NCN@Purdue Summer School: July 14-25, 2008

"Electronics from the Bottom Up"

Exercises on Carrier Scattering in Nanoscale MOSFETs

Mark Lundstrom
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Discovery Park, Purdue University

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Objective:
To help you gain familiarity with comparing measured data t against the ballistic limit, you will be asked to perform an analysis similar to the one done in Lecture 5.

1) Consider a silicon PMOS technology with the following characteristics;

Nitrided gate oxide (k = 5, tinv = 2.5 nm, EOT=1.7 nm)
Polysilicon gate
V_{DD} = 1.2V
Not intentionally strained
All measurements at T ~ 300K
Minimum mask channel length = 100 nm
Minimum physical channel length (SEM) = 85 nm

Note that this is an older, unstrained technology. Modern PMOS technology uses strained silicon to boost performance (i.e. on-current).

The measured characteristics of the devices are:

V_T(sat) (V)	0.22
V_T(lin) (V)	0.32
I_{ON} (μA/μm)	360
I_{OFF} (μA/μm)	2.89×10^{-2}
S (mV/dec)	94

DIBL (mV/V)	101
R_{TOT} (Ω-μm)	1217
g_m(MAX) (μS/μm)	483

Perform an analysis of this device and estimate $B_{lin} = T = I_{Dlin}/I_{Dlin}(ball)$ and $B_{sat} = T/(2-T) = I_{ON}/I_{ON}(ball)$. Assume that the series resistance is $R_{SD} = 200 \pm 50\ \Omega - \mu\text{m}$. To keep the analysis simple, just treat the heavy hole and assume it is a single parabolic sub-band with a heavy hole effective mass of $m^*/m_0 = 0.54$.

Matlab scripts that compute the ballistic channel resistance and the ballistic injection velocity for electrons are attached and can be modified for this exercise.