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Dielectric thickness dependence of carrier mobility in graphene with Al_2O_3 and HfO_2 top dielectrics BABAK FALLAHAZAD, SEYOUNG KIM, University of Texas at Austin, LUIGI COLOMBO, Texas Instrument, EMANUEL TUTUC, University of Texas at Austin — We study the carrier mobility in graphene with high-k top dielectrics, as a function of the dielectric thickness and temperature. Metal-oxide high-k films, Al_2O_3 (k $\sim$8.4) and HfO_2 (k $\sim$16), are deposited on graphene by atomic layer deposition (ALD), at deposition temperatures of 200-250 $^\circ$C. A considerable ($\sim$50%) mobility drop is observed after the deposition of the first 2-4 nm of dielectric. For thicker dielectrics the mobility is relatively insensitive to thickness. The carrier mobility has a weak temperature dependence, which indicates that phonon scattering is not the primary mobility limiting factor in these devices. Our results suggest that Coulomb scattering caused by fixed charged impurities located in the high-k dielectric, and in proximity to the graphene layer plays a significant role in mobility degredation. The ALD grown high-k films are inherently oxygen deficient, and oxygen vacancies form donor levels which become positively charged in the proximity of the graphene layer. We speculate that Coulomb scattering due to charged point defects is the mobility limiting mechanism in graphene devices with Al_2O_3 or HfO_2 high-k dielectrics.

Babak Fallahazad
University of Texas at Austin

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