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Medium Energy Ion Scattering Study of Oxygen Diffusion-Reactions in High-k Dielectrics on Si LYUDMILA GONCHAROVA, DMITRI STARODUB, ROBIN BARNES, ERIC GARFUNKEL, TORGNY GUSTAFSSON, Rutgers University, GENNADI BERSUKER, BRENDAN FORAN, PAT LYSAGHT, Sematech — Understanding the thermodynamics and kinetics of film growth during fabrication of high-κ gate stacks is vital to establish atomic level control of interfacial layers and to minimize defects. Annealing such films in different atmospheres may lead to diffusion and reactions with significant consequences on the electrical properties. We have used high-resolution medium energy ion scattering in combination with isotope tracing to investigate oxygen transport in model systems, including Hf and Ce oxides. The reaction of oxygen (p_{O2}=10^{-2}Torr) with $HfO_2(SiO_2)_x$/Si films at 500^oC was dominated by oxygen isotopic exchange (not SiO_2 interfacial growth). The oxygen exchange rate decreases with an increase of SiO_2 fraction in Hf silicate films and is almost fully suppressed (at 500^oC) for a (HfO_2):(SiO_2)=1:1 film composition. This reaction saturated with time and appeared to be enhanced after film recrystallization. Annealing in a nitrogen-containing atmosphere result in reduced O^{18} incorporation and exchange. In comparison to Hf dielectrics, Ce silicates exhibit rapid interface growth upon oxygen exposure. Incorporating nitrogen into the structure lowers the rate of subsequent oxygen diffusion and incorporation.

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