Contribution ID: **1073** Type: **Poster**

3P06 - Plasma Properties in a High Pressure ALD Reactor

Wednesday 26 June 2019 13:30 (1h 30m)

The quality of a plasma enhanced atomic layer deposition (PEALD) film ultimately depends on controlling the flux of the reactive species onto the wafer. In a typical SiO_2 PEALD process, the first step is to treat the substrate with Si-containing precursor, usually without a plasma. Then the oxidation process is performed by exposing the substrate to an O_2-containing plasma. To achieve a high oxidizing radical flux to the substrate while limiting the ion energy to reduce damage on the film, a capacitively coupled plasma (CCP) operating in a few Torr is often used to. In these high pressures, a high radical flux can be produced while the ion energy onto the wafer is low due to the collisional nature of the sheath. The challenge to optimize this system includes improving plasma uniformity, minimizing ion energy and reducing UV/VUV damage.
In this work, results from a computational investigation of a high-pressure CCP reactor for PEALD of SiO_2 will be discussed. The goal is to provide insights on the tradeoffs in optimizing deposition conditions. The focus of this work will be the fluxes of radicals and ion into a feature with a moderate aspect ratio. The modeling platforms used in this study are the Hybrid Plasma Equipment Model (HPEM) and the Monte Carlo Feature Profile Model (MCFPM). The example system uses an Ar/O_2 mixture at 1-5 Torr with power deposition up to a few kW. The fundamental properties of the plasma (e.g. electron density, electron temperature, radical fluxes to the substrate) will be discussed. The ion energy and angular distributions (IEADs) are used for the feature scale modeling.
Work supported by Lam Research Corp. and the DOE Office of Fusion Energy Science.

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Session Classification: Poster - Industrial/Commercial/Medical Applications and Plasma and Pulse Power Diagnostics

Track Classification: 6.1 Nonequilibrium Plasma Applications