

Towards Circular and Sustainable Semiconductor Manufacturing

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The production of semiconductor chips is highly resource-intensive, involving substantial water usage, energy consumption, and emissions. Despite their ubiquity in daily life, the increasingly shorter lifecycles of products containing these chips lead to premature obsolescence. The disposal of these chips generates significant waste streams, containing valuable resources, and raises environmental concerns. Additionally, the chip production demands ever-increasing quantities of rare and valuable materials, which are in limited supply. Efforts to address these issues have primarily focused on lifecycle assessment to evaluate and enhance operational efficiency and waste elimination in manufacturing facilities. However, addressing impacts during manufacturing—one stage of the lifecycle—alone is insufficient to tackle the challenges faced.

This presentation will explore the 6R and total lifecycle-based approach to sustainable manufacturing aimed at decoupling resource extraction and negative environmental impacts from economic growth to promote circularity and sustainability. It will highlight the importance of product, process, and system integration, and the central role of design in transitioning to sustainable manufacturing. Additionally, novel, metrics-based methods for assessing circularity and sustainability will be introduced. These foundational concepts, applicable across various industry sectors, will be leveraged to explore innovative strategies for enhancing circularity and sustainability in semiconductor manufacturing.