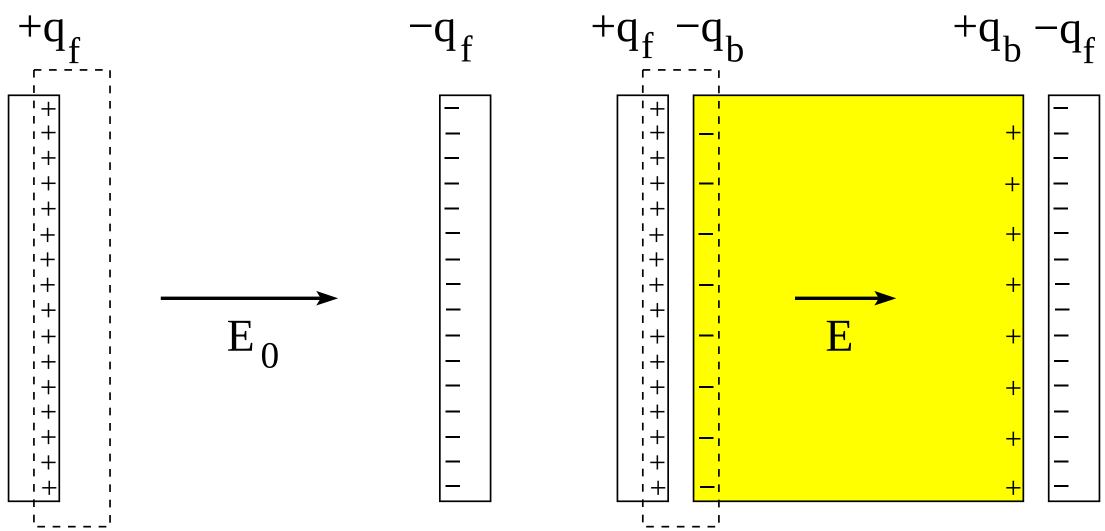
Parallel-Plate Capacitor with Dielectric (1)

The polarization produces a bound charge on the surface of the dielectric.

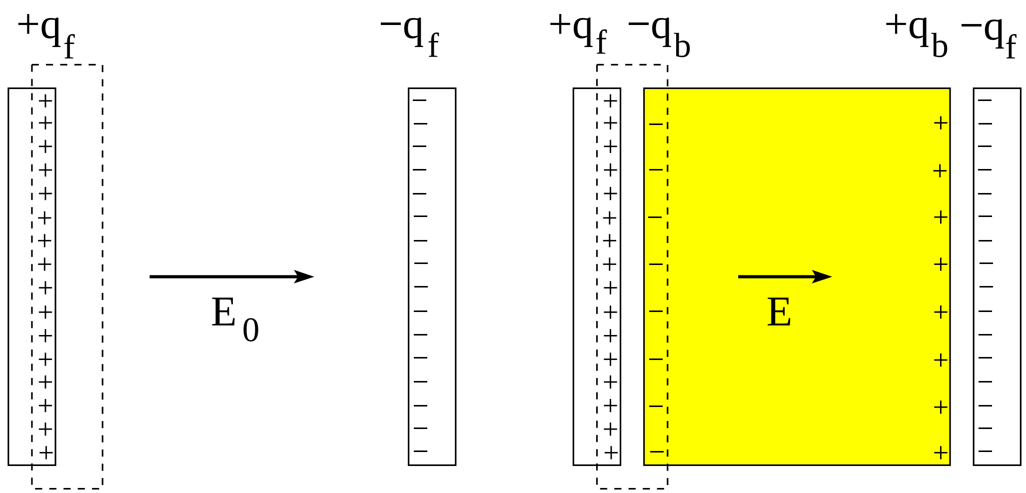


The bound surface charge has the effect of reducing the electric field between the plates from $\vec{E}_0$ to $\vec{E}$.

- A: area of plates
- d: separation between plates
- $\pm q_f$: free charge on plate
- $\pm q_b$: bound charge on surface of dielectric
- $\vec{E}_0$: electric field in vacuum
- $\vec{E}$: electric field in dielectric

Parallel-Plate Capacitor with Dielectric (2)

Use Gauss' law to determine the electric fields $\vec{E}_0$ and $\vec{E}$.



- Field in vacuum: $E_0 A = \dfrac{q_f}{\epsilon_0} \quad \Rightarrow \quad E_0 = \dfrac{q_f}{\epsilon_0 A}$
- Field in dielectric: $EA = \dfrac{q_f - q_b}{\epsilon_0} \quad \Rightarrow \quad E = \dfrac{q_f - q_b}{\epsilon_0 A} < E_0$
- Voltage: $V_0 = E_0 d$ (vacuum), $V = Ed = \dfrac{V_0}{\kappa} < V_0$ (dielectric)

Dielectric constant: $\kappa \equiv \dfrac{E_0}{E} = \dfrac{q_f}{q_f - q_b} > 1.$ Permittivity of dielectric: $\epsilon = \kappa\epsilon_0$.