Gas Flow Simulation in a PECVD Reactor
PhD Thesis
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In this work they are presented the gas flow simulation in a home made PECVD-TEOS reactor. We used the FLOTRAN-CFC code of the ANSYS simulator to predict the velocity distribution in the reactor. The results showed strong influence of the reactor geometry and the deposition process pressure in the gas velocity distribution curves.

Previous experiments on TEOS silicon oxide deposition process showed, in some conditions, a thickness nonuniformity in the deposited layer, because a gas flow variation occurs inside the reactor. This variation is due to the design of the gas flow system that is not optimized for all deposition conditions.

The reactor configuration has no axial simetry, because the gas misture is introduced laterally in the PECVD chamber (figure 1).

Figure 1: Schematic drawing of the PECVD reactor showing the relevant components.

Figure 2 shows the curve of the simulated velocity distribution as function of the chamber radius. We observe that the metallic disc (distribution plate) that is placed in order to achieve a better gas distribution modify the velocity distribution inside the PECVD reactor leading to higher velocity values near the gas outlet. Also there is one region where the gas velocity is near zero. This is due to the change in the gas flux direction.

Figure 2: Distribution velocity in the PECVD Reactor chamber.

After this simulation, we analyzed two different gaseous flux: 155 sccm (15 sccm TEOS plus 40 sccm O₂ plus 100 sccm Ar) and 505 sccm (5 sccm TEOS plus 500 sccm O₂).

The simulated velocity distribution curves do not have axial symmetry, even using the metallic disc and the shower. We concluded that this lack of simetry is the main reason for the nonuniformity in the silicon oxide deposition process.

Figure 3 shows the curves of the velocity distribution obtained for the 505 sccm gas flux case. The pressure is varied by changing the conductance between the chamber and the vacuum pump.

Figure 3: Velocity distribution curves

The influence of the distance between electrodes in the velocity of the gas flow in the PECVD reactor chamber was studied. The gas velocity decreases when increasing the distance between electrodes as observed in figure 4, and when the distance becomes larger than 2.0 cm we observe very low gas velocities. In these conditions we can predict a low quality of the deposited layer, because the residence time increases, which promotes the vapor phase reaction during the deposition process as well as the film deposition on the reactor walls.

Figure 4: Velocity Profile

From the present study it was shown that varying PECVD-TEOS process parameters we can change the residence time of active species on the wafer thus explaining the non-uniformities of deposited oxide films observed in previous experiments.

BIBLIOGRAPHY

1. Flotran-CFC manual