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Conformality of Thin Films Grown by Remote Plasma-Enhanced Atomic Layer Deposition

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Plasma-Enhanced Atomic Layer Deposition (PEALD) is a thin film deposition method derived from thermal atomic layer deposition (ALD). In ALD a thin film is deposited by exposing a substrate alternatively to precursors. Precursors react with the reactive groups of the substrate or growing film and film is deposited “layer by layer”. One major advantage of thermal ALD is the ability to deposit totally conformal thin films on demanding high aspect ratio structures. However, in remote PEALD a concern has been the possible limited conformality of thin films. Radical recombination on the walls of 3D structures can hinder growth especially at the bottom of high aspect ratio structures.[1] It is still under evaluation which are the limits of conformality in remote PEALD.

The conformality of several PEALD thin film materials (including Al_2O_3, TiO_2, Ta_2O_5 and SiO_2) was studied. Thin films were deposited by remote PEALD into trenches with aspect ratios varying from 20:1 to 60:1. Conformal coating was confirmed even on trenches with aspect ratios of 60:1.[2] In addition to recently published results we will discuss the role of secondary thermal ALD reactions. In a PEALD process the thermal ALD reaction is likely when water is formed as a byproduct and a metal-precursor is reactive with water in ALD conditions.[3] This could in theory enhance conformality in PEALD. To rule out the thermal pathway TiO_2 thin films were deposited from $TiCl_4$ or $(Me_5Cp)Ti(OMe)_3$ and O_2 plasma. In the case of $TiCl_4$ no water is formed and with $(Me_5Cp)Ti(OMe)_3$ water is not reactive enough oxygen precursor.

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