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Foreword

Atomic Layer Deposition (ALD) is not a new technique, since the first experiments were carried out over 40 years ago. Industrial use began in 1983 with the production of thin film electroluminescent displays. In these displays, the dielectric-luminescent layer-dielectric thin films stack is made in a continuous process. Interestingly, this stack is 1–1.5 micron thick. Other industrial applications of ALD remained limited for 20 years, but during the past 10–15 years microelectronics has been the major driver for ALD technology.

In the late 1990s, it became obvious that the continuation of Moore's law would require introduction of new materials into microelectronics. Additionally, new deposition methods were needed in IC technology since materials had to be deposited with atomic level accuracy as very thin films uniformly over the increasing wafer sizes and conformally over the increasingly demanding three-dimensional (3D) device structures. New interest was paid to ALD and enormous research activities went into the development of processes to manufacture high-*k* dielectric materials, metals, and materials for barrier layers.

High-*k* dielectric materials for both gate oxides in metal–oxide–semiconductor field effect transistors (MOSFET) and capacitor dielectrics in Dynamic Random Access Memories (DRAM) have been the most important topics in ALD research during last 10–15 years. Especially, DRAMs require complex 3D capacitor structures and no other thin film technology than ALD can be employed in their production. ALD has been used in these high-*k* applications already for some time. Furthermore, at the moment the dielectrics used in DRAMs are ZrO_2–Al_2O_3–ZrO_2 nanolaminates the preparation of which on a 3D structure is even more challenging. The DRAMs contain electrodes which also need to be conformal. ALD TiN is the material of choice for this application.

About 6 years ago, it was announced that the first microprocessors using MOSFETs containing high-*k* dielectrics were coming to the market. These revolutionary new devices contained ALD-made hafnium-based oxides as dielectrics and metals as gate electrodes. The current MOSFETs are still planar devices and as such not so much dependent on ALD as the 3D DRAMs. On the other hand, the replacement gate approach and the future 3D transistor structures will also make MOSFET processing a 3D task and thereby involve ALD.