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Nitrided hafnium silicates for gate dielectrics CHANG-GONG WANG, MOHITH VERGHESE, ERIC SHERO, GLEN WILK, ASM America, Inc., JAN WILLEM MAES, W. DEWEERD, IMEC, R. OPILA, University of Delaware, J. MORAIS, Instituto de Fisica — Nitrided hafnium silicate (HfSiON) gate dielectric films deposited by atomic layer chemical vapor deposition (ALCVD^{TM}) show excellent capacitor and transistor characteristics with both poly-Si and metal gates, which are directly correlated with local physical and chemical properties. A wide range of compositions are demonstrated, with Si/(Hf+Si) percentages from 0 to 75% and uniformly distributed N levels up to 30 at. %. XPS is used to distinguish the local bonding arrangements of N to Hf, Si and O. The distribution and depth profile of these N bonds is directly attributable to the observed electrical and physical properties of these films as measured by TOF-SIMS, TEM, EELS, nuclear reaction analysis and angle-resolved XPS. Using poly-silicon gate electrodes with chemical or thermal oxide underlayers, EOT values down to 1.3nm with substantial leakage reduction vs. SiO2 have been achieved using stacks with ultrathin HfSiON. Hysteresis and midgap interface density (Dit) are less than 10mV and $5X10^{10}cm^{-2}eV^{-1}$, respectively. Transistors (gate length of 110nm) with these ALD HfSiON films display excellent $V_T$stability and channel electron mobility $>$ 90% of SiO2 at high Eeff. Detailed analysis on silicate compositions, the distribution of nitrogen in the interface layers, and corresponding impact on device performance will be presented.

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