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Quantum mechanical solver for confined heterostructure tunnel field-effect transistors DEVIN VERRECK, imec, KU Leuven, MAARTEN VAN DE PUT, BART SOREE, imec, Universiteit Antwerpen, ANNE VERHULST, imec, WIM MAGNUS, imec, Universiteit Antwerpen, WILLIAM VANDENBERGHE, University of Texas at Dallas, GUIDO GROESENEKEN, imec, KU Leuven — Although the tunnel field-effect transistor (TFET) is a promising candidate to replace the MOSFET in low-power applications because of its sub-60mV/dec subthreshold swing (SS), on-currents are typically too low. Introducing a heterostructure of III-V materials at the tunnel junction enables higher on-currents, but the influence of quantum effects like size confinement is poorly understood. We therefore present a ballistic quantum transport formalism, combining for the first time a novel heterostructure envelope function formalism with the multiband quantum transmitting boundary method, extended to 2D potentials. First, the subband modes are obtained in the contacts, where the potential is assumed constant in the transport direction. Next, the modes are injected one by one into the device. Finally, the resulting transmission probabilities are integrated, weighted with a Fermi-Dirac distribution, to obtain the current. This multiband formalism has been implemented for the 2-band case. First, heterostructure diodes were simulated, showing a decrease in transmission probabilities for thin devices. Next, p-n-i-n heterostructure TFETs were studied. It was found that the improved gate control in thin devices counteracts the size confinement.

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