

Yasna Aberi

Atomic Layer Deposition Parameter Optimization

Atomic Layer Deposition (ALD) is a method to synthesize ultrathin and conformal films with a precise control of thickness and material properties. ALD got a lot of interest for a variety of applications such as microelectronics wherever control of the ultrathin high- k films is required. Shrinking of feature sizes at the nano-scale in semiconductor industry with high aspect ratio structures meets the requirements of atomic level control of thin film deposition and conformal coating which could be provided using ALD.

The ALD mechanism is based on alternate introducing of two precursor materials into a vacuum chamber. These precursor vapors react with the surface using self-limiting and saturated reactions which lead to the formation of one monolayer of film per deposition cycle. By exposing the substrate surface with the precursors cyclically, a binary compound film is formed. A certain amount of material is deposited onto the surface in each cycle, known as “growth per cycle” which is between 0.1 and 3 Å. The thickness of the formed film could be precisely controlled by the number of deposition cycles as many times as required rather than the deposition time.

A number of thin films can be synthesized using ALD, such as nitrides (e.g. TiN, TaN, WN, NbN), binary oxides (e.g. Al₂O₃, TiO₂, ZnO, ZrO₂, HfO₂, and Ta₂O₅), metals (e.g. Ru, Ir, Pt) and metal sulfides (e.g. ZnS). The most common high- k oxides that have been widely investigated by using ALD are Al₂O₃, ZrO₂ and HfO₂.

In this project thermal and plasma-assisted ALD processes were developed to deposit Al₂O₃ and SiO₂ films at low temperature of 250 °C. The results demonstrated an efficient ALD process with relatively short pulse and purge times. The films indicated an excellent controlled thickness with growth per cycle of 1.1 Å/cycle. An optimized recipe for both thermal and plasma ALD processes was obtained.

Supervisor: **Ivan Maximov**

Project 15 ECTS credits in Physics

Division of Solid State Physics, Department of Physics, Lund University