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TEOS Silicon Oxides Deposition to Low Temperature Applications

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In this work, we developed high quality silicon oxide to low temperature applications. Plasma Enhanced Chemical Vapor Deposition (capacitive coupling) – PECVD and a High Density (inductive coupling) – HD-PECVD techniques were compared. Oxygen and TEOS (TetraEthylOrthoSilicate) reacts under a RF discharge to promote the oxidation of the organic species to deposit silicon oxide. To improve the quality of the silicon oxide deposited films, it was used very low content of TEOS in the gas mixture, as studied before (1,2,3).

The process parameters used to deposit TEOS silicon oxide in the reaction chambers are presented in **Table I**. The **Figure 1** shows the deposition rates as a function of the substrate temperature to PECVD and as a function of RF Power to HD-PECVD system.

Table I: Process parameters to silicon oxide deposition processes in PECVD and HD-PECVD reaction chambers.

Process Parameters	HD-PECVD	PECVD
Pressure (mTorr)	30	1000
Temperature (°C)	375	25 < T < 375
TEOS flow (sccm)	0.5	2
Oxygen flow (sccm)	60	200
RF power (W)	$50 < W_{RF} < 200$	400

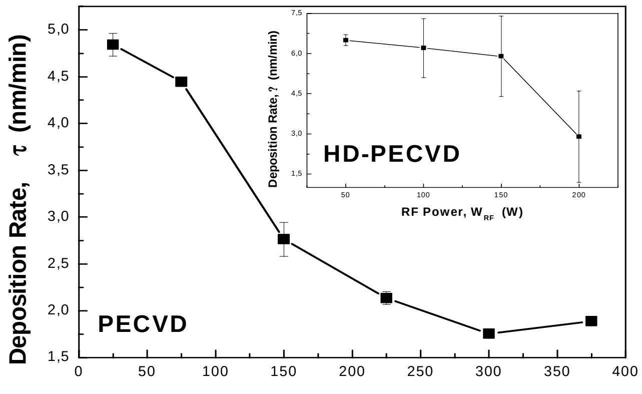

Figure 1: Deposition Rates: Higher deposition rates are obtained for lower PECVD process temperatures, attributed to the possible incorporation of non-dissociated TEOS subproducts. HD-PECVD: Up to 150 W of RF power, the deposition rate has a slight decrease. To 200 W, an abrupt decrease is observed. It can be explained by a combination of two effects. The first one is the higher ion bombardment over the substrate that densifies the deposited film. The second one is related to the better gas mixture plasma decomposition and elimination of TEOS sub-products when higher RF power is applied.

Figure 2 presents the current density versus breakdown strength field curves obtained from the MOS capacitors.

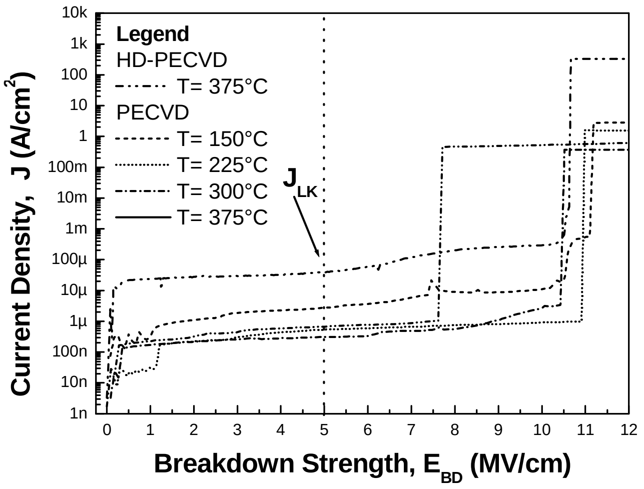

Figure 2: Current density as a function of breakdown strength of the MOS capacitors fabricated with silicon oxide films deposited in both reactors.

PECVD: We have studied the electrical characteristics of PECVD silicon oxide deposited with low TEOS contents at low temperatures. It was found that when the deposition rate increases the film quality decreases and the films are less dense. Electrical characteristics of deposited films parameterized according to substrate temperatures indicate that the best results were obtained for the samples deposited at higher temperature. The samples deposited at 225°C presented some capacitors with $\varepsilon_{ox} = 3.9$ and $E_{BD} = 11.85$ MV/cm. The temperature of 225°C can be considered as the threshold to obtain films with electric properties very close to the ones deposited at 375°C. The dielectric constant for the films deposited at lower temperature are higher due to the post deposition water incorporation into the oxide films. The dangling bonds density is higher for the films deposited at lower temperatures due to their more defective structure, which promotes an increase of the effective charge density.

HD-PECVD: OES technique was used to determine the preliminary results deposition parameters of the silicon oxide in the HD-PECVD chamber. FTIRS measurements was used to verify the OH contamination's bonds as a function of RF power and it was found a low intensity peak concerning with Si-OH bonds. Finally, the MOS capacitors were fabricated with the deposited silicon oxide as gate insulator and its electric properties were calculated. The Q_{SS}, E_{BD} and I_{LK} (at 5 MV/cm) were 2.0×10^{12} cm^{-2}, 10.6 MV/cm and 3.9×10^{-5} A/cm^2, respectively. Those values are not good enough to these films be applied as gate dielectric in TFT's. However for device passivation these films shown suitable characteristics.

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3. C. E. Viana, J. L. R. Santos and N. I. Morimoto, Proc. Electrochem. Soc. V.2002-08, p.92-100 2002.

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