

# Computational Electronics: Mobility Modeling

Dragica Vasileska and Gerhard Klimeck

1. Plot the doping dependence of the low-field electron mobility, as described by the conventional mobility model, Klaassen's mobility model, the Arora model and the Dorkel and Leturg model. In your calculation use the parameters specified in the corresponding papers. Consider  $n$ -type semiconductor with donor doping density varying from  $10^{14} \text{ cm}^{-3}$  to  $10^{20} \text{ cm}^{-3}$ . Note that the Dorkel and Leturcq model has a problem, so please use the following expressions when implementing the model:

- Mobility limited due to lattice scattering:

$$\mu_L = 1430 \left( \frac{T}{300} \right)^{-2.20} \text{ cm}^2/\text{V}\cdot\text{s}$$

- Mobility limited due to Coulomb scattering:

$$\mu_I = \frac{AT^{3/2}}{N} \left[ \ln \left( 1 + \frac{BT^2}{N} \right) - \frac{BT^2}{N + BT^2} \right]^{-1}$$

where:  $A = 4.61 \times 10^{17} \text{ cm}^{-1}\text{V}^{-1}\text{s}^{-1}\text{K}^{-3/2}$ ,  $B = 1.52 \times 10^{15} \text{ cm}^{-3}\text{K}^{-2}$ , and  $N$  is the doping concentration.

2. Assume that the doping density is  $N_D=10^{17} \text{ cm}^{-3}$ . Plot the field-dependent mobility. Vary the electric field value between  $0.1 \text{ kV/cm}$  and  $100 \text{ kV/cm}$ .
3. Plot the perpendicular field dependence of the low-field electron mobility using the Yamaguchi and the Shirahata models. In your calculations assume  $n$ -channel MOSFET device with uniform substrate doping equal to  $3.9 \times 10^{15} \text{ cm}^{-3}$ ,  $2 \times 10^{16} \text{ cm}^{-3}$ ,  $7.2 \times 10^{16} \text{ cm}^{-3}$  and  $3 \times 10^{17} \text{ cm}^{-3}$ . Vary the transverse electric field from  $10^4 \text{ V/cm}$  to  $10^6 \text{ V/cm}$ . Compare your model results with the experimental data of Takagi, Toriumi, Iwase and Tango (*IEEE Trans. Electron Devices*, Vol. 41, pp. 2357-2362, 1994).