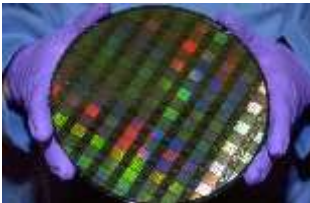


European Semiconductor Industry Association

Chemical Stewardship in Semiconductor Device Manufacturing

A. Presentation of Semiconductor Industry



The semiconductor device industry is the world's most innovative industry. Over the past forty years its average annual growth has exceeded that of all other industry sectors. Semiconductors devices are the key components of electronics, which penetrate into all industries. Our products are the enabling technology for further Information Technology innovations driving economic growth and providing significant societal benefits in terms of energy efficiency, communications, access to information, education and innovations in health care technologies. We serve a worldwide consumption market of € 248 bn with a European share of €31.8 bn. Our operations are global. We transfer technology (process and product) from all over the world to and from EU Member States; this transfer process should proceed in a short space of time and requires exact copying of process chemicals. We are driven by extremely rapid product development cycles and time to market is where the industry can make or lose money. The investment for a new production site (300 mm wafer) is ~ € 2-3 bn. Most of our European sites are EMAS or ISO 14 k certified.

B. The Semiconductor Industry and Environment Safety and Health Issues

Our industry takes a proactive approach to Environment Safety and Health (ESH) issues anticipating and preventing problems rather than having to correct them. Our industry has an excellent ESH performance record and wants to continue to be proactive in these areas. In accordance with scientific findings and technological improvement, we make continuous investments in support of our commitments. We maintain a safe and healthy work environment for our employees and promote safe and health conscious working practices. 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. We support international collaborative R&D efforts to create the science, technology, and educational methods to remain in a leadership position regarding safe and environmentally conscious manufacturing.

C. Product Stewardship



We primarily manufacture electronic components and therefore we face many challenges when products break, wear out or otherwise reach the end of their lives. We are working with our customers and end- equipment manufacturers on proper disassembly and disposal at the end of our product's life. We provide our manufacturing customers with contents information on the substances contained in our products. We provide options to reduce and eliminate lead from our products and packaging.



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D. Nature of Chemicals used in Semiconductor Manufacture

The production of semiconductor devices involves the use of many different chemicals and gases in very low volumes. 100 – 150 substances (chemicals and mixtures) are used in production for a single semiconductor. Roughly 2000 different chemicals and mixtures are used in the sector as a whole. A small % of the substances used by the semiconductor manufacturing will be classified as substances of very high concern (SVHC) under the 2006 EU Reach regulation. Additionally as semiconductor manufacturing changes over time, it is difficult to predict what proportion of substances will be subject to authorisation in the future. Single constituent bulk chemicals are typically purchased from manufacturers, whereas special mixtures and formulations are obtained from third parties (blenders and equipment manufacturers). **The majority of the substances used by the semiconductor industry are from suppliers who are not manufacturers of the substances themselves. The chemicals and substances have gone through a chain of suppliers.**

E. Substitutes

For the most part, there are no readily available substitutes. Some substances, such as dopants e.g. arsenic compounds, are irreplaceable and are a vital element in the production of semiconductor devices due to arsenic's specific ability to influence the conducting properties of silicon. **Organic solvents and in particular special polymers as part of photo resists or strippers** are other substances that also provide **unique functionalities** for the semiconductor manufacturing processes. Semiconductor product and process development takes approximately 10 years. Substitution during the later years of product or process development would be almost technically impossible and prohibitively expensive.

F. Chemicals Management Programme

F 1. Chemical Selection and Screening Process

The semiconductor industry has adopted **risk-based programmes to fully assess the ESH impact** of proposed new chemicals and gases. This assessment includes how chemicals are created, used, reused and properly disposed. These programmes are continuously updated to include the most current information available. The chemical selection is primarily aimed to prevent the use of hazardous or substances of highest concern. However, in some cases application of harmful chemicals is inevitable, since there are no known or proven alternatives. In those cases all possible efforts are directed to minimize the exposure risk for employees and for the environment. This is achieved by the consistent **creation of 'enclosed processing systems'**. An enclosed process system signifies that production process modules are almost completely isolated from employees and the environment, thus warranting minimal to zero exposure risk.



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F 2. Chemical Information

To the greatest extent possible, major constituents of chemical formulations and their potential hazardous properties are known and made available through the chemical supply chain (i.e. the suppliers of chemicals and gases). Up-to-date use and handling information is made available to employees and contractors at every step of the process.

F 3. Emergency Response

Each fabrication site has recruited emergency response teams. The team members are highly trained for mitigating and reducing the impact of a hazardous substance release incident. These teams are trained to respond to all chemical - even when suspected - releases, to secure the release area, to contain the released chemical and to decontaminate the area allowing employees to return to normal work operations. They serve a vital role in limiting employee contact with chemicals and maintaining control of emergency situations.

F 4. Employee Training

Throughout their employment, employees receive training on chemicals hazards and ways to protect themselves. The key elements are information provided through labels and material safety data sheets and work instructions. Use of personnel protective equipment (PPE), engineering controls as well as spill response and good housekeeping practices are stressed during these training sessions.

F 5. Subcontracted, Repair & Maintenance Work

As service providers work on our premises, they are subject to the same high safety performance expectations that our employees must meet. All repair and maintenance activities are performed under strict safety precautions (e.g. organizational and personal protection equipment).

G. Engineering Controls:

G 1. Closed Chemical Handling Systems

Engineering controls are used widely in our manufacturing sites to minimize employee exposure to hazardous substances. These controls include **closed chemical handling systems**, ‘double containment’ piping systems, and most important of all, **local exhaust ventilation (LEV)** to remove vapors, fumes and mists generated by various processes. These controls are designed to eliminate most of direct handling between the wafers and chemicals. Along with the chemical feed system, these controls limit employee contact with chemicals to a minimum. Automated wafer handling between chemical baths eliminates worker exposure. The employee in the clean



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room area is not in contact with chemicals during normal working conditions because of the closed systems approach.

Some of the chemicals that are vital to a semiconductor or to other manufacturing processes require special handling to avoid potentially acute exposures. Employees are protected from hazardous exposure to these chemicals by handling these in enclosed areas with special ventilation systems that remove the chemical before unsafe exposure can occur.

The combination of LEV and wafer auto-handling systems provide a safe operating system and ensure that exposure to chemicals is minimised. Each manufacturing tool that has a potential to release chemicals into the ambient air is equipped with LEV to sweep the chemical vapors and mists away from the operator. These systems minimize any personnel exposure by carrying the chemical emissions to point sources. All quantities which are discharged pass through protective measures such as **wastewater treatment** (e. g. neutralization, precipitation, filtration) **or air abatement devices** (wet scrubbers, burners, dry absorbers). Where on-site treatment facilities are not available, licensed disposal contractors are used to reuse valuable constituents and to destroy wastes in accordance with legal requirements.

As an added level of protection, **automatic monitoring systems** for gases and liquids are installed where needed in exhausted enclosures and open work areas around equipment and piping to detect incidental chemical releases. Because of the extensive engineering controls, such detections are virtually always limited to exhausted enclosures or chemical containment areas such as valve manifold boxes, gas cabinets, and process tools. If a release of chemicals is detected, the monitoring systems alert employees and emergency responders before adverse health effects can occur. Depending on the chemical or gas detected, the chemical supply will be shut down and the work area will be evacuated until the situation is deemed safe and the area is released for re-entry. Work areas will be evacuated long before chemical levels are identified as potentially harmful to a person's health.

Important Information / Disclaimer

The information provided in this document covers EECA ESIA's Semiconductor device manufacturers and operations only. Given the dynamic nature of the semiconductor product and process development, certain information may not always be current.