

Transparent conductors: Electron effective mass

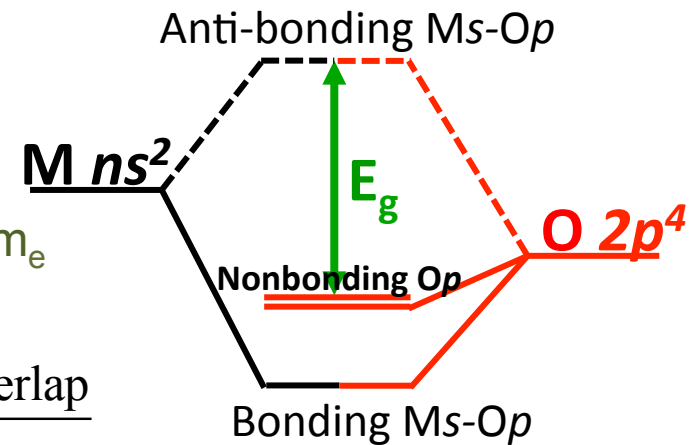
Strong (Metal)s — (Oxygen)p interactions

- Ms-Op network for charge transport
- Small electron effective mass:

CdO $0.23 m_e$, In_2O_3 $0.28 m_e$, SnO_2 $0.31 m_e$, ZnO $0.35 m_e$

From k-p theory:

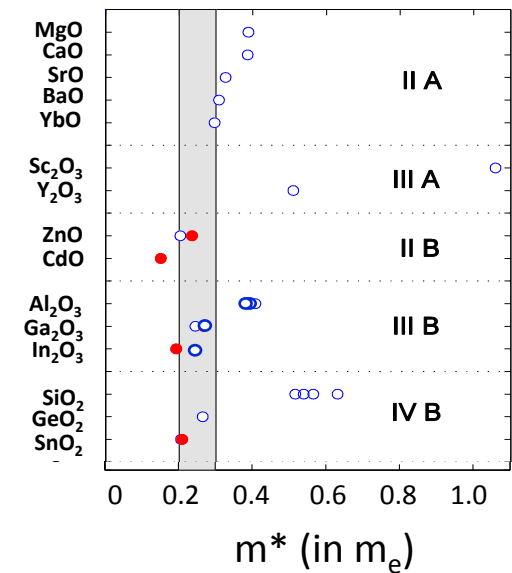
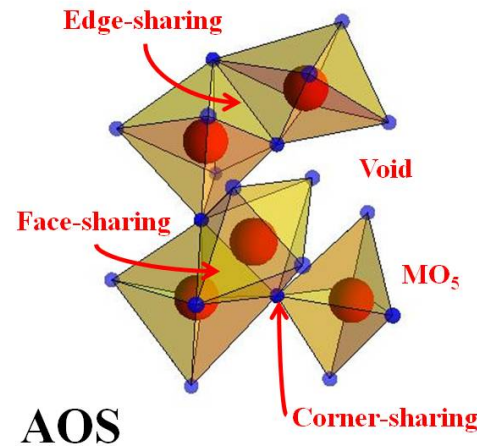
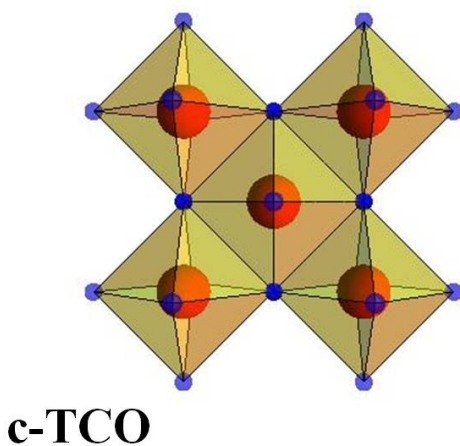
$$\frac{m_e}{m^*} = 1 + \frac{2}{m_e} \sum \frac{|\langle u^c | \hat{p}_i | u^v \rangle|^2}{E^{\text{conduction}} - E^{\text{valence}}} = 1 + \frac{\text{Ms-Op overlap}}{E_g}$$



Larger Ms-Op overlap \Rightarrow smaller mass

Smaller band gap \Rightarrow smaller mass

- m^* – isotropic and insensitive to structural variations



- m^* alone cannot explain differences in transport properties of oxides