Special Topics on Basic EECS I Design Technology Co-Optimization

Lecture 22

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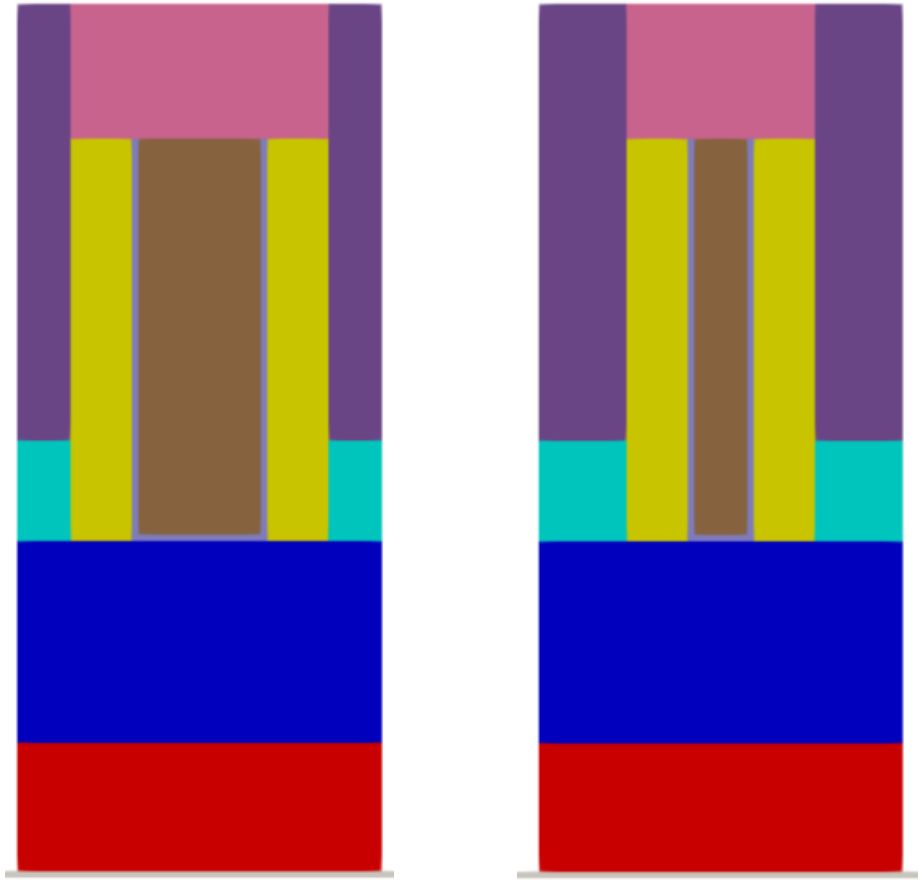
L22

CPP = L_G + 2L_{spacer} + L_{SD}

- When the CPP is fixed, we must decompose it into three parameters.
  - If L_G decreases, the channel conductance improves. But, the short channel effect becomes significant.
  - If L_{spacer} decreases, again, the short channel effect.
  - If L_{SD} decreases, the source/drain resistance increases.
  - Note: Our L_G includes the high-k thickness (twice).
- Other geometric parameters are fixed.
  - No calibration for material parameters
- Perfect contact alignment

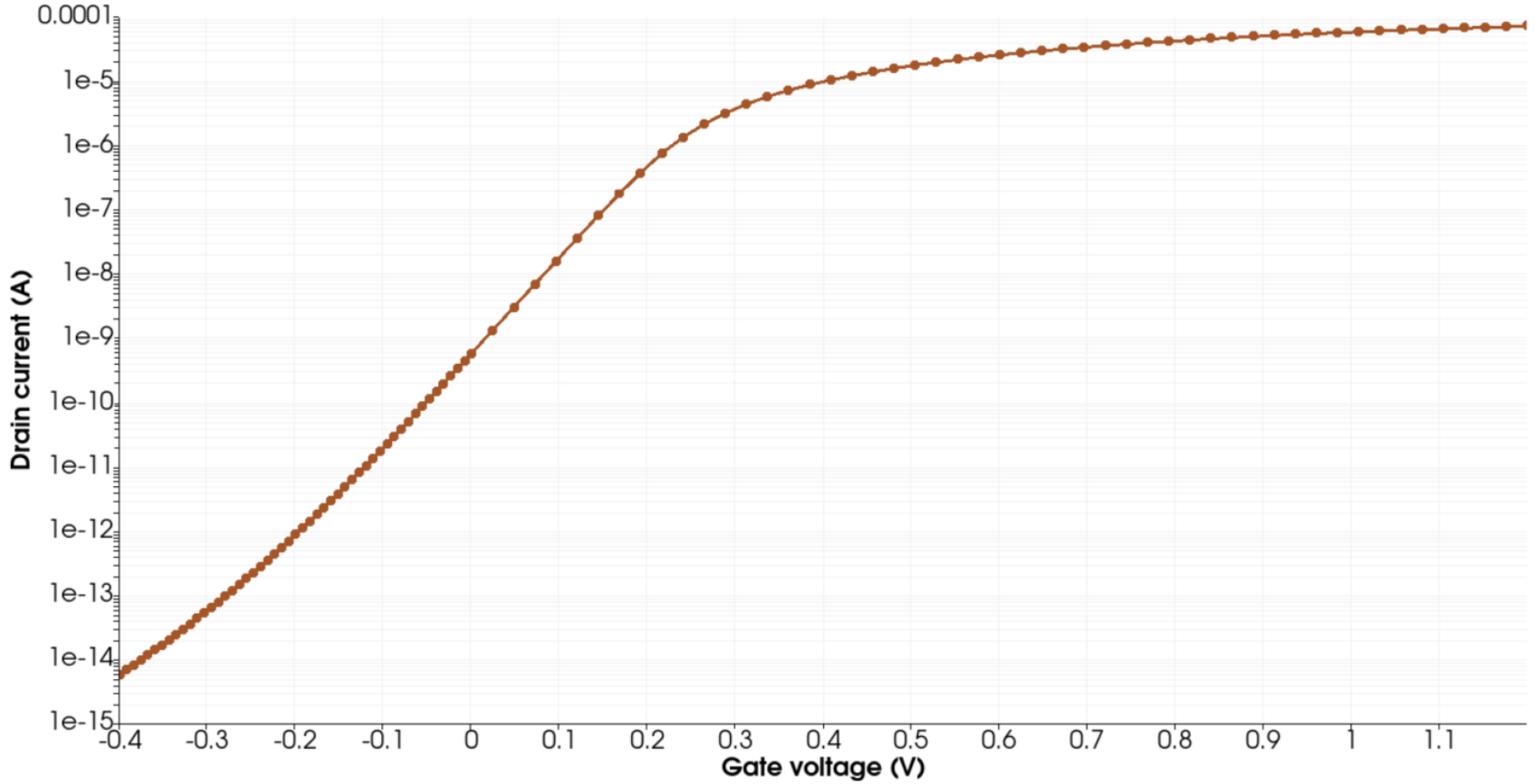
A scenario of L_{spacer} = 9 nm

- It means $L_G + L_{SD}$ = 36 nm.
  - Measure I_{ON} with I_{OFF} = 1 nA.
  - How can we find it efficiently?
  - Run a simulation with a wider voltage range. Then, just shift it.
  - List of L_G values: 20 nm (Baseline), 18 nm, 16 nm, 14 nm, 12 nm, and 10 nm



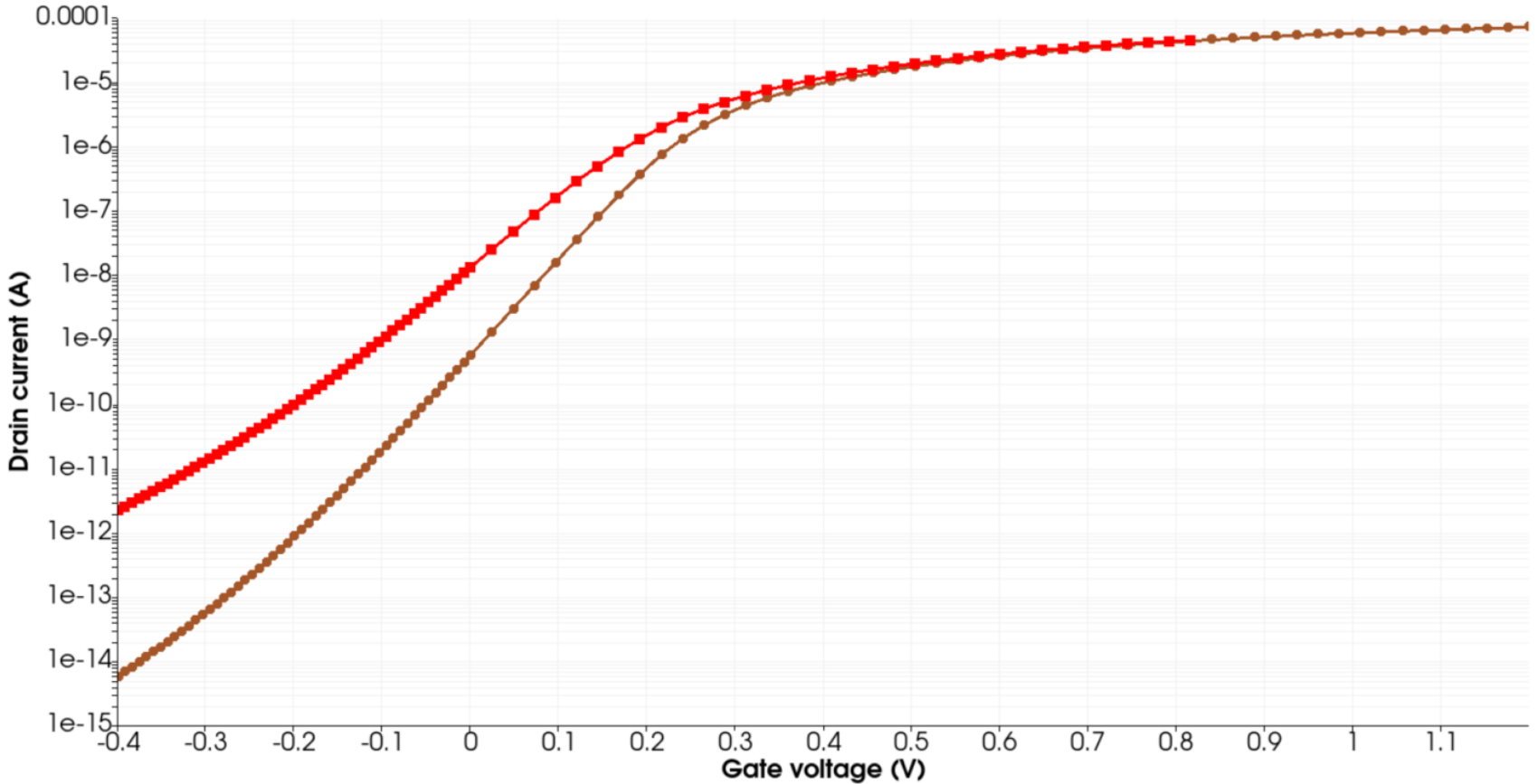
Data for L_G = 20 nm

- Workfunction of 4.4 eV
  - After shifting ~16 mV, I_{ON} is ~35.2 μA. (Or, 496 μA/μm with effective width)



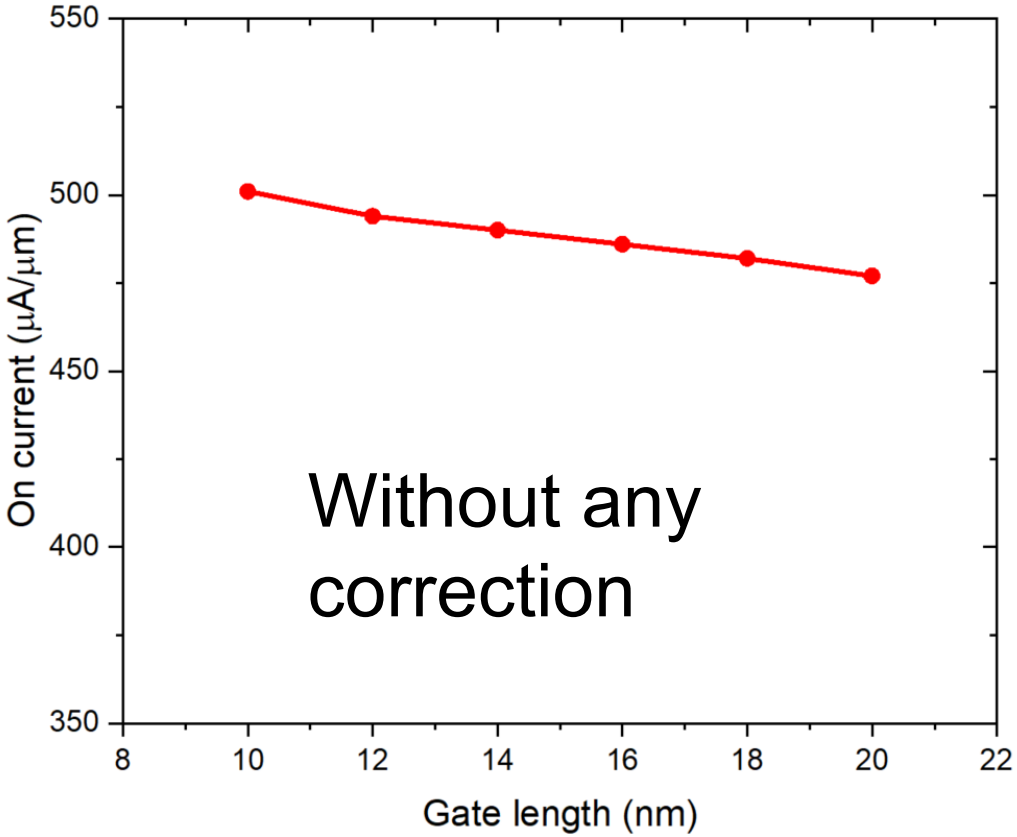
Data for L_G = 10 nm

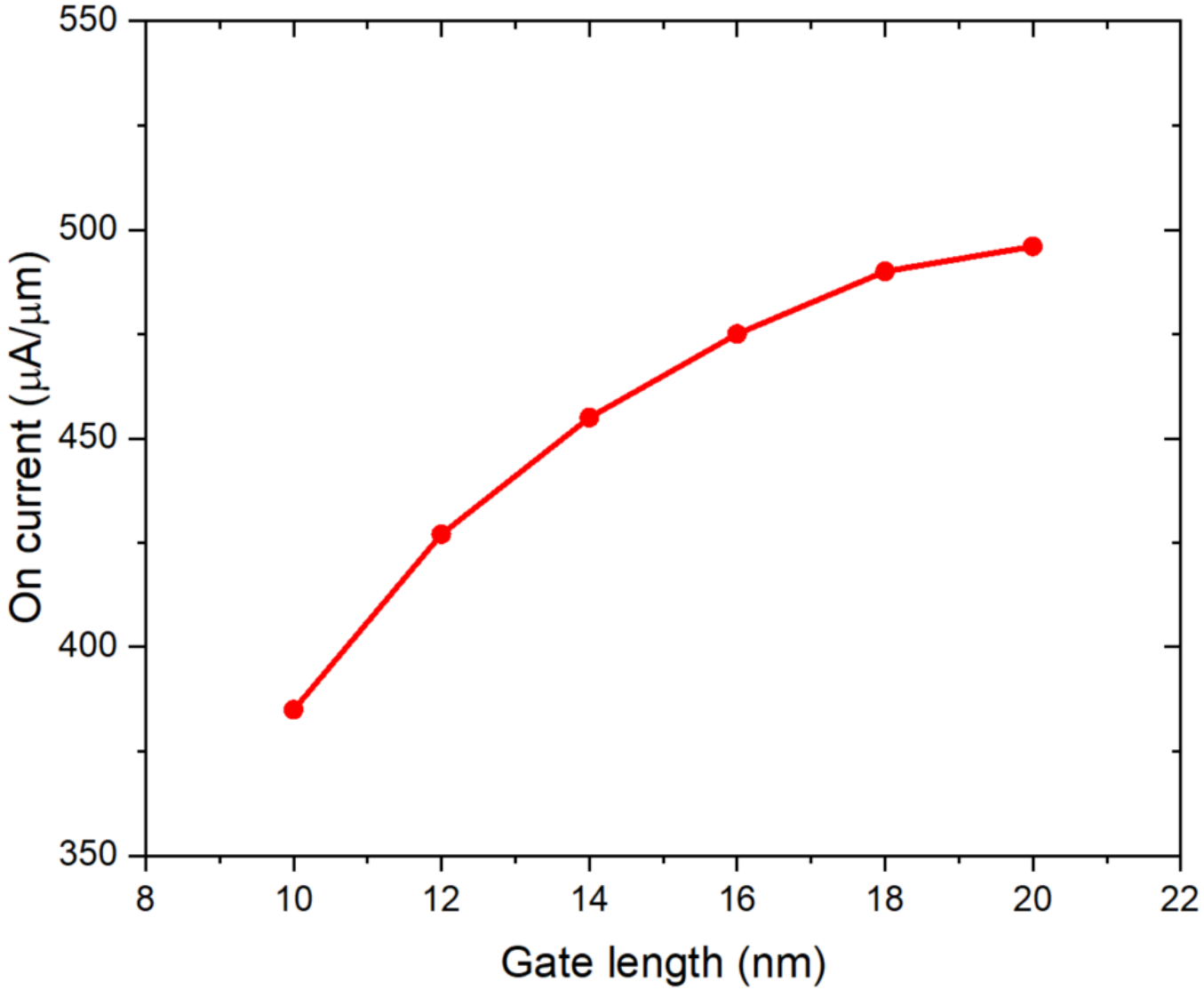
- Workfunction of 4.4 eV
  - Now, I_{ON} is ~27.3 μA. (Or, 385 μA/μm with effective width)
  - 22 % reduction due to the short channel effect



I_{ON} (@ iso-I_{OFF}) as a function of L_G

- L_G scaling degrades I_{ON}.
  - It does not follow $\propto \frac{1}{L_G}$.





Thank you!