REDUCTION OF THE ELECTRON MOBILITY IN HIGH-κ MOS SYSTEMS CAUSED BY REMOTE SCATTERING WITH SOFT INTERFACIAL OPTICAL PHONONS*

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The poor electron mobility presently observed in metal-insulator-semiconductor devices using high-κ insulators may be due to a variety of processing and material-related issues. However, in this talk it will be argued that the high-κ itself may present an intrinsic, unavoidable cause of this poor performance. Indeed, the high dielectric constant is usually accompanied by the presence of soft optical phonons. The long-range dipole field associated with the interface excitations, while small in the case of SiO₂, for most high-κ materials is sufficiently large to depress the effective electron mobility in the inversion layer of the Si substrate. We study the dispersion of the interfacial coupled phonon-plasmon modes, their electron-scattering strength, and their effect on the electron mobility for Si-gate structures employing films of SiO₂, Al₂O₃, AlN, ZrO₂, HfO₂ and ZrSiO₄ for `SiO₂-equivalent' thicknesses ranging from 5 nm to 0.5 nm.

*In collaboration with Deborah A. Neumayer, and Eduard A. Cartier