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Quantum Transport in Ultra-scaled Junctionless Transistors[1]
SUNGGEUN KIM, Purdue University, MATHIEU LUISIER, ETH Zurich, GERHARD KLIMECK, Purdue University, NCN COLLABORATION[2] — As the dimensions of metal-oxide-semiconductor field-effect transistors have been scaled down to a few nano-meters, short channel effects have started to significantly degrade their performance. The junctionless transistor is an alternative device structure which is expected to reduce short channel effects. However, an extreme device scaling raises another issue, namely, source-to-drain tunneling. Junctionless transistors contain several doping atoms in the channel which can enhance tunneling processes and cause electrons to scatter with them. Through self-consistent quantum transport simulations based on the tight-binding model with elelctron-phonon scattering included, it is found that junctionless nanowire transistors with a gate length of 5 nm do not outperform conventional inversion-mode transistors with the same dimension in terms of their on-state characteristics, mainly due to impurity scattering in the channel. The advantage of the junctionless transistor in the the subthreshold region vanishes due to large tunneling currents through doping impurities.

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