

# Transparent conductors: Carrier generation

- **Neutral oxygen vacancy corresponds to a non-conductive state** (deep defect band is fully occupied by the vacancy-induced  $2e^-$  which are localized at the defect)
- **Optical excitation**  $V_o^0 \rightarrow V_o^+ + e^-$  (or  $V_o^x \rightarrow V_o^\bullet + e'$ ) **leads to a metastable conductive state**
- $V_o^+$  (or  $V_o^\bullet$ ) is shallow for  $\text{In}_2\text{O}_3$  and  $\text{ZnO}$

	$\text{In}_2\text{O}_3$	$\text{ZnO}$	$\text{Ga}_2\text{O}_3$
Energy of $V_o^0 \rightarrow V_o^+ + e^-$ , eV	1.63	2.35	2.90
= Wavelength, nm	760	530	428
Location of $V_o^+$ below CBM, eV	0.48	0.19	0.92

- **Substitutional doping (e.g.,  $\text{In}_2\text{O}_3:\text{Sn}^{4+}$ ) is better alternative**

Lower formation energy, less scattering, larger mobility, low absorption

