Growth Mechanisms and Selectivity During Atomic Layer Deposition

Annelies Delabie, Annelies.delabie@imec.be
Imec, Belgium
KU Leuven (University of Leuven), Belgium

Area-selective deposition (ASD) holds the potential to build nanostructures from the bottom up, only where needed, with atomic precision in both vertical and lateral direction. The technique is of great interest for nano-electronic device manufacturing, as it can be applied for bottom-up deposition in small trenches or holes, or to create nanoscale structures with great accuracy by self-alignment. In addition, ASD can simplify complex integration flows and is a cost-effective approach that consumes less chemical products and energy as compared to traditional top-down patterning. Today, many materials can be deposited by atomic layer deposition (ALD), but only few ALD processes show selectivity. ASD is governed by a complex interplay of several processes, including adsorption, desorption, surface reactions and diffusion. Fundamental understanding of the mechanisms during ALD can contribute to the design of new ASD processes for a wider range of materials. This tutorial will therefore first address the growth mechanisms during ALD on an initially homogeneous substrate surface. Several quantitative growth models have been proposed to describe the initial ALD growth regime. Next, we discuss the mechanism of ASD in nanoscale patterns, and how the growth behavior during ASD can differ from regular growth on homogeneous substrates. Finally, we address strategies to minimize deposition in the non-growth surface area, while simultaneously maintaining or enhancing growth on the growth surface area.