Public Abstract

First Name: Ramasamy
Middle Name:
Last Name: Ravindran
Degree: MS
Degree Program: Electrical and Computer Engineering
Advisor's First Name: Shubhra
Advisor's Last Name: Gangopadhyay
Co-Advisor's First Name:
Co-Advisor's Last Name:
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Title: Deposition and Characterization of High Permittivity Thin-Film Dielectrics

Rapid advances in performance and capability have made computers an indispensable part of our daily lives. Moore's Law states that integrated circuit (IC) complexity will double roughly every two years, something that has occurred steadily for the last 35 years. Continuing this trend into the future requires overcoming several obstacles. Transistors are now on the scale of a few tens of nanometers. The density within ICs and their increasing core clock speeds have mandated the use of new designs and materials in fabrication. Finding solutions to these issues will enable faster and more power efficient IC devices including microprocessors and memory devices.

This research studied potential candidates for addressing a particular transistor level challenge. The insulating film at the heart of all modern ICs, known as the gate oxide, needs to be replaced with higher dielectric constant materials within a few generations. Currently employed materials such as silicon dioxide and silicon oxynitride will become unacceptable from a performance and power consumption standpoint with ever decreasing transistor dimensions. Over the course of this work, insulating films known as high-κ dielectrics were deposited and characterized using electrical and optical methods. Detailed in this thesis are the procedures and results of efforts to further enhance the dielectric constant of hafnium dioxide and aluminum oxide. New techniques for depositing these films were developed using systems and processes common in the semiconductor industry.