PECVD of Hafnium Based High K Dielectrics for Field Effect Transistors

Harish Bhandari

University of Alabama
Department of Chemical Engineering

Abstract

The semiconductor industry’s rapid development has been predicted by Moore’s law which states that the number of transistors on a silicon chip doubles every 18 months. The demand for high performance at a low cost has translated into downscaling of metal oxide semiconductor field effect transistor (MOSFET) devices resulting in shrinking of SiO\textsubscript{2} gate oxide layer. At the present sub nanometer thickness conventional SiO\textsubscript{2} gates suffer from high leakage current and reduced reliability due to quantum mechanical tunneling of electrons. Hafnium oxide and hafnium silicate are promising materials to replace SiO\textsubscript{2} because they combine high dielectric properties with thermal stability suitable for MOSFET processing temperatures. Hafnium oxide and hafnium silicate films were plasma-enhanced chemical vapor deposited (PECVD) on n-type silicon substrate using oxygen precursors, silane and hafnium tert-butoxide. The films were deposited at 275\textdegree{}C, 360\textdegree{}C, and 425\textdegree{}C substrate temperatures and compared using different oxygen precursors: water vapor, high purity O\textsubscript{2} and N\textsubscript{2}O in order to study their effect on film properties. The deposited films were furnace annealed in air at 1100\textdegree{}C for 30 mins to study their stability at high temperature. The films were characterized for surface chemical composition and states using XPS, and thickness was measured using ellipsometry.