



## **Etch Process Technology for Emerging Semiconductor Applications**

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Advances in the semiconductor industry, historically based on Moore's Law and Dennard scaling, have become progressively challenging as device technology moves beyond the 7nm node. Instead of continuing to optimize compute performance in the classic sense, more and more emphasis is being put on optimizing and/or redeveloping computational approaches and device architectures to produce more efficient and higher performance systems. Hardware for novel AI systems is no exception,. New integration schemes, novel materials, multi-component materials or even nanoscale materials and the ability to integrate all of these approaches together becomes the compounded challenge. Etch technologies that offer differentiating solutions to these issues therefore need to meet somewhat conflicting demands, such as low damage processing as well as high rate processing beside many other issues.

Novel thin films, thin film laminates and alloys promising unprecedented performance are growing the need for the ultimate etch solution: etching with atomic layer precision. Atomic layer etching is a promising path to answer the processing demands of new devices at the Angstrom scale. Self-limiting reactions, discrete reaction and activation steps or extremely low ion energy plasmas are some of the pathways being pursued for precise material removal control and maintaining the original film performance. The ability to achieve atomic layer precision is reviewed in detail for a variety of material sets and implementation methods.

Multi-component integration is raising the importance of heterogeneous integration challenges. An early adapter of such integration strategies is Silicon Photonics, which leverages the microelectronic wafer fabrication infrastructure to create photonic circuits with unprecedented complexity and cost-efficiency. Novel packaging approaches for Silicon Photonics will be discussed in detail. A further outlook on heterogeneous integration approaches and how etch process development may be a critical enabler in cost reduction will be reviewed.