



## Pioneering the Future of Semiconductors: Merck's Innovations in Material Science Propel Global Semiconductor Development

Best practice category **Materials, chemicals and equipment**

Stakeholder group **Large Enterprises**

Value chain position **Material and chemicals**

### General Information

Merck, a leading science and technology company founded in 1668 and headquartered in Darmstadt, Germany, has established itself as a frontrunner in the development of advanced materials for the semiconductor industry. With a rich history of scientific innovation, Merck's Semiconductor Materials division is dedicated to advancing the performance and functionality of semiconductors through breakthroughs in material science. Leveraging a global presence, with R&D facilities across six continents, Merck is pivotal in enabling the next generation of semiconductor technologies that power a wide range of applications, from mobile devices and automotive electronics to AI and beyond.

Merck is recognised in this list for setting Best Practices in the Materials, chemicals and equipment. The first recognition comes from Merck's strategic focus on the development of cutting-edge materials, including photoresists, dielectric and conductive patterning materials, and advanced silicon precursors that are crucial for fabrication processes.

### Activities and best practices

Merck plays a critical role in several key areas of semiconductor materials development. Firstly, the German company has developed advanced photoresists for extreme ultraviolet (EUV) lithography, a critical technology for manufacturing ultra-small features on chips. Their product line includes lift-off resists, KrF thick film resists, thick film resists and core resists, all of which are designed to withstand EUV light, enabling the creation of circuits smaller than 7 nanometers.

Merck's portfolio also boasts high-purity metal organic precursors used in the deposition of thin films through chemical vapour deposition (CVD) and atomic layer deposition (ALD) processes. The company offers innovative spin-on dielectric materials that reduce electrical interference between wires on a chip, enhancing performance and energy efficiency. Their offering includes the Spinfill® series (600 and 800), low-temperature silicon base RS series, as well as the EBR solvent Rinse 500, among others.

These materials are essential for gap-filling and planarisation for Front-End Of Line (FEOL) applications in advanced device manufacturing, and contribute to producing smaller, faster, and more reliable chips.

Furthermore, Merck is a key supplier of advanced materials for the packaging and assembly phase. Its portfolio includes sintering pastes and alternative solder materials and chemistries which “enable lead(Pb)-free, gold-free, and nano-free packaging solutions for a wide variety of demanding applications requiring high thermal conductivity, high temperature stability, and superior long-term reliability.” Their Transient Liquid Phase Sintering (TLPS) products are particularly worth highlighting for their use of high melting point metal powders and lead-free solder powders.

Finally, understanding the environmental impact of semiconductor manufacturing, Merck is dedicated to developing materials and processes that reduce the industry's carbon footprint. Their efforts include creating more efficient and less waste-generative manufacturing processes, as well as their focus on creating green solvent formulations. Thus, the company developed AZ® 910 Remover, an NMP-free (N-methylpyrrolidone) based chemistries designed for faster dissolution of photoresist patterns in a cost-effective and more environmentally-friendly way.

## Challenges addressed with this practice

Merck's approach to semiconductor materials development addresses several critical challenges in the industry. Their focus on advanced material science helps overcome physical limitations to chip miniaturisation, enhances the performance and energy efficiency of semiconductor devices, and supports the sustainability objectives of the sector. Through these efforts, Merck is contributing significantly to the global semiconductor ecosystem, ensuring the industry's ability to support an increasingly connected and digital world.