From *Semiconductor Physics and Devices: Basic Principles* (4th Edition), Donald A. Neamen, McGraw Hill, 2012, ISBN 978-0-07-352958-5.

p type ~~metal~~(deg.-doped polysilicon)-oxide-semiconductor (MOS)

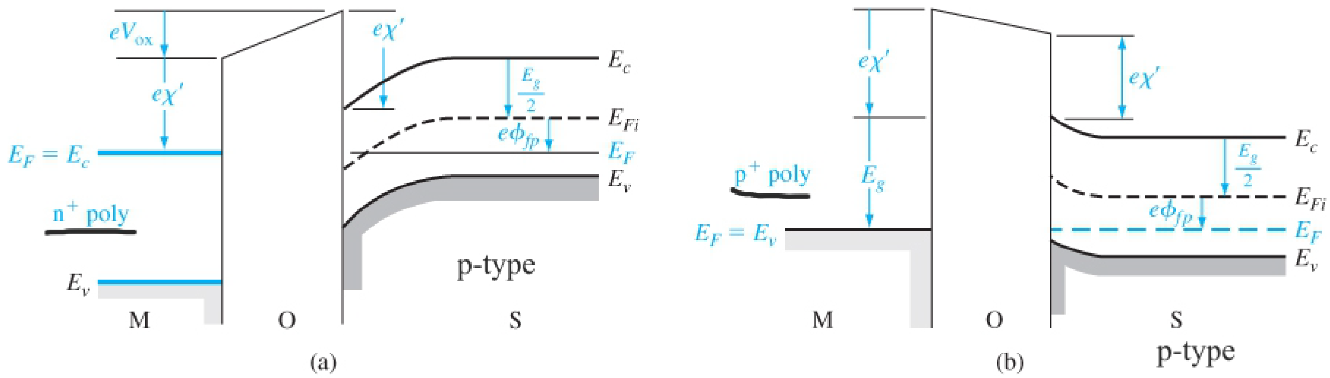

Figure 10.14 | Energy-band diagram through the MOS structure with a p-type substrate at zero gate bias for (a) an n^+ polysilicon gate and (b) a p^+ polysilicon gate.

- No metal work functions!
- For n+ poly, we get $\phi_{ms} = -(E_g/2e + \phi_{fp})$.
- For p^+ poly, we get $\phi_{ms} = E_g/2e - \phi_{fp}$.

n type semiconductor substrate MOS, system

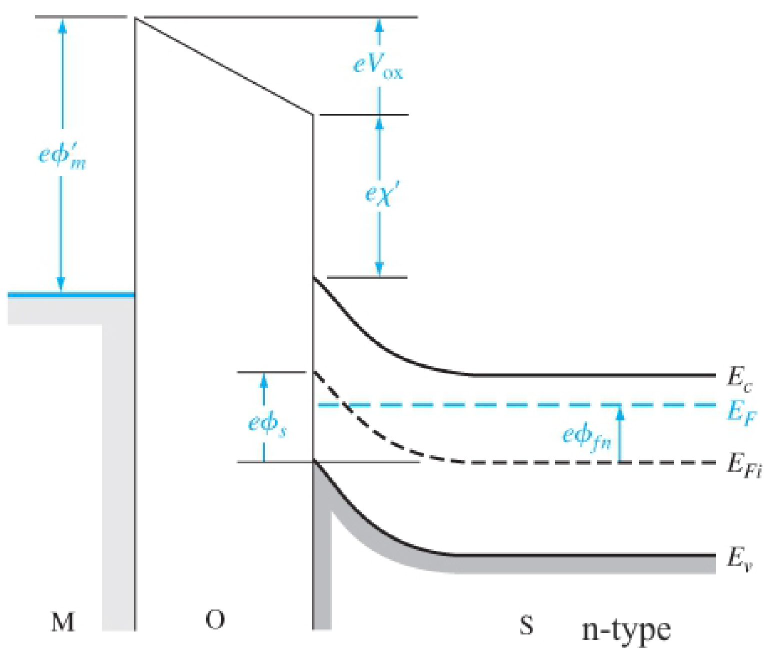

Figure 10.15 | Energy-band diagram through the MOS structure with an n-type substrate for a negative applied gate bias.

- Here, a negative voltage is applied to gate to get inversion.
- The metal-semiconductor work function is $\phi_{ms} = \phi'_m - (\chi' + E_g/2e - \phi_{fn})$.

Metal-Semiconductor work function for various material and doping

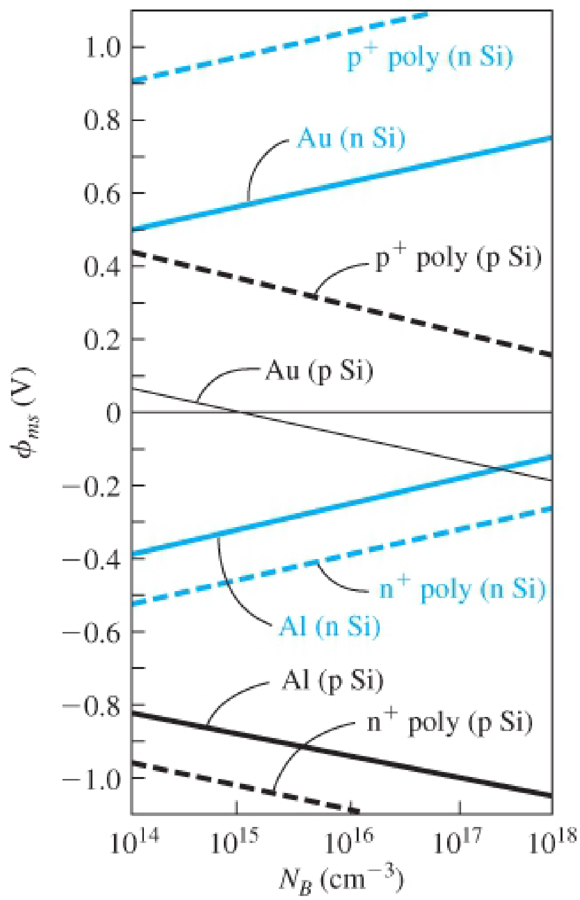

Figure 10.16 | Metal–semiconductor work function difference versus doping for aluminum, gold, and n⁻ and p⁻ polysilicon gates. *(From Sze [17] and Werner [20].)*

- Note, for p-type substrates, ϕ_{ms} decreases with increasing substrate doping concentrations.
- Note, for n-type substrates, ϕ_{ms} increases with increasing substrate doping concentrations.
- ϕ_{ms} is lower (compared to metals) with degenerately-doped n^+ polysilicon used in place of metal.
- ϕ_{ms} is higher (compared to metals) with degenerately-doped p^+ polysilicon used in place of metal.