Essentials of MOSFETs

Unit 3: MOS Electrostatics

Lecture 3.5: MOS CV

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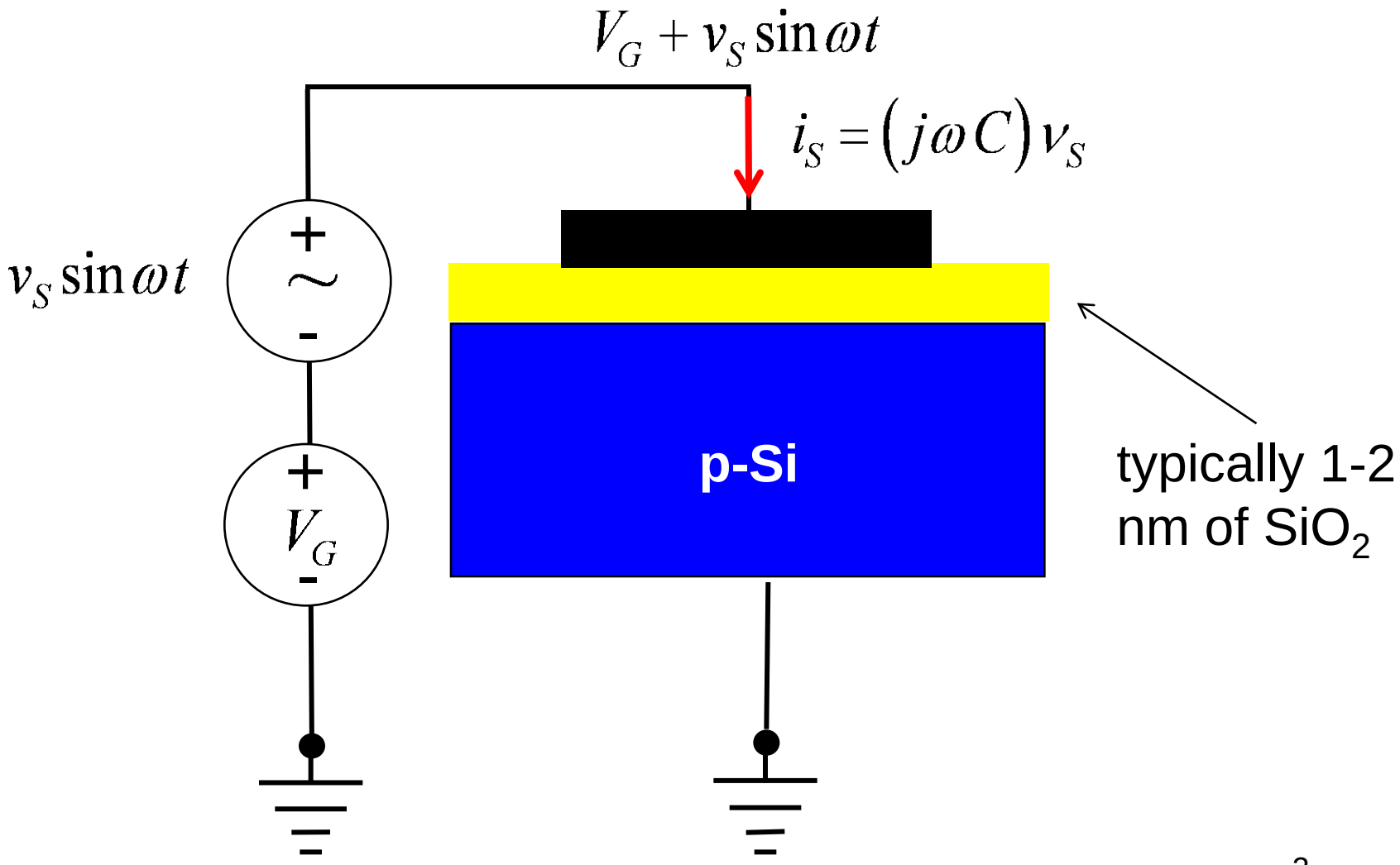
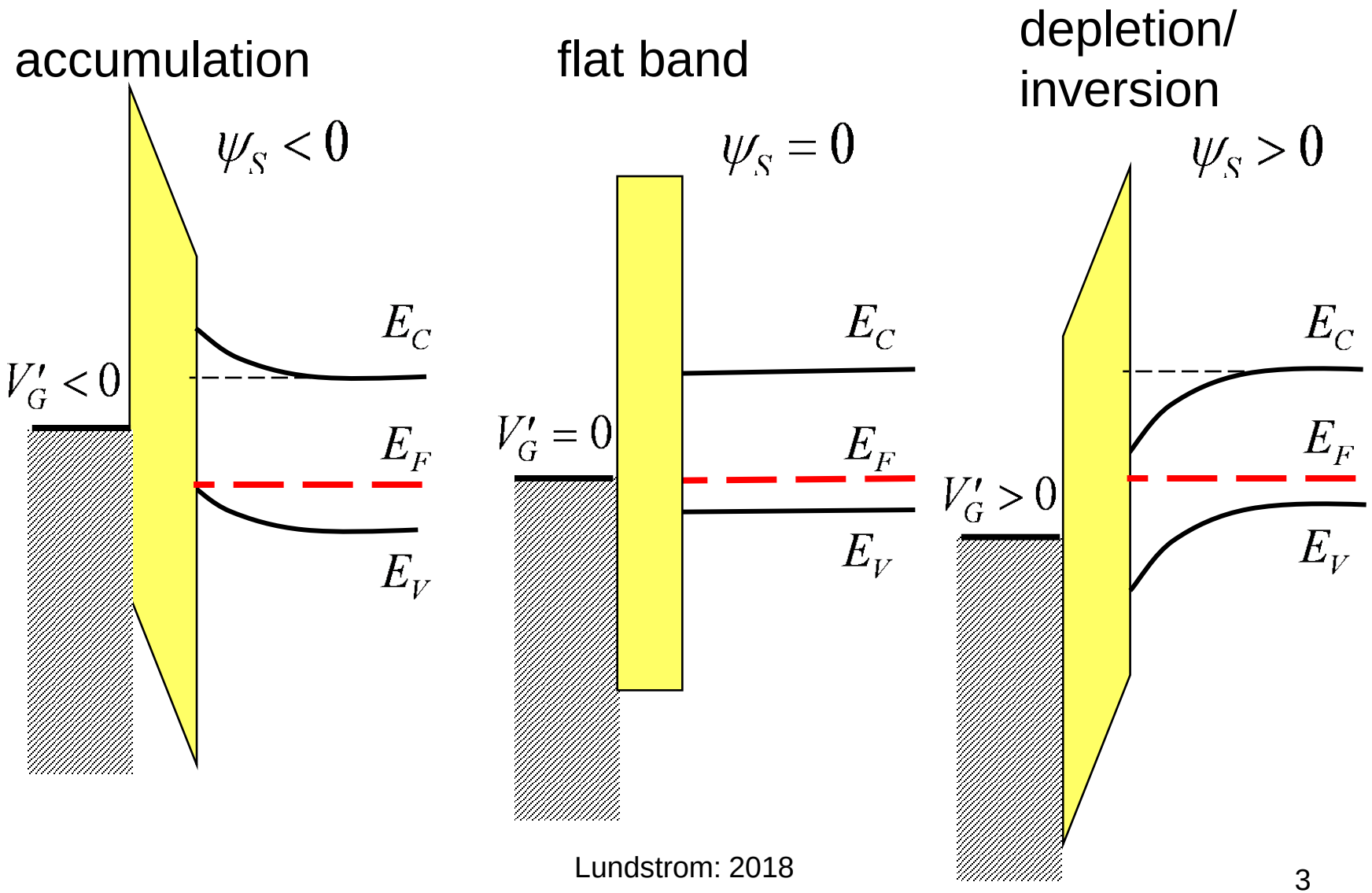
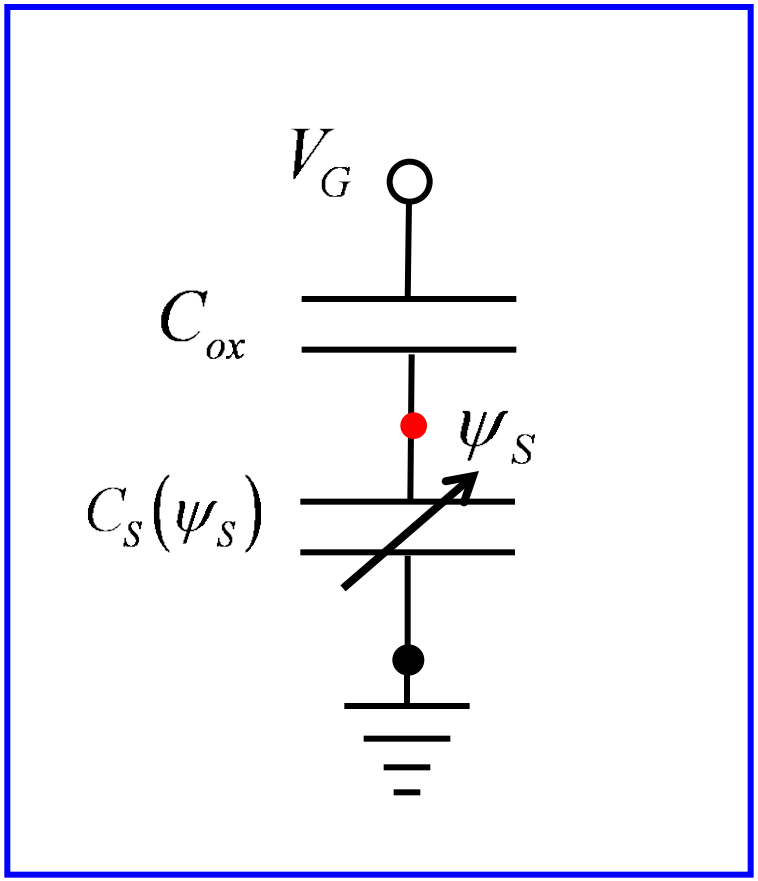
MOS capacitor



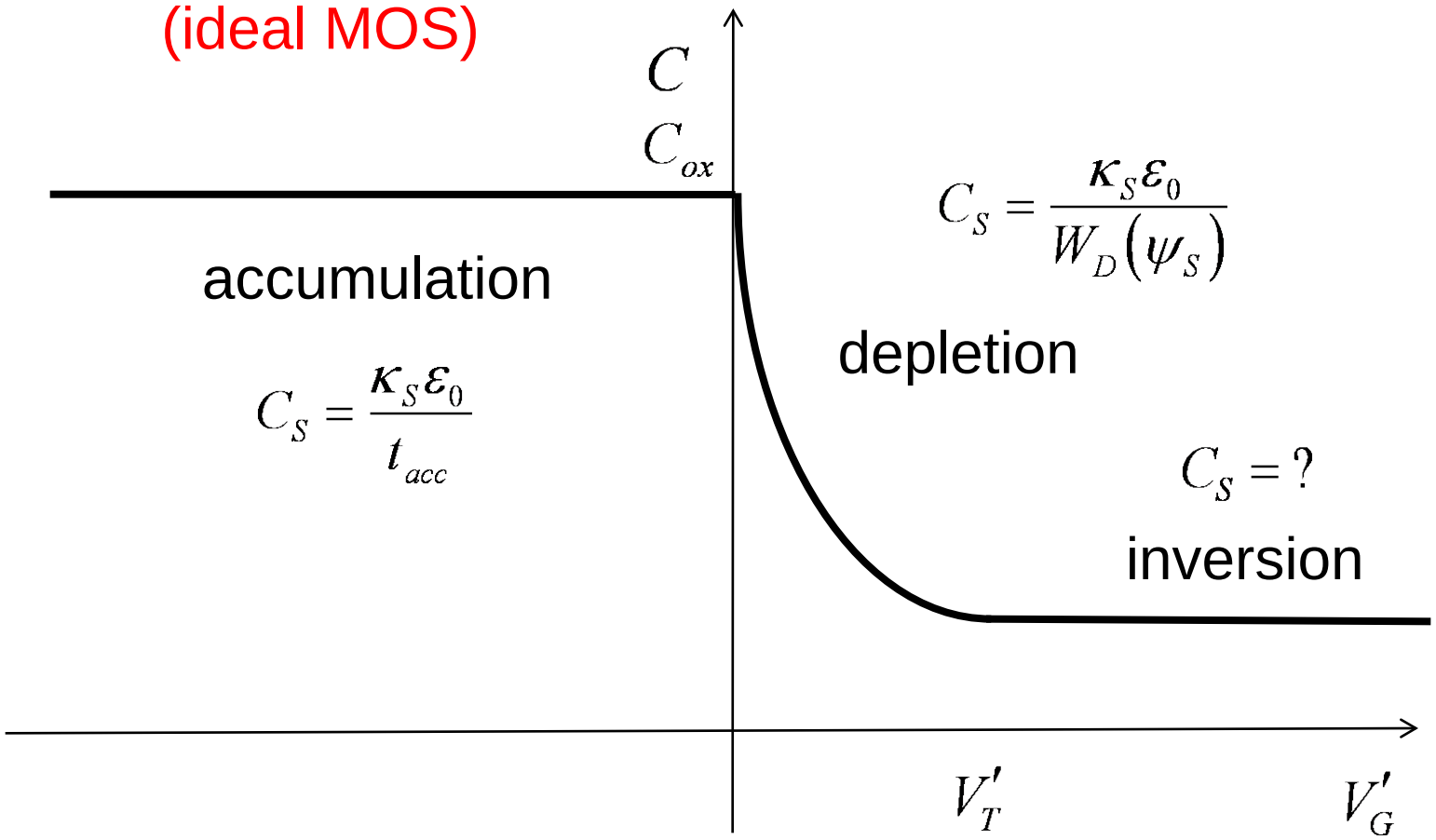
Effect of DC bias



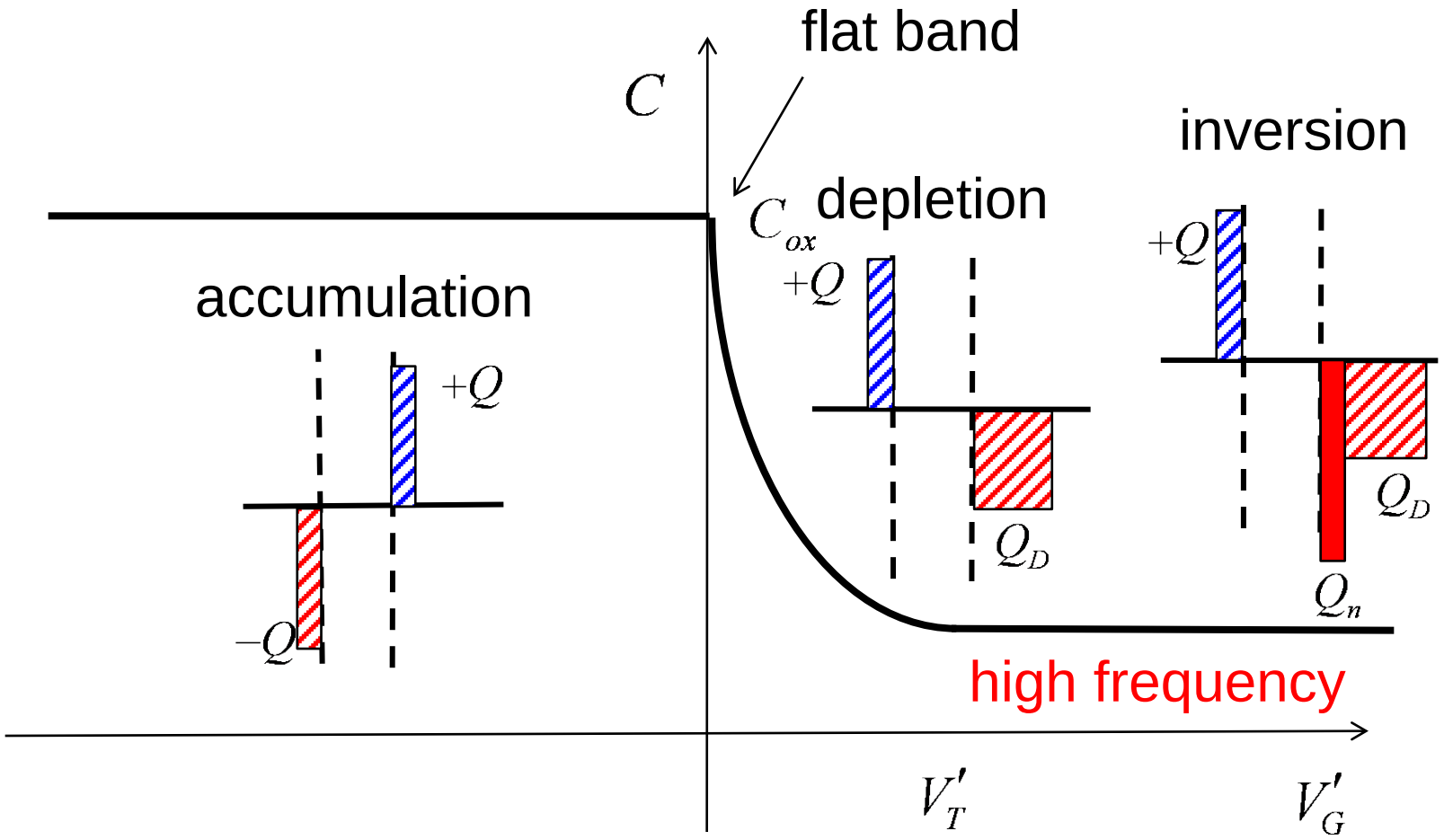
Two capacitors in series



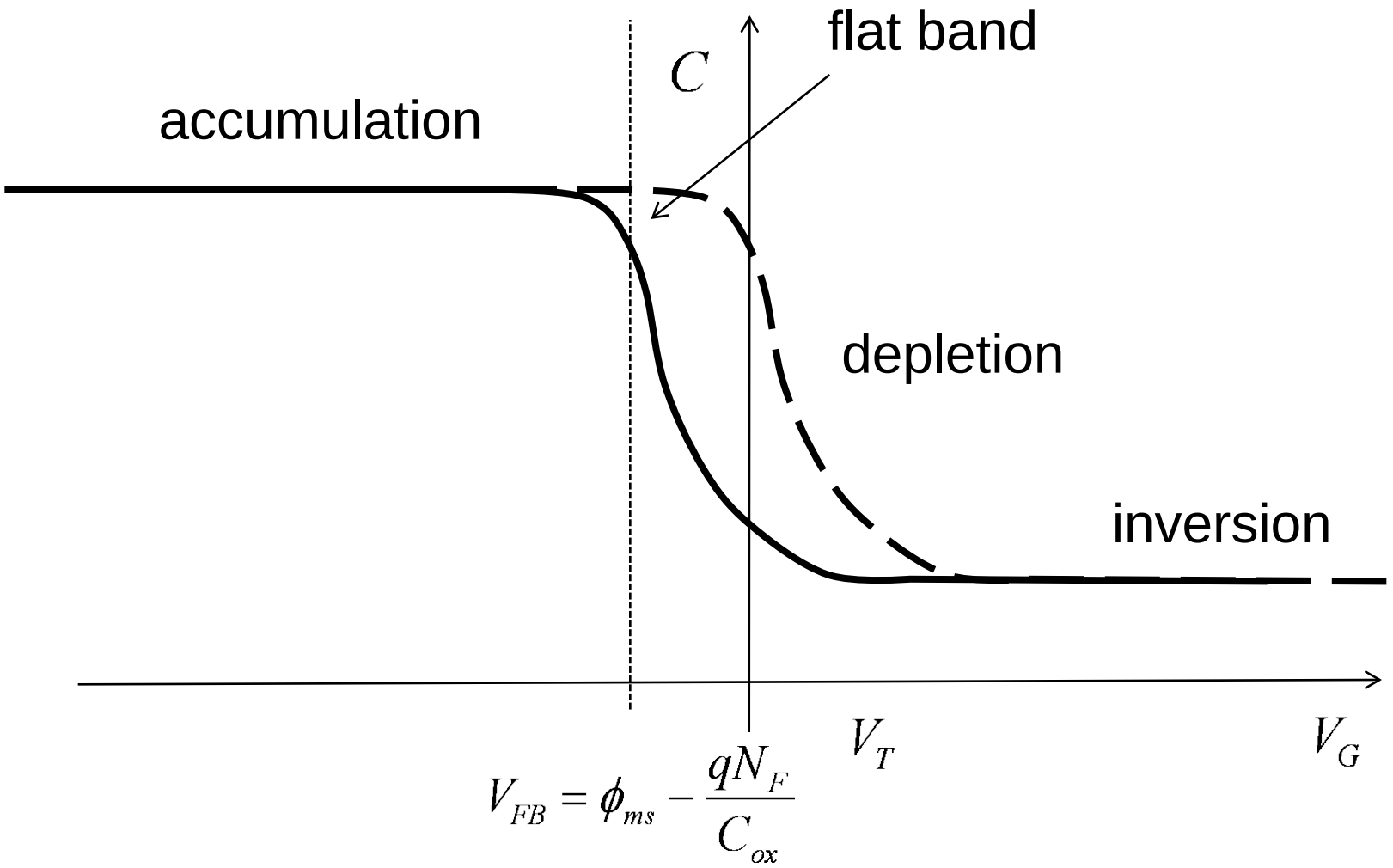
Small signal gate capacitance vs. d.c. gate bias



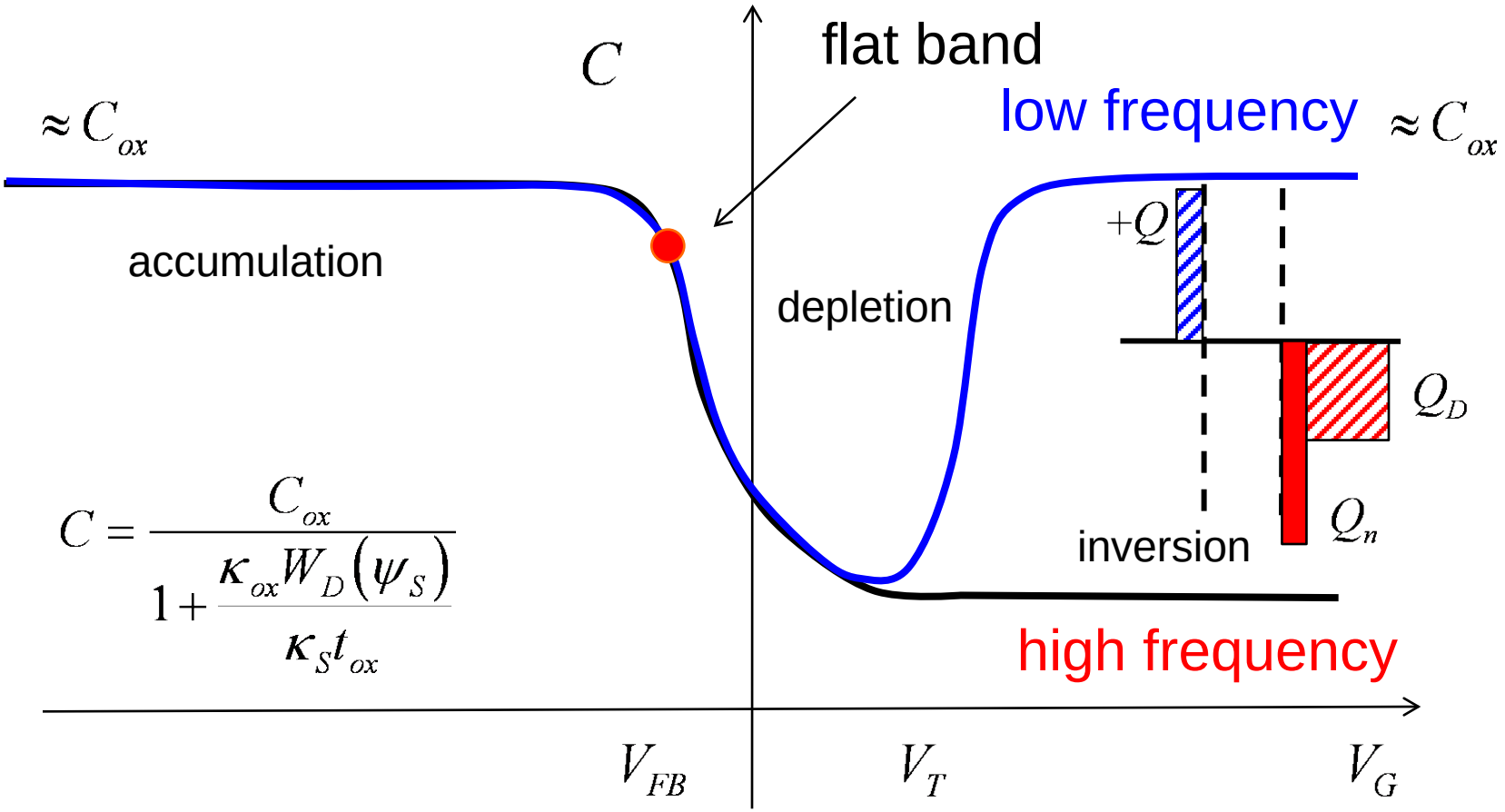
s.s. gate capacitance vs. d.c. gate bias



Realistic MOS CV / Critical voltages

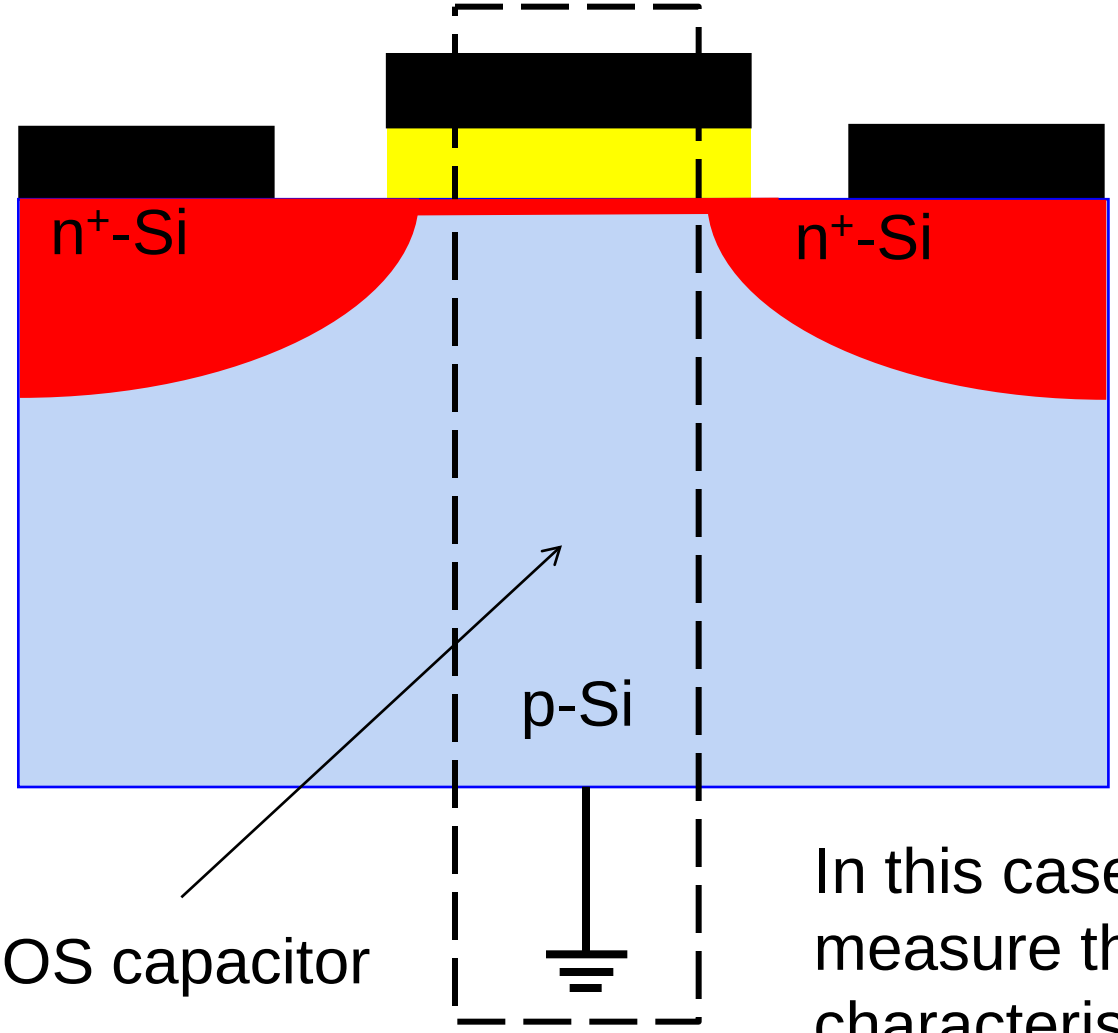


High frequency vs. low frequency CV



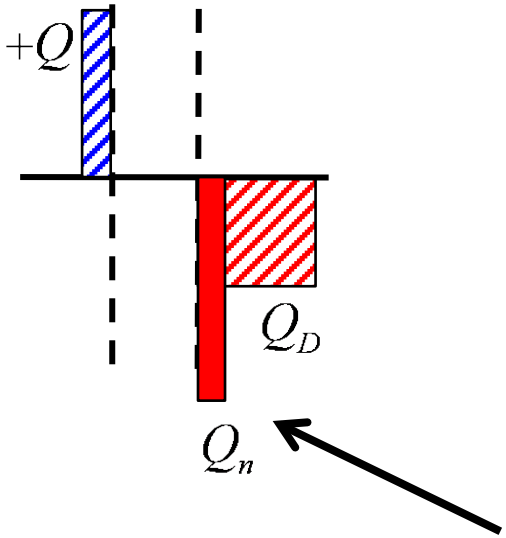
$$C = \frac{C_{ox}}{1 + \frac{\kappa_{ox} W_D(\psi_S)}{\kappa_S t_{ox}}}$$

HF vs. LF CV



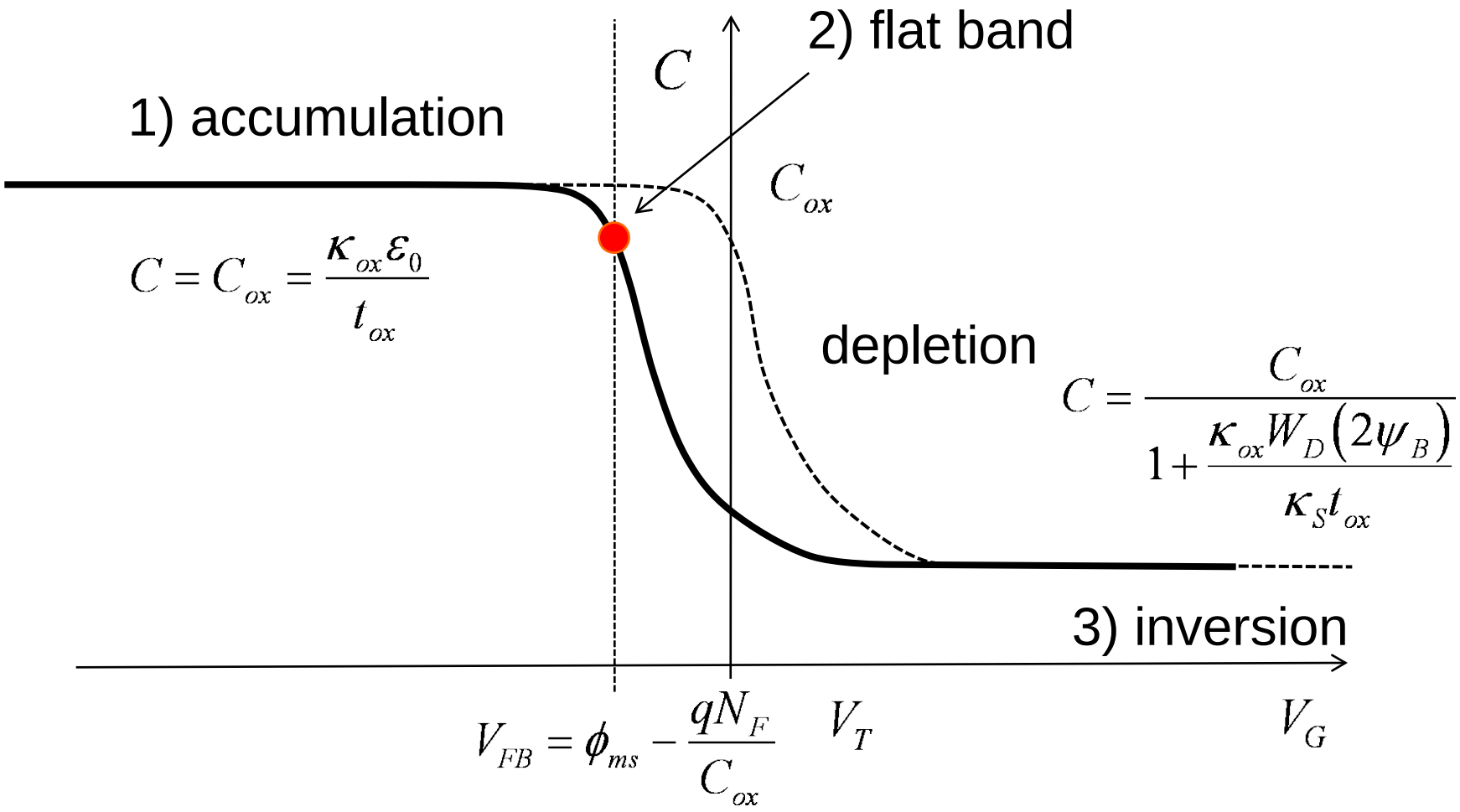
MOS capacitor

inversion



In this case, we will always measure the low frequency characteristic.

CV measurements as an analysis tool

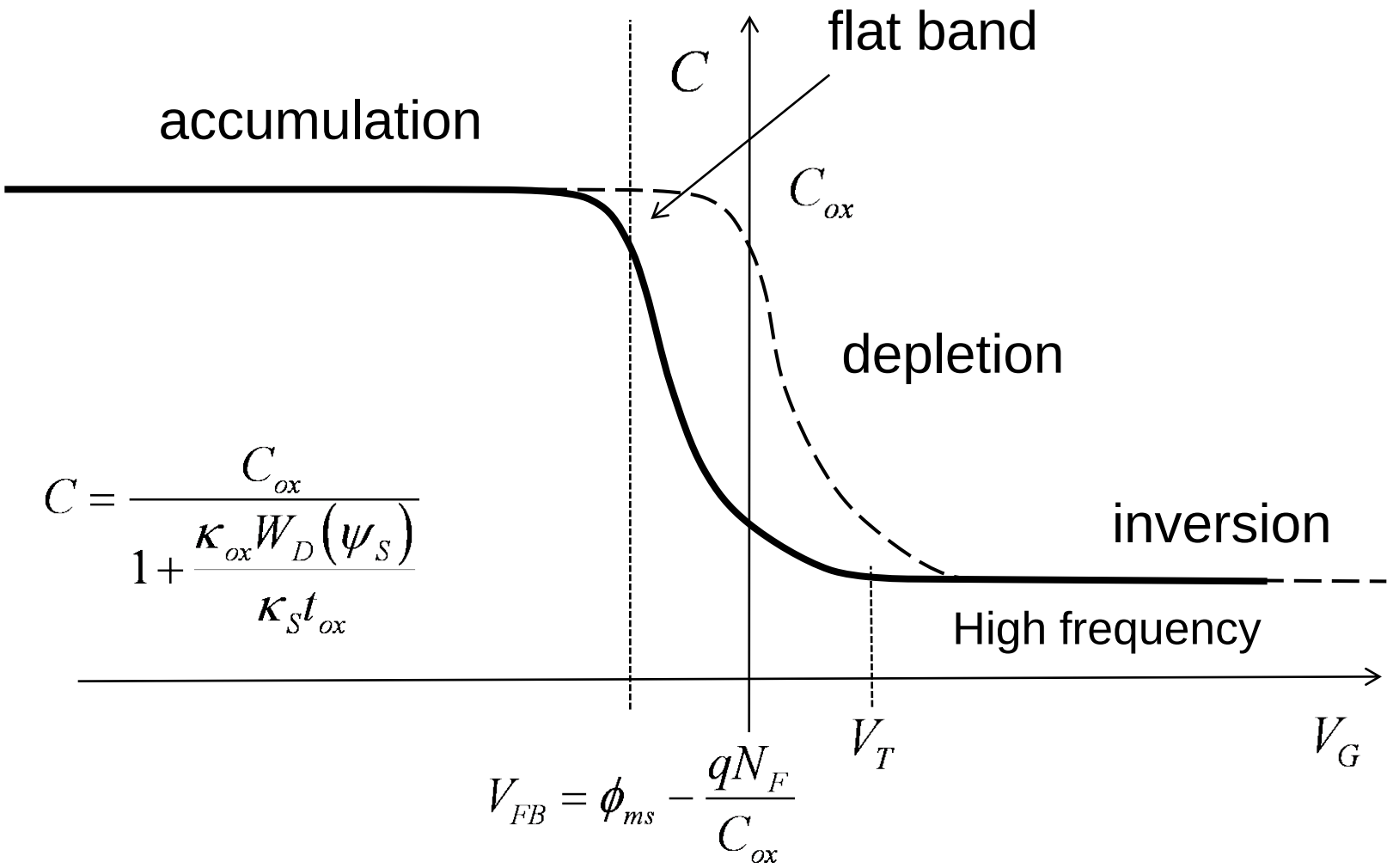


CV measurements as an analysis tool

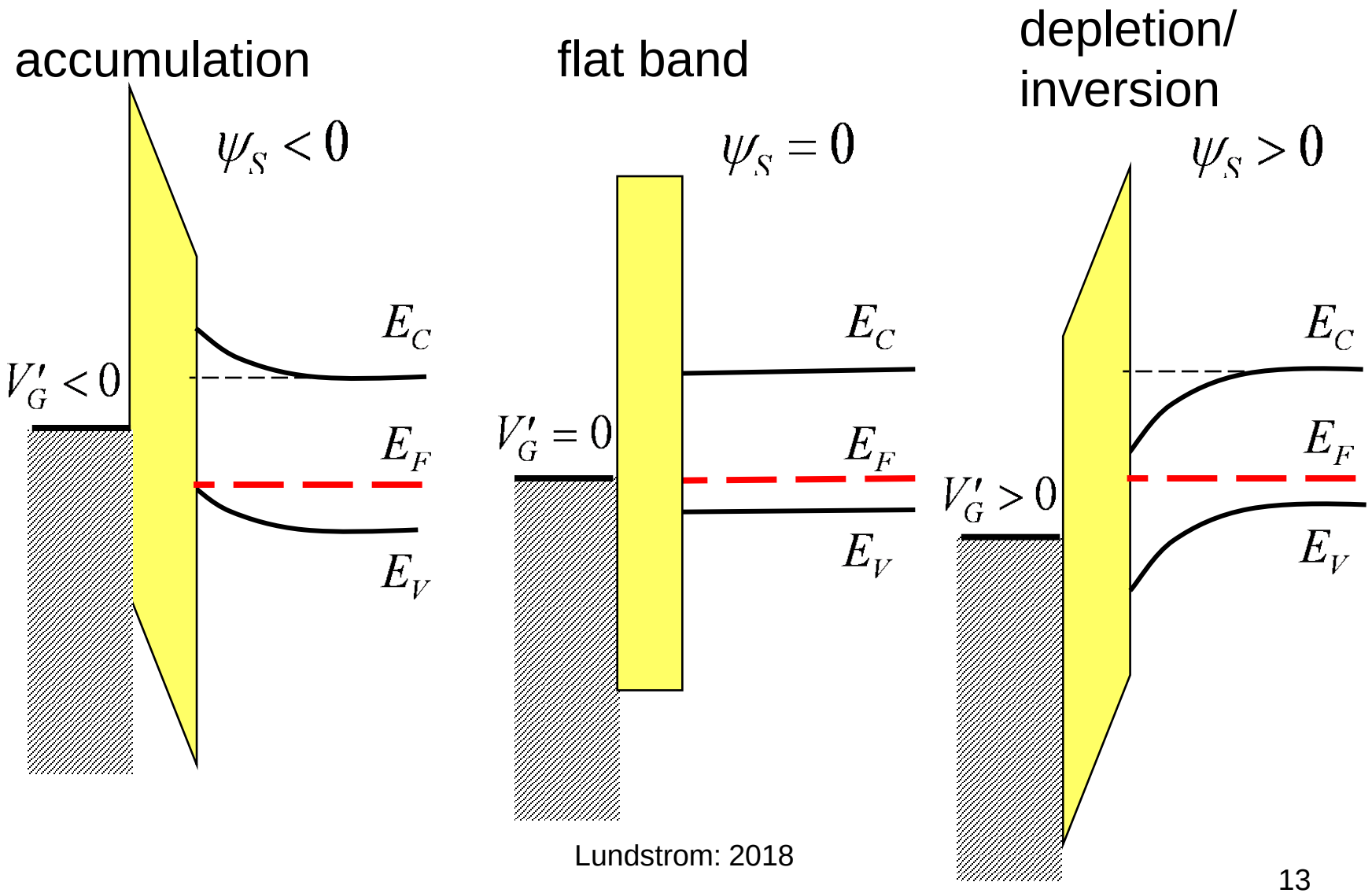
- Oxide thickness
- Flatband voltage
- Doping density

More advanced techniques can also probe various types of charges in the oxide and at the oxide/semiconductor interface.

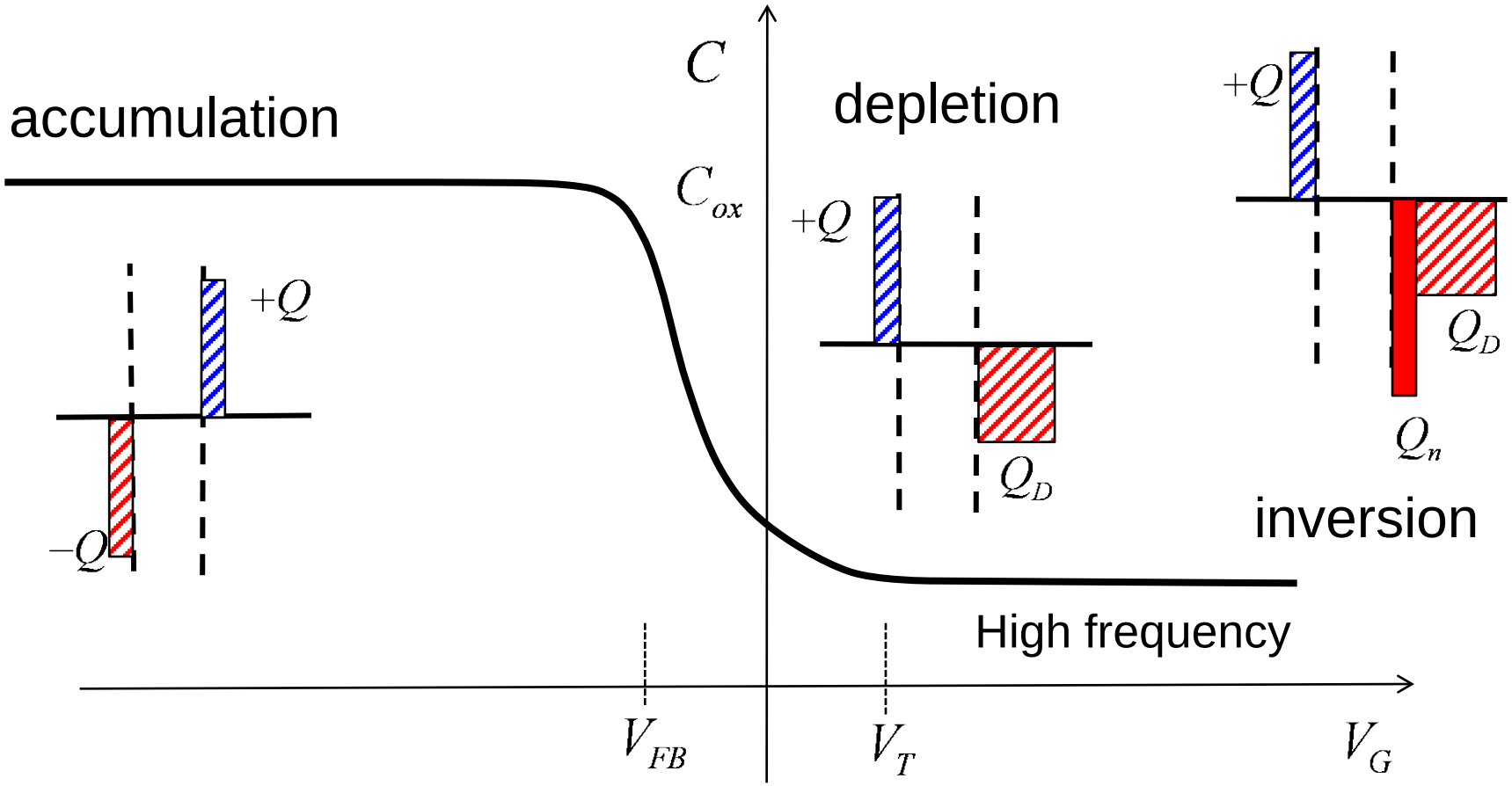
Summary (i)


flat band
C
accumulation
C_{ox}
depletion
$C = \frac{C_{ox}}{1 + \frac{\kappa_{ox} W_D(\psi_S)}{\kappa_S t_{ox}}}$
inversion
High frequency
V_T
V_G
$V_{FB} = \phi_{ms} - \frac{qN_F}{C_{ox}}$

Summary (ii)


accumulation
flat band
depletion/
inversion
$\psi_S < 0$
$\psi_S = 0$
$\psi_S > 0$
$V_G' < 0$
$V_G' = 0$
$V_G' > 0$
E_C
E_F
E_V

Summary (iii)


accumulation
C
depletion
C_{ox}
+Q
Q_D
+Q
Q_D
Q_n
inversion
+Q
−Q
High frequency
V_{FB}
V_T
V_G

Next topic

The mobile charge (the electron or holes in the inversion layer) carries the current in a device.

Our goal in the next lecture is to understand how the mobile charge varies with surface potential and gate voltage.

$$Q_n(\psi_S) \qquad\qquad Q_n(V_G)$$