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Semiconductor-on-epitaxial insulator: towards ultrathin and nonclassical semiconductor devices[1]

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The microelectronics industry is currently moving from bulk Si field-effect transistors (FETs) with silicon-dioxide gate insulators to high-k gate dielectric FETs and semiconductor-on-insulator (SOI) substrates, with alternative non-Si channel materials and nonplanar device layouts on the horizon. The possibility of integrating epitaxial insulator layers with well-controlled bandgaps and near-monolayer thickness control may open up new opportunities for nonclassical devices and possibly optical sources. Unlike their III-V counterparts, where epitaxial heterostructures have been available for decades, epitaxial oxide-based SOI devices have the crucial advantage of potential integrability with dominant silicon technology. This talk will discuss the examples of tunneling FETs and real-space transfer devices, as well as a proposed tunneling-based SOI intersubband laser. At this point, all of the proposed devices require epitaxial control and material quality that exceeds the state-of-the-art. Still, the unique characteristics deriving from quantum mechanical tunneling make such devices an interesting playground for innovative device research, essentially replicating the III-V heterostructure device platform in the silicon-dominated microelectronics industry just as standard Si FET technology heads towards the long-predicted end of the miniaturization paradigm.

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