Atomic Layer Deposition

Atomic layer deposition (ALD) is a thin film deposition technique that is based on the sequential use of a gas phase chemical process. The majority of ALD reactions use two chemicals, typically called precursors. These precursors react with a surface one-at-a-time in a sequential manner. By exposing the precursors to the growth surface repeatedly, a thin film is deposited

Introduction

ALD is a self-limiting (the amount of film material deposited in each reaction cycle is constant), sequential surface chemistry that deposits conformal thin-films of materials onto substrates of varying compositions. ALD is similar in chemistry to chemical vapor deposition (CVD), except that the ALD reaction breaks the CVD reaction into two half-reactions, keeping the precursor materials separate during the reaction. Due to the characteristics of self-limiting and surface reactions, ALD film growth makes atomic scale deposition control possible. By keeping the precursors separate throughout the coating process, atomic layer control of film growth can be obtained as fine as ~0.1 Å (10 pm) per monolayer. Separation of the precursors is accomplished by pulsing a purge gas (typically nitrogen or argon) after each precursor pulse to remove excess precursor from the process chamber and prevent 'parasitic' CVD deposition on the substrate.

ALD had been developed and introduced worldwide with the name Atomic layer epitaxy (ALE) in the late 1970s.[2] For thin film electroluminescent (TFEL) flat-panel displays, high quality dielectric and luminescent films were required on large-area substrates, thus the deposition method of ALD was developed. Interest in ALD has increased in steps in the mid-1990s and 2000s, with the interest focused on silicon-based microelectronics. ALD is considered as one deposition method with the greatest potential for producing very thin, conformal films with control of the thickness and composition of the films possible at the atomic level. A major driving force for the recent interest is the prospective seen for ALD in scaling down microelectronic devices.

ALD can be used to deposit several types of thin films, including various oxides (e.g. Al_2O_3, TiO_2, SnO_2, ZnO, HfO_2),metal nitrides (e.g. TiN, TaN, WN, NbN), metals (e.g. Ru, Ir, Pt), and metal sulfides (e.g. ZnS).

ALD process

The growth of material layers by ALD consists of repeating the following characteristic four steps:

1. Exposure of the first precursor.
2. Purge or evacuation of the reaction chamber to remove the non-reacted precursors and the gaseous reaction by-products.
3. Exposure of the second precursor – or another treatment to activate the surface again for the reaction of the first precursor.
4. Purge or evacuation of the reaction chamber.

Each reaction cycle adds a given amount of material to the surface, referred to as the growth per cycle. To grow a material layer, reaction cycles are repeated as many as required for the desired film thickness. One cycle may take time from 0.5s to a few seconds and deposit between 0.1 and 3 Å of film thickness. Before starting the ALD process, the surface is stabilized to a known, controlled state, usually by a heat treatment. Due to the self-terminating reactions, ALD is a surface-controlled process, where process parameters other than the precursors, substrate, and temperature have little or no influence. And, because of the surface control, ALD-grown films are extremely conformal and uniform in thickness

참고

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