Essential Considerations for the Regulation of
Chemicals Used in Semiconductor Manufacturing and Products

This paper reflects the views of the World Semiconductor Council (WSC) including SIA in China, SIA in Chinese Taipei, SIA in EU, SIA in Japan, SIA in Korea, SIA in the U.S.

The global semiconductor industry supports the goals of the sound management of chemicals throughout the life cycle while promoting continued innovation in the design and manufacture of semiconductors. The process used to manufacture semiconductors is highly complex and requires advanced manufacturing equipment, highly controlled environments, and the use of specialized chemicals to produce these complex products. Semiconductors are a basic "building block" of the modern economy and are the enabling technology that contributes to improvements and solutions in communications, health care, energy efficiency and environmental protection, transportation, education, entertainment, and other vital sectors of the economy, as well as national security. Accordingly, policy on chemicals management for the semiconductor industry must recognize the critical nature of these products and the importance of continued innovation in this industry.

Chemicals play a critical role in semiconductor manufacturing. We recognize that some of these chemicals pose ESH challenges. We devote the best of science and technology to ensure chemicals can be used safely. When hazardous chemicals are used it is due to their unique functionality and because there are no viable alternatives. We promote international cooperation in our industry regarding chemical management, utilizing scientific evidence, health assessment and risk assessment as the basis for effective workplace protection. The semiconductor industry has adopted risk-based programs to fully assess the ESH impact of proposed new chemicals and gases. This assessment includes how chemicals are used, reused and disposed. These programs are continuously updated to include the most current information available. The industry uses chemicals in 'enclosed processing systems' which isolates chemicals from employees and the environment, thus reducing exposure risk and environmental emissions to de minimis levels. These efforts provide a safe, healthy work environment for our employees, the communities we operate in and society as a whole.

Minimal quantities of chemicals are contained in the semiconductor product itself, and the inherent characteristics of the products do not allow for releases of chemicals to the environment or exposure to product users. The industry is a recognized leader in promoting high standards for environmental, safety, and health of its operations and products.

Because of the essential role of chemicals in the production of semiconductors, the major global semiconductor trade associations that comprise the World Semiconductor Council (WSC) support sound chemicals management by our companies and balanced regulatory approaches based on the following principles:

<u>Address key principles when regulating chemicals</u>
The regulation of chemicals should be informed by science. Initiatives to ban or restrict chemicals should take into account the combined use hazard and risk of exposure rather than inherent hazard alone. If limits on a chemical are necessary, such restrictions should take into account essential uses and the availability of potential substitutes and the environmental impacts of potential substitutes, provide for appropriate exemptions based on the quantities of use and potential for exposure, and allow for sufficient time to phase-out existing uses and develop suitable alternatives.

Provide Exemptions and Adequate Timelines for Development of Substitutes

When chemicals need to be replaced or restricted, the process for approving new chemicals, new uses of chemicals, and alternatives to existing chemicals should recognize the timeline for integrating chemicals into the complex, highly precise semiconductor manufacturing process. The material development cycle in the semiconductor industry typically is 10-15 years, consisting of fundamental research, hazard and risk evaluation, demonstration and integration with manufacturing equipment (and sometimes the development of new manufacturing equipment), and production. Where chemicals already used in manufacturing need to be replaced, ample time must be provided to develop substitutes for these chemical uses. Moreover, restrictions on the use of chemicals should provide for appropriate exemptions that account for critical uses and the availability of substitutes.

Ensure an Efficient and Timely Chemical Review and Approval Process

The material development cycle in the semiconductor industry typically is 10-15 years. A key enabler of this overall development process is an efficient and timely approval process for new chemicals and new uses.

Balance Disclosure with Respect for Confidential Business Information

The semiconductor industry relies on the specialized use of chemicals for continued innovation. Disclosure of chemical manufacturing use information to promote transparency must be balanced by the need to protect confidential business information. Disclosure of information on materials in products should leverage the internationally agreed standards and industry initiatives (e.g., IEC 62474 Materials Declaration Standard/JIG) and ensure protection of confidential business information.

Recognize industry initiatives, standards, and research supporting the use and control of chemicals in manufacturing

Initiatives related to the use and control of chemicals in manufacturing processes should recognize the existing regulations and management practices that minimize releases and occupational exposure. Our industry has demonstrated responsible control of the uses of chemicals for the protection of our worker's health. We have comprehensive industry agreed standards for safety protocols for semiconductor manufacturing equipment. The industry spends approximately $100 million (US) annually to fund University R&D activity, including research specifically focused on ESH (Environmental Safety and Health). We share this information through such activities as International High-Tech ESH (IHTESH) Conference, the International Technology Roadmap for Semiconductors (ITRS), and via industry consortia.

Approaches to the sound management of chemicals in electronic products should promote a global market and be based on relevant international standards, including the use of international test methods and laboratories. Such measures will enable the environmental management of chemicals while also facilitating trade and economic development, improving efficiency and avoiding duplication of effort, and protecting intellectual property. Accordingly, product regulations should recognize existing regulation, international standards and voluntary initiatives to address substances of concern in products.

Recognize Successful Voluntary Initiatives

Initiatives on chemicals should recognize and support the ongoing voluntary activities of industry. For example, the WSC has recently announced successful achievements in two areas involving PFCs (Perfluorinated Chemicals): (1) surpassing its 10-year goal in reducing the emissions of PFC gases from

semiconductor fabs; and (2) eliminating non-essential uses of perfluorooctanyl sulfonates (PFOS) and reducing all remaining uses. These achievements are summarized in Attachment 1.

Flexible Systems are Needed to Support Rapid Product and Technology Changes

Governments, industry, and other stakeholders should work in partnership to address information regarding hazard and risk associated with emerging technologies that may become critical to new innovations. As ESH challenges are identified with new innovations, governments, industry and others should work through consultation groups to develop solutions. For example, one method that the semiconductor industry uses to address new technologies is ITRS. This roadmap recognizes the need for the concurrent development of increased environmental, safety, and health solutions along with advances in manufacturing technology.

Ensure Globally Consistent Regulations and Efficient Implementation

Global chemical regulations should be harmonized to the greatest extent possible to prevent trade barriers and ensure the free flow of products. Regulations should be written so they can be efficiently implemented. Administrative requirements should be kept to a minimum and compliance assurance should utilize self-certification methods employing international standards.

Attachment 1
WSC Record in Addressing Perfluorinated Chemicals (PFCs)

The semiconductor industry has a strong record of environmental stewardship of chemicals. The WSC has recently announced successful achievements in two areas involving PFCs: (1) surpassing its 10-year goal in reducing the emissions of PFC gases from semiconductor fabs; and (2) eliminating non-essential uses of perfluorooctanyl sulfonates (PFOS) and reducing all remaining uses. The WSC announcement on these achievements is available at: http://www.semiconductorcouncil.org/wsc/uploads/WSC-2011.pdf.

Achievement of PFC Reduction Goal and New Commitment

Over 10 years ago the associations and companies of the WSC made a 10-year commitment to reduce PFC gas emissions by at least 10 percent below baseline levels. In fact, the WSC announced that the global industry achieved a 32 percent reduction over this 10-year period.

The WSC is now building on this success through a new 10-year PFC goal. The WSC announced a 2020 goal based on the implementation of best practices at new fabs that will result in a Normalized Emission Rate (NER) of 0.22 $kgCO_2e/cm^2$, which is equivalent to a 30 percent NER reduction from the 2010 aggregated baseline. This new goal will also include "Rest of World" fabs (fabs located outside the WSC regions that are operated by a company from a WSC association) in reporting of emissions and the implementation of best practices for new fabs.

Achievement of PFOS Reduction Goal

WSC also announced the successful phase-out of non-essential uses of perfluorooctanyl sulfonates (PFOS), a chemical that was widely used throughout the industry but was identified in the Stockholm Convention as being a substance of concern. The WSC announced the successful conclusion of a multi-year effort to eliminate non-essential uses of PFOS and reduce all other uses. The industry also reduced global emissions of PFOS to de minimis levels (<6 kg per year).

PFOS has been a critical component in the manufacturing process for semiconductors. Specialty chemicals like PFOS are vital during this process. Photolithography applications that use PFOS are critical to achieving the required precision. PFOS is a chemical component in photoresist as photoactive compounds (PACs), photo-acid generators (PAGs) and surfactants, and as surfactants in anti-reflective coatings (ARCs). When the Stockholm Convention's technical Review Committee listed PFOS, it did not specify whether PFOS should be added to the "elimination" annex (Annex A) or the "restriction" annex (Annex B). Nor did it specify which control measures should be applied. Fortunately, the Convention concluded that PFOS should be added to the restricted list, which provided the global industry with time to identify and test alternatives in non-essential applications. Because substitutes to PFOS were unknown at that time, a different result from the POP's Convention would have caused significant disruption to the global supply chain for semiconductors and products that depend on them. Given this time, the global industry was successful in eliminating non-essential uses and reducing all remaining uses, and reducing global emissions to very small levels.