer or in subsequent process steps; thus, the industry is not a processor of D4 and D4 itself is not incorporated in semiconductor devices.

4,4'-(1- Methylethylidene)bis[2, 6-dibromophenol] (TBBPA)

The use of TBBPA in the semiconductor industry occurs during a stage in the process known in the industry as "assembly, packaging and test" (APT). During the APT stage, a finished semiconductor wafer is divided into individual "chips," encased in a plastic or ceramic "package," and tested. This step in the process is where TBBPA is used as a flame retardant in semiconductor packages. This step in the process prepares an individual "chip" for incorporation into a circuit board used in a finished electronic device (e.g., mobile phone, computer, automobile, etc.) to ensure fire safety. Most electronic devices now contain printed circuit boards providing intelligent and interactive functions. Due to the nature of their composition (flammable components) and function (transmission of electrical charges), printed circuit

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[2] https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/supporting-documents-manufacturer-requested-risk

boards require ignition protection to help ensure product safety and performance. TBBPA is essential to help meet fire safety standards and certification requirements for printed circuit boards.

TBBPA is one of the base chemicals components used to react with an epoxy and becomes part of a polymer that encases the chip to form the semiconductor package. The TBBPA is not available for extraction from the polymer because the TBBPA becomes a part of the polymer. Semiconductor manufacturers may also make modules that contain multiple chips on a circuit board. TBBPA may be a part of the resin system in the circuit board. Other articles imported by the semiconductor industry that may contain TBBPA include cables and transceivers.

TBBPA has a strong safety profile. Government assessments world-wide also confirm TBBPA does not present a risk to human health or the environment. TBBPA is currently undergoing a risk evaluation by EPA under the TSCA.

Fluorinated Chemistries

Certain other developing or potential materials and products regulations need to be carefully reviewed and drafted so that regulatory definitions are clear and focused and not overly broad (for example, in the case of potential PFAS-related regulations) such that key fluorinated chemistries that are essential to the semiconductor industry are not inadvertently restricted. To this end, we support coordination among all key agencies so that appropriate regulations can be developed and science based to account for all policy objectives, including ensuring strong domestic supply chains for key industries such as the semiconductor industry.

Hydrofluorocarbons

The EPA is also beginning the regulatory process to implement the American Innovation in Manufacturing (AIM) Act that was included in the Consolidated Appropriations Act, 2021. The AIM Act sets out requirements for the phasedown of hydrofluorocarbons (HFCs), including establishing production and consumption allocation levels for HFCs used in the semiconductor manufacturing process. This process should also be appropriately coordinated with EPA to ensure the equitable distribution of HFC allocations among key producers and consumers.

Phenol Isopropylated Phosphate (3:1) (PIP (3:1))

EPA has noted that PIP (3:1) has been identified as being used in machinery used to produce semiconductors, such that the production of semiconductors could be adversely affected if machinery cannot be serviced. Although an EPA regulation targeted PIP (3:1) and articles containing it for restriction, EPA has reopened the comment period, and on March 8 issued a *No Action Assurance Regarding Prohibition of Processing and Distribution of Phenol Isopropylated Phosphate (3:1), PIP (3:1) for Use in Articles, and PIP (3:1)-containing Articles* under 40 CFR 751.407(a)(1). During this period, it is important that key agencies coordinate with EPA so appropriate regulatory action can fully consider supply chain needs and policy objectives.

Conclusion

U.S. chemical manufacturers, our customers, and workers have benefited from global supply chains and also recognize that certain risks can arise that must be mitigated. We welcome the Biden Administration's focus on risks to the semiconductor supply chain, of which the business of chemistry is a vital part. In

Commerce's review, we encourage a holistic examination of risks that includes trade policy and regulation. Robust interagency and stakeholder consultation will be key to arriving at effective recommendations that are fit for purpose and support free and open trade and investment. ACC is ready to serve as a source of information and experience regarding the role of the business of chemistry in enabling a more vibrant, resilient, and secure semiconductor manufacturing industry in the United States.

Sincerely,

Ed Brzytwa
Director for International Trade
American Chemistry Council