Scattering-limited and ballistic transport in a nano-CMOS circuit

Abstract

The mobility and saturation velocity in the nanoscale metal oxide semiconductor field effect transistor (MOSFET) are revealed to be ballistic; the former in a channel whose length is smaller than the scattering-limited mean free path. The drain-end carrier velocity is smaller than the ultimate saturation velocity due to the presence of a finite electric field at the drain. The current-voltage characteristics of a MOSFET are obtained and shown to agree well with the experimental observations on an 80 nm channel. When scaling complementary pair of NMOS and PMOS channels, it is shown that the length of the channel is proportional to the channel mobility. On the other hand, the width of the channel is scaled inversely proportional to the saturation velocity of the channel. The results reported may transform the way the ULSI circuits are designed and their performance evaluated.