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Impurity and phonon scattering in silicon nanowires W. ZHANG, Beijing National Laboratory for Condensed Matter Physics, China, M.P. PERSSON, H. MERA, CEA-UJF, INAC, SP2M/L-Sim, Grenoble, France, C. DELERUE, IEMN - Dept. ISEN, Lille, France, Y.M. NIQUET, CEA-UJF, INAC, SP2M/L-Sim, Grenoble, France, G. ALLAN, IEMN - Dept. ISEN, Lille, France, E. WANG, School of Physics, Peking University, Beijing, China — We model the scattering of electrons by phonons and dopant impurities in ultimate [110]-oriented gate-all-around silicon nanowires with an atomistic valence force field and tight-binding approach. All electron-phonons interactions are included. We show that impurity scattering can reduce with decreasing nanowire diameter due to the enhanced screening by the gate. Donors and acceptors however perform very differently : acceptors behave as tunnel barriers for the electrons, while donors behave as quantum wells which introduce Fano resonances in the conductance. As a consequence the acceptors are much more limiting the mobility than the donors. The resistances of single acceptors are also very dependent on their radial position in the nanowire, which might be a significant source of variability in ultimate silicon nanowire devices. Concerning phonons, we show that, as a result of strong confinement, i) electrons couple to a wide and complex distribution of phonons modes, and ii) the mobility has a non-monotonic variation with wire diameter and is strongly reduced with respect to bulk. French National Research Agency ANR project QUANTAMONDE Contract No. ANR-07-NANO-023-02 and by the Délégation Générale pour l'Armement, French Ministry of Defense under Grant No. 2008.34.0031.

Christophe Delerue
ISEN-IEMN

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