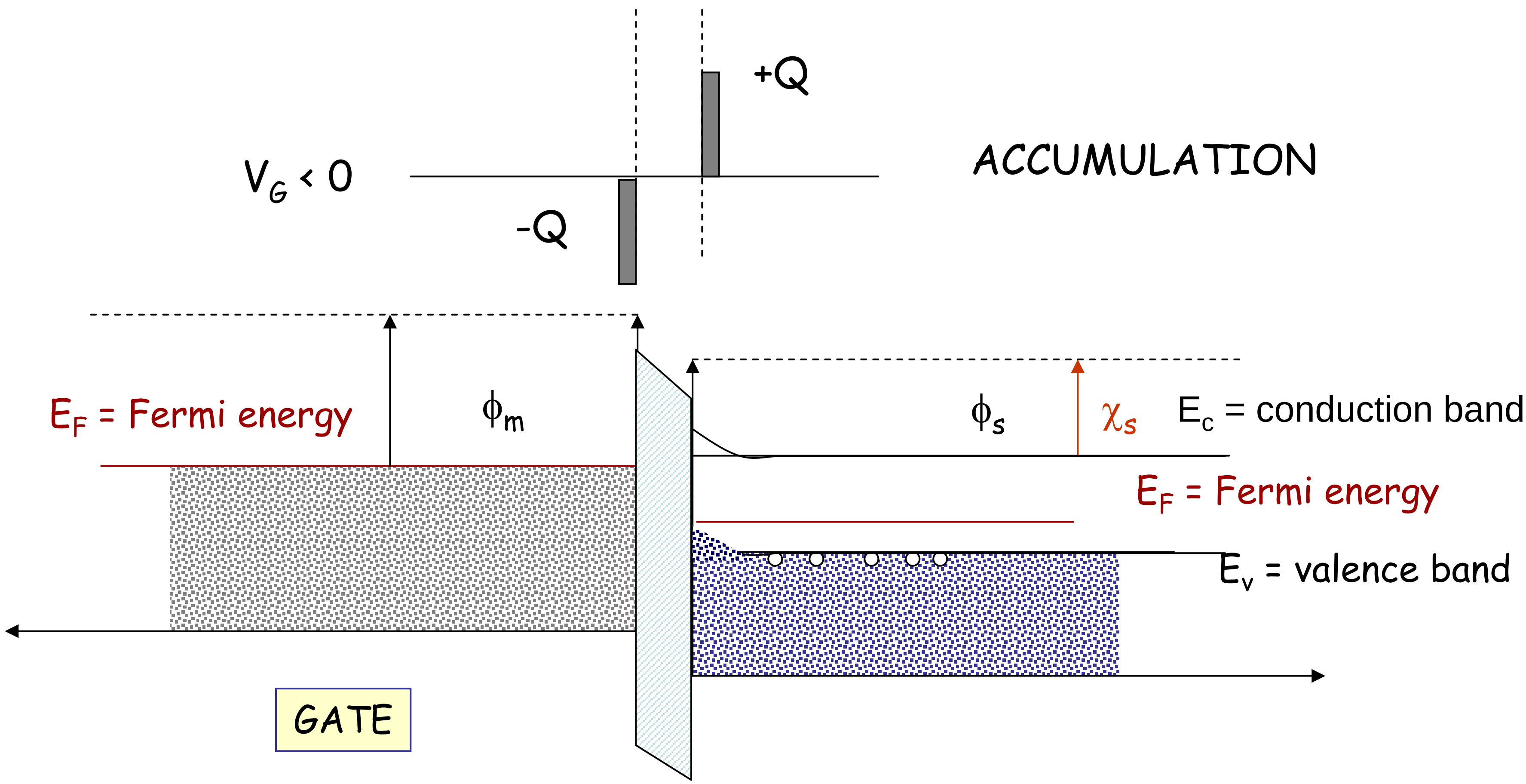
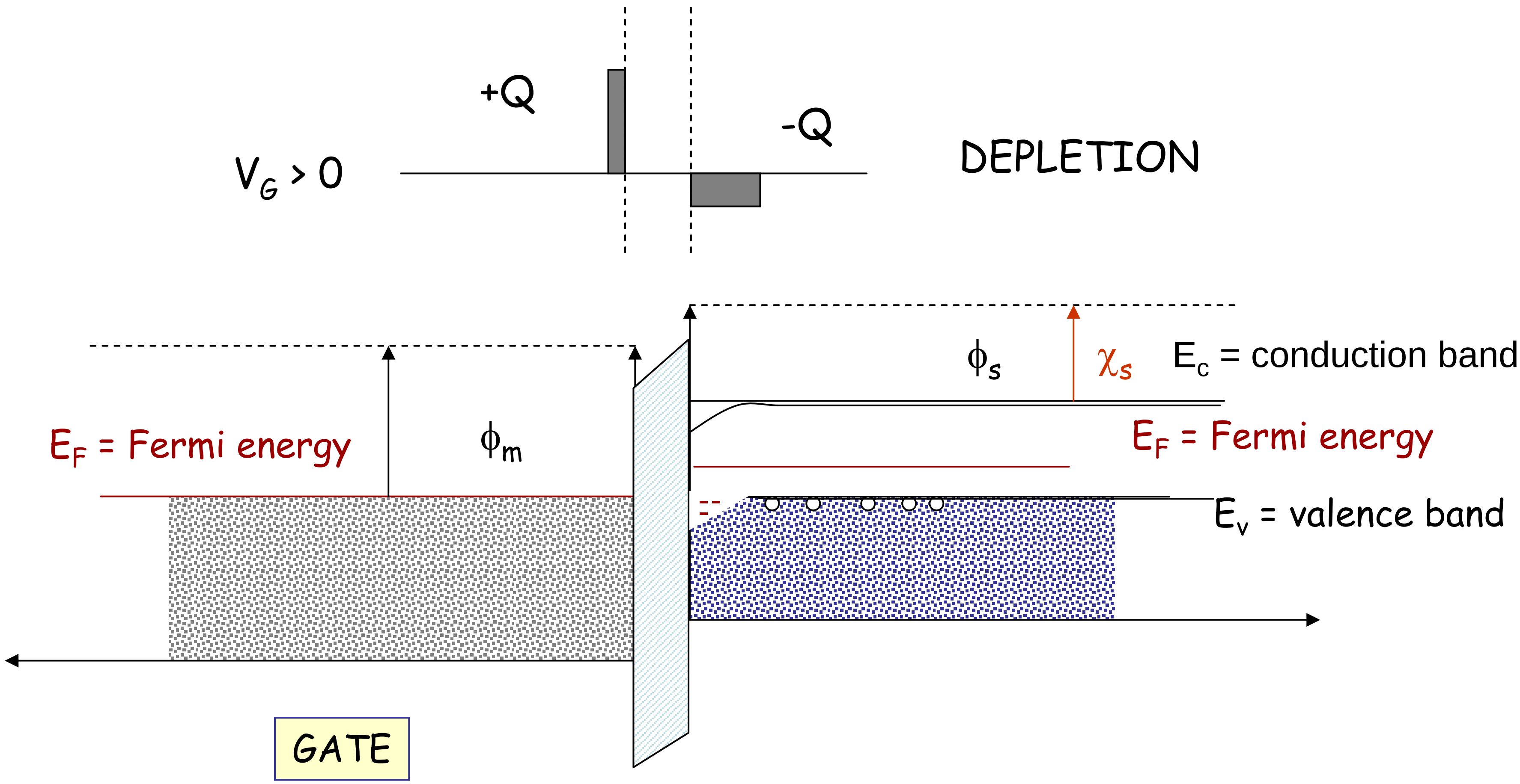
CHANGING RELATIVE VOLTAGES

Gate voltage NEGATIVE relative to semiconductor



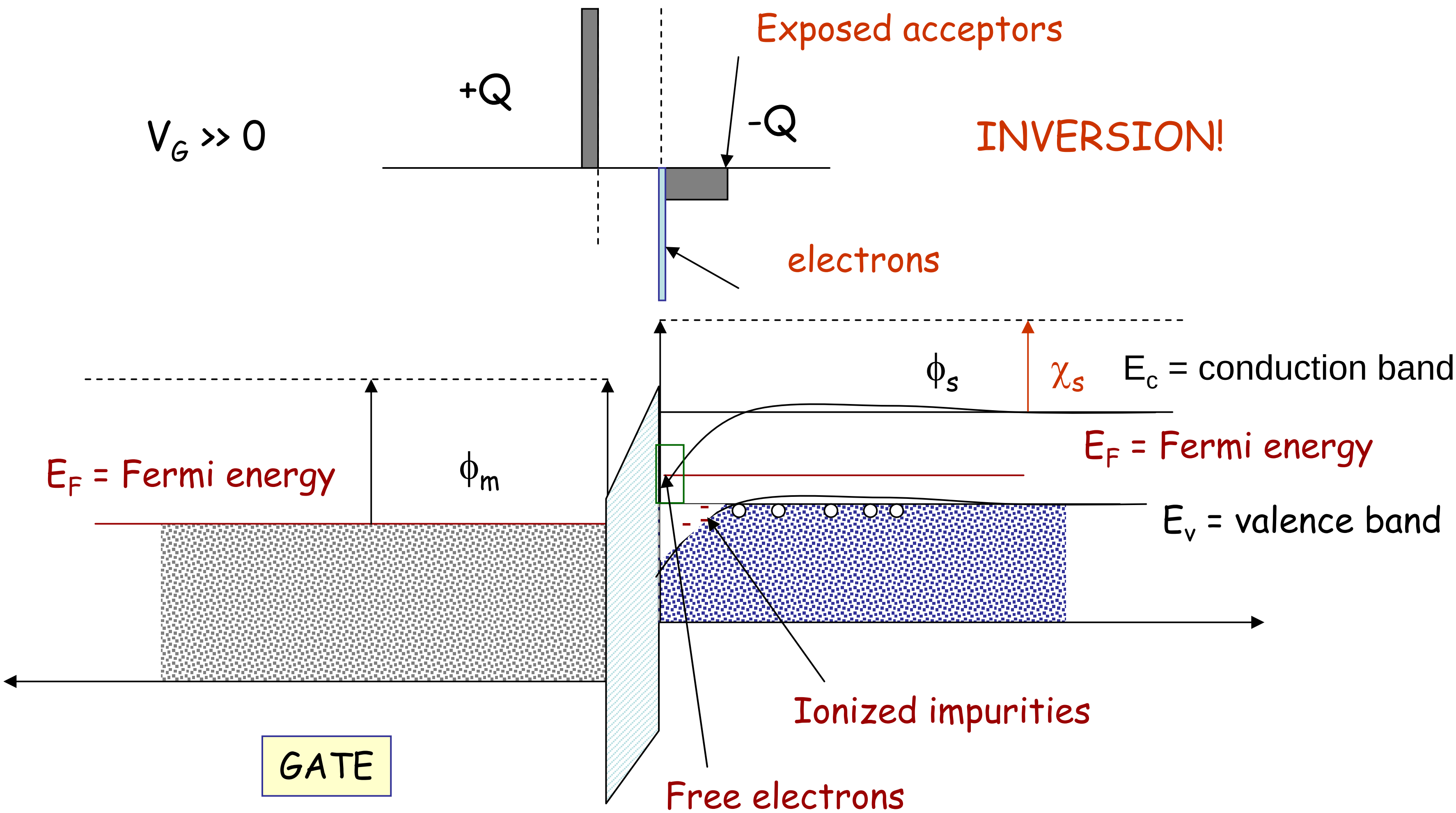
CHANGING RELATIVE VOLTAGES

Gate voltage POSITIVE relative to semiconductor



CHANGING RELATIVE VOLTAGES

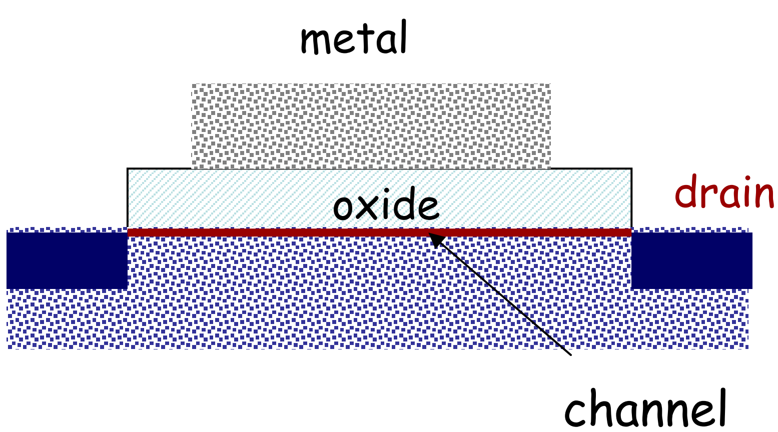
Gate voltage MUCH MORE POSITIVE than semiconductor



Voltage modulation of charge (current)

- Vg < 0 ACCUMULATION
- Vg > 0 DEPLETION
- Vg >> 0 INVERSION

Free carriers
Fixed charge
Free carriers



What can CAPACITANCE measurements tell us about the material structure and the interfaces?

Change of capacitance with voltage

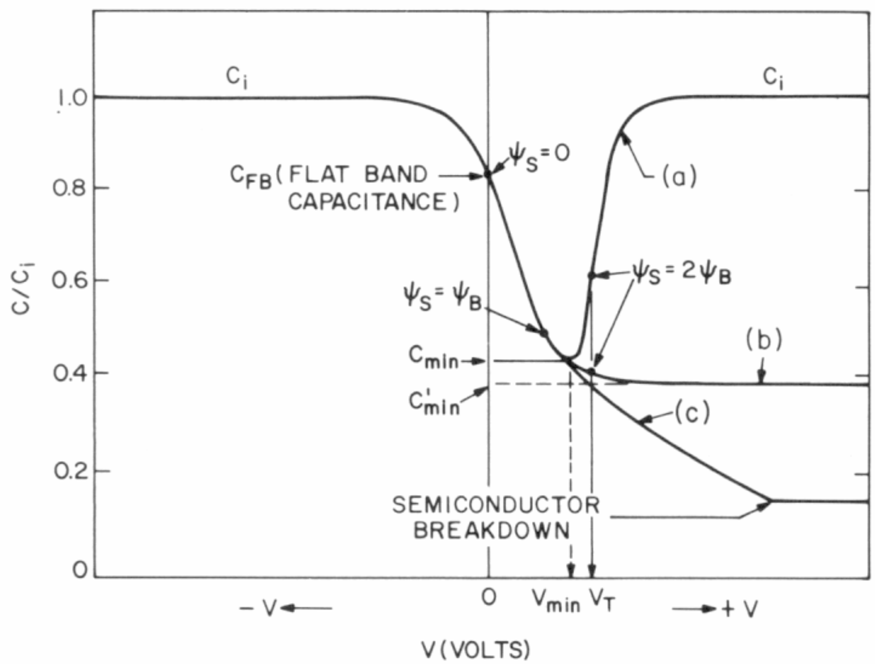


Fig. 7 MIS capacitance–voltage curves. (*a*) Low frequency. (*b*) High frequency. (*c*) Deep depletion. (After Grove et al., Ref. 16.)

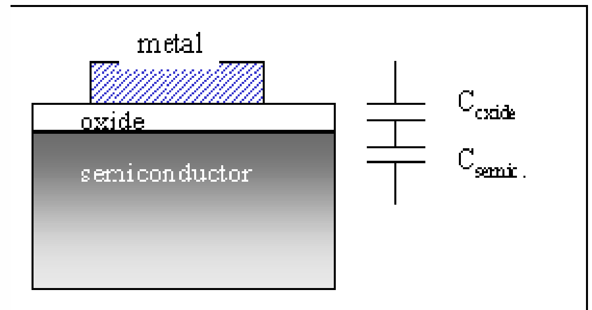


Figure 4. MOS capacitors.

- By sweeping voltage from positive to negative values, semiconductor surface goes through inversion, depletion, accumulation
- Voltage-tunable capacitance, as the depletion layer width changes

The CV can give insight about the values of oxide thickness, semiconductor doping…

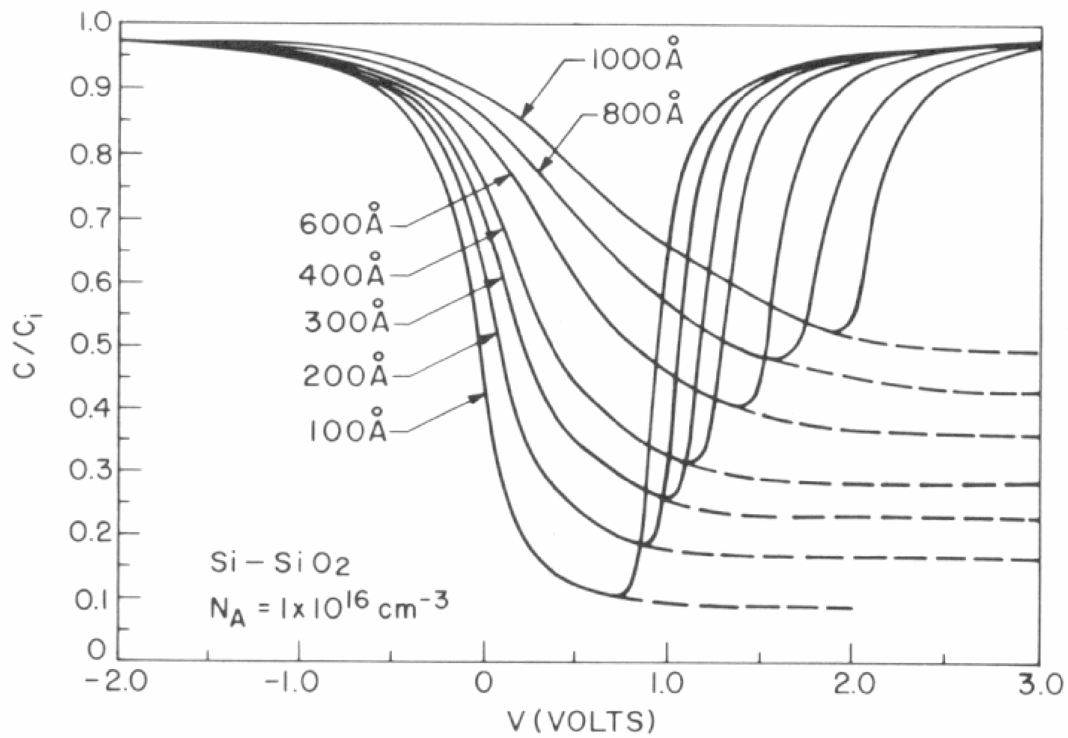


Fig. 10 Ideal MIS *C–V* curve. Solid lines for low frequencies. Dashed lines for high frequencies. (After Goetzberger, Ref. 18.)

Impurities in Oxides

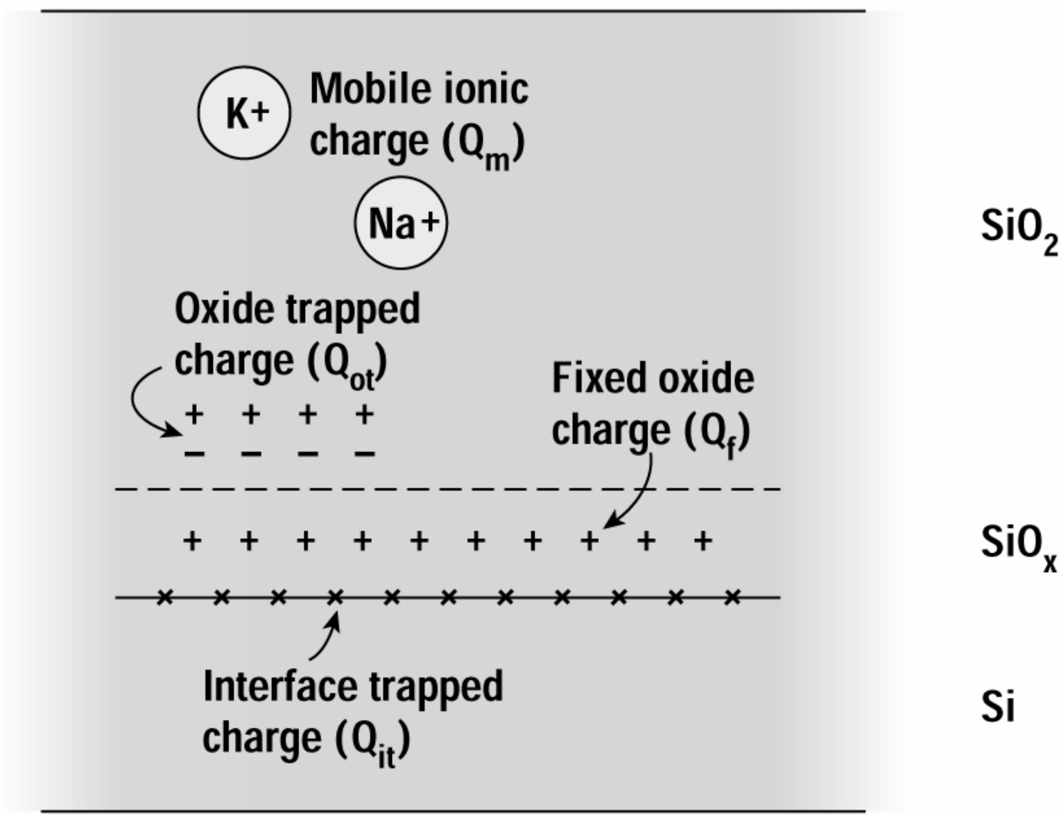


Figure 4.14 Silicon–silicon dioxide structure with mobile, fixed charge, and interface states *(© 1980, IEEE, after Deal)*.

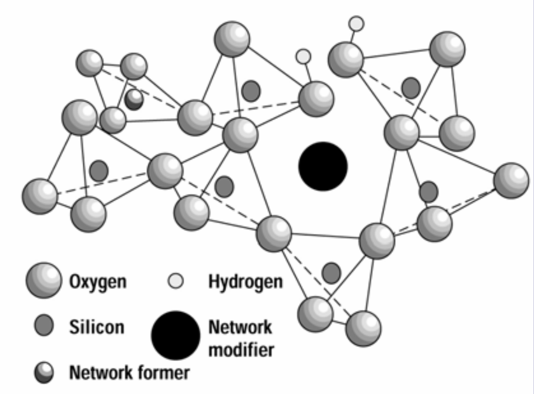


Figure 4.8 Schematic of impurities and imperfections in SiO_2.

What affect do DEFECTS
in the oxides have on CAPACITANCE?

CV can diagnose faults in the MOS structure

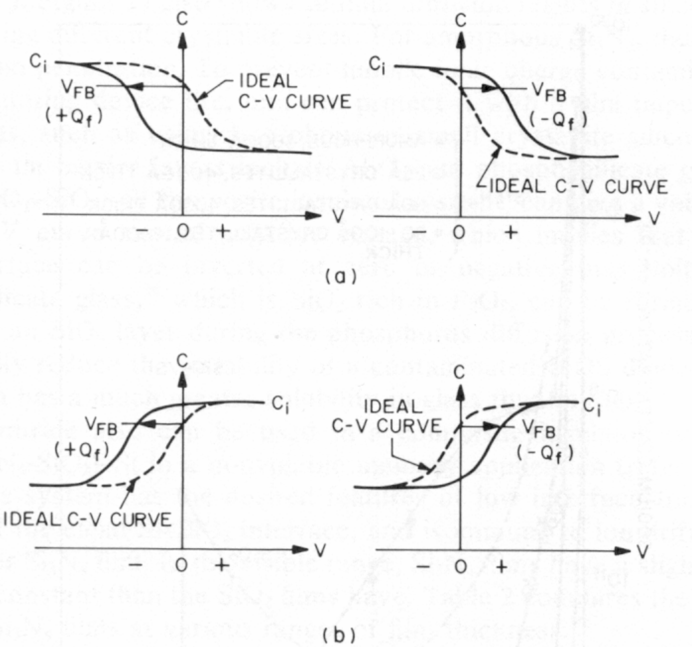


Fig. 23 *C–V* curve shift along the voltage axis due to positive or negative fixed oxide charge. (*a*) For *p*-type semiconductor. (*b*) For *n*-type semiconductor. (After Nicollian and Brews, Ref. 7.)

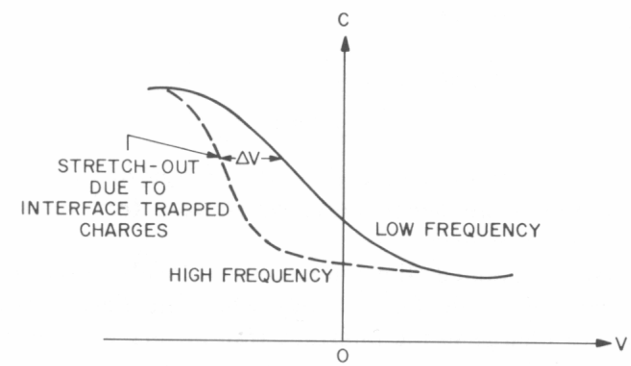


Fig. 17 Capacitance stretch-out due to interface trapped charges.

Shift -> fixed charge

Distortion of shape, and frequency
Dependence -> traps & mobile charge

Single Electron Transistor