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The Device Physics of Experimentally Validated Analytical Theory of Transport in Ballistic Carbon Nanotube Transistors DEJI AKINWANDE, JIALE LIANG, H.-S. PHILIP WONG, Stanford University — We have developed a fully analytical ballistic theory of carbon nanotube field effect transistors (CNFETs) enabled by the development of an analytical surface potential capturing the temperature dependence and gate and quantum capacitance electrostatics. The analytical ballistic theory is compared to the experimental results of a ballistic transistor with good agreement. The validated analytical theory enables qualitative and quantitative intuitive insight into transport in CNFETs, provides techniques for extracting device parameters such as the bandgap and the surface potential from experimental current-voltage characteristics, and elucidates on the relatively new device physics of drain optical phonon scattering and its role in reducing the linear conductance and intrinsic gain of the transistor. These results apply to all ballistic CNFETs with a channel length that is less than the acoustic phonon mean free path.

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