UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO

CENTRO DE NANOCIENCIAS Y NANOTECNOLOGÍA

Fundamentals and Applications of Atomic Layer Deposition

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Atomic layer deposition (ALD) has emerged as an important technique for depositing thin films for a variety of applications. Semiconductor processing has been one of the main motivations for the recent development of ALD. ALD is able to meet the needs for atomic layer control and conformal deposition using sequential, self-limiting surface reactions. Most ALD processes are based on binary reaction sequences where two surface reactions occur and deposit a binary compound film. Because there are only a finite number of surface sites, the reactions can only deposit a finite number of surface species. If each of the two surface reactions is self-limiting, then the two reactions may proceed in a sequential fashion to deposit a thin film with atomic level control.

The advantages of ALD are precise thickness control at the Ångstrom or monolayer level. The self-limiting aspect of ALD leads to excellent step coverage and conformal deposition on high aspect ratio structures. Some surface areas will react before other surface areas because of different precursor gas fluxes. However, the precursors will adsorb and subsequently desorb from the surface areas where the reaction has reached completion. The precursors will then proceed to react with other unreacted surface areas and produce a very conformal deposition.

The self-limiting nature of the surface reactions also produces a nonstatistical deposition because the randomness of the precursor flux is removed as an important factor. As a result, ALD films remain extremely smooth and conformal to the original substrate because the reactions are driven to completion during every reaction cycle. Because no surface sites are left behind during film growth, the films tend to be very continuous and pinhole-free. This factor is extremely important for the deposition of excellent dielectric films. ALD processing is also extendible to very large substrates and to parallel processing of multiple substrates. The ALD precursors are gas phase molecules, and they fill all space independent of substrate geometry and do not require line- of-sight to the substrate. ALD is only limited by the size of the reaction chamber. The ALD process is also dominated by surface reactions. Because the surface reactions are performed sequentially, the two gas phase reactants are not in contact in the gas phase. This separation of the two reactions limits possible gas phase reactions that can form particles that could deposit on the surface to produce granular films.

Because of these merits, ALD is becoming an important tool in the semiconductor industry for the deposition of high-k oxides (e.g., HfO_2 and Al_2O_3), diffusion barriers, and three-dimensional (3-D) trench capacitors. Recently ALD has started to be utilized for tailoring the physical properties of nanomaterials (e.g., mechanical strengthening of spider silk, addition of photocatalytic effect to magnetic materials), and for template-assisted fabrication of complex nanostructures (e.g., hollow particles, tubes, and compound wires via interfacial solid state reactions.

SUMMARY

Teoría (1hr)

a) Introduction
b) Fundamentals.
c) Advantages between other deposition techniques.
d) Thermal ALD and Plasma-enhanced- ALD (PEALD)
e) Applications.
f) State of art of ALD at CNyN

Practica (3hrs)

a) Ultra thin-films deposition on silicon substrates.
b) ALD Powder coating