Transparent conductors: Materials

In_2O_3, ZnO, CdO, SnO_2

- **Wide-band-gap semiconductors:** optical gap **3.4 – 3.7 eV**
- **Small electron effective mass:** **$m^* = 0.23 – 0.35\ m_e$**
- **Must be degenerately doped:** shallow donors ⇒ σ = **$10^3 – 10^4$ S/cm**

Challenges/Questions:

i. Trade-off between conductivity and transparency
   - Carrier concentration ↔ optical absorption
   - Shallow donors ↔ large band gap

$$\sigma = ne\mu$$
$$\mu = e\tau/m^*$$

ii. Need controllable properties
   - By chemical composition in multicomponent oxides
   - By carrier generation (concentration vs mobility)
   - By crystal structure (oxygen coordination)

iii. Amorphous transparent (semi)conducting oxides:
   How carrier generation/transport is affected?

iv. Metallic $Ca_{12}Al_{14}O_{33}$ (observed σ=1700 S/cm):
   What is different with classical insulators CaO, Al_2O_3?