Effects of Sealing Components on ALD Film Quality

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Abstract

Atomic layer deposition (ALD) of high quality thin films has recently penetrated manufacturing lines of several major memory and logic manufacturers due to the promise of unprecedented control of thickness, uniformity, quality and material properties. ALD tools were designed around the anticipation that future ultrathin materials are likely to be binary, ternary or quaternary alloys or nanolaminate composites. A unique chemical delivery system enables synergy between traditional, production-proven low pressure chemical vapor deposition (LPCVD) technology and atomic layer deposition (ALD) controlled by sequential surface reactions. Source chemicals from gas, liquid or solid precursors are delivered to arrive on reactive surfaces where self-limiting surface reactions yield film growth with layer-by-layer control. Surfaces are made reactive by the self-limiting reactions, by surface species manipulation, or both. The substrate is exposed to one reactant at a time to suppress possible chemical vapor deposition (CVD) contribution to the film. Precisely controlled composite materials with multiple-component dielectric and metal–nitride films can be deposited by ALD techniques. The research community has demonstrated these capabilities during the past decade. Accordingly, ALD equipment for semiconductor processing is unanimously in high demand. Sealing parts like O-rings and lip-seals used to isolate chamber from outside world play a critical role, more so in ALD processes than any other Semiconductor manufacturing process. This is because any minute outgassing or permeation through O-ring polymer poses grave risk to quality of film deposited. Conventional Perfluoroelastomer (FFKM) O-rings with inherent porosity are not the ideal material of choice for ALD processes. In this article, we will demonstrate the effect of outgassing and permeation from sealing parts on ALD film uniformity, stoichiometry and overall thin film quality. Flodynamix LLC has developed a unique fluoropolymer called Kratos® ideal for ALD and PVD processes.

Permeation Properties of Kratos®

	Viton®	Kratos®	FFKM
O_2	1.8	1.3	7.4
He	15.5	13.2	72.0
N_2	0.06	0.05	9.5

Unit in 10^{-8} sccm-cm/sec-cm^2-atm @ 25°C

Thermal Resistance of Kratos®

Viton®	Kratos®	FFKM
220°C	275°C	320°C