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Stability of Metal Oxide/Ge and Metal Oxide/III-V Interfaces and Implications for Low Defect Density MOS Devices[1]

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The need to achieve high performance in MOS transistors as they scale to their ultimate size limits prompts interest in channel materials, such as Ge and III-V compound semiconductors, which exhibit larger intrinsic carrier mobilities than Si. Given the need to reduce gate leakage current density while maintaining electrostatic control of the devices, it is necessary to deposit high-k gate dielectrics onto these novel channel materials. Unlike silicon, high mobility channel materials do not form a highly-stable and stoichiometric native oxide; therefore, control of the state of oxidation at the metal oxide dielectric/channel interface during and after gate dielectric deposition is essential. This presentation will summarize findings reported to date on 1) chemical stability of Ge and III-V surfaces in the presence of oxygen and 2) oxide/channel defect formation and passivation. New results on pre-high-k chemical surface preparation, structural modification during metal oxide deposition and the resulting effects on MOS capacitor and transistor characteristics will also be presented, with emphasis on Al_2O_3 and HfO_2 gate insulators grown by atomic layer deposition onto Ge and InGaAs channels. *In situ* and *ex situ* monitoring of chemical bonding at the gate insulator/channel interface by photoelectron spectroscopy will be correlated with the D_{it}, fixed charge and charge trapping behavior of MOS devices.

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