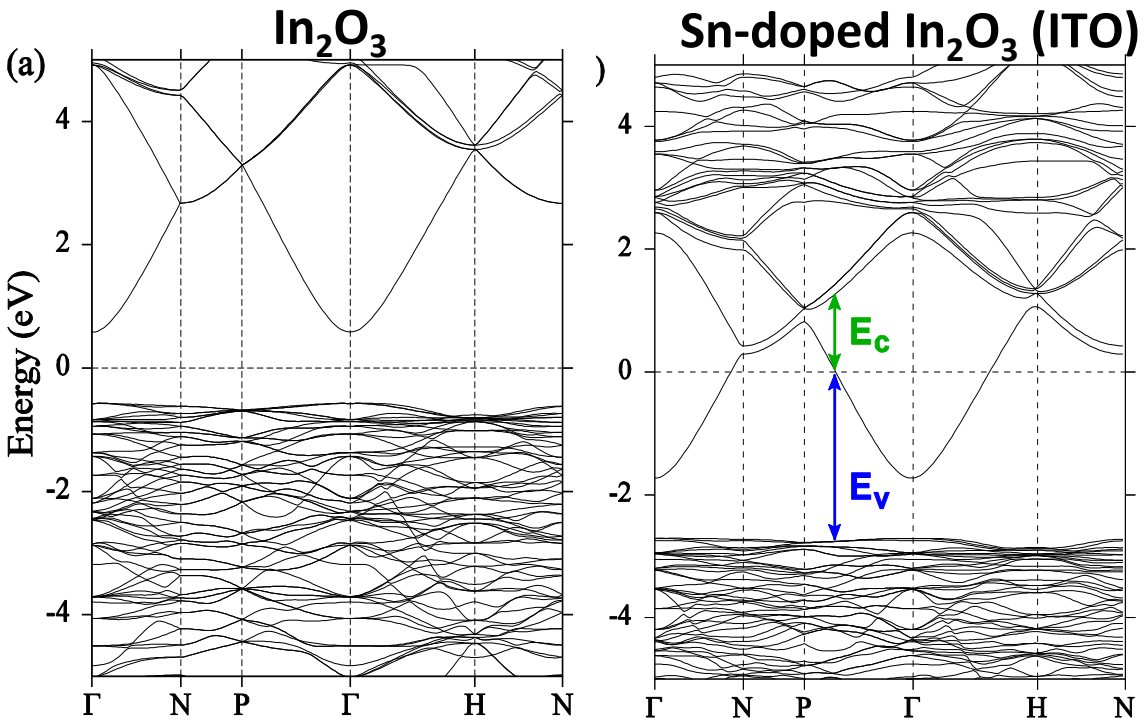
Trade-off between transparency and conductivity



Optical absorption:

Short wavelength region

- Intense transitions from valence band up to Fermi level
- Low-intensity transitions from the Fermi level up to the next empty bands

Long wavelength region

- Low-intensity intra-band transitions
- Plasma oscillations will lead to reflection of the frequencies below that of plasmon

Large carrier concentration desired for better conductivity, increases optical absorption

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

Solutions:

Enhance carrier mobility not concentration

- increase relaxation time by spatially separating carrier donors and carrier paths
- choose materials with low electron effective mass

J. Medvedeva, Phys. Rev. Letters (2006); Europhysics Letters (2007)