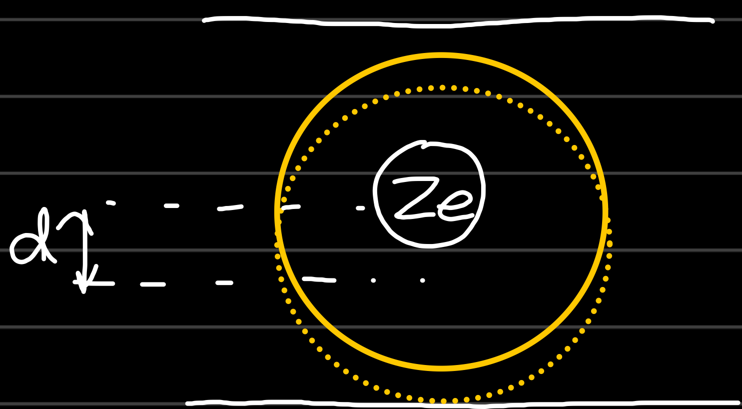
Lecture

Polarization:

electron cloud displaced by d.

Force on electrons $\{F = ZeE\}$

Elastic restoring force in the atom: $F = -\beta d$



$$F = -\beta d$$
$$= ZeE$$

$$ZeE = +\beta d$$

$$\boxed{d = \frac{ZeE}{\beta}}$$

$$\mu = Zed$$

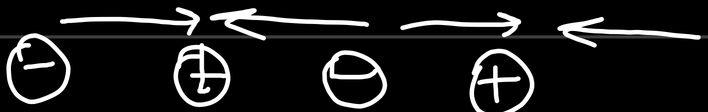
$$\mu = \frac{(Ze)^2 dE}{\beta}$$

$$N\mu = \frac{N(Ze)^2 dE}{\beta}$$

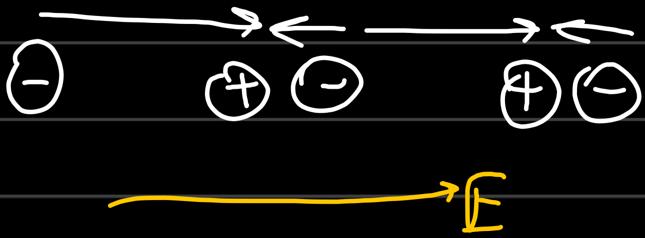
Electronic polarization:
↳ electrons moving away from nucleus

Molecular Polarization:

↳ ions moving independently in crystal.
↳ eg: NaCl crystal.



equal & opp dipoles makes NaCl neutral



On application of E
↳ net polarization achieved.

Orientational Polarization:

↳ inherent dipole moment in molecule
↳ aligns in direction of applied electric field.

α = polarizability → measure of no. of dipoles created on application of electric field E.

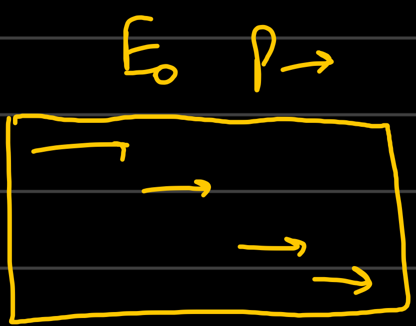
↳ Electric field oscillates:

↳ Thermal resistance to reorient dipoles

existing polarization.

$$\frac{dP}{dt} = -\frac{P - \chi E(\omega)}{\tau}$$

$\tau \rightarrow$ relaxation time to reorient dipoles.



$E_0 \rightarrow E$

excess polarization : $P - \chi E$

$$\frac{dP}{dt} = -\frac{P - \chi E}{\tau}$$

Comparing with Drude's conductivity.

$$\chi(\omega) = \frac{\chi(0)}{1 + j\omega\tau}$$

Electric	Dielectric
$\sigma(\omega) = \dfrac{\sigma_0}{1+i\omega\tau}$	$\alpha(\omega) = \dfrac{\alpha(0)}{1+j\omega\tau}$
$p \to$ momentum	$P \to$ polarizability

* $P = \alpha E$ and $P = \chi \varepsilon_0 E$

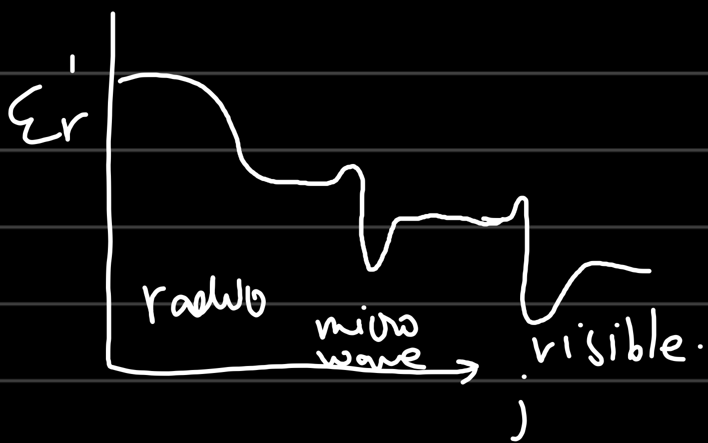
$$\varepsilon_r = 1 + \chi$$

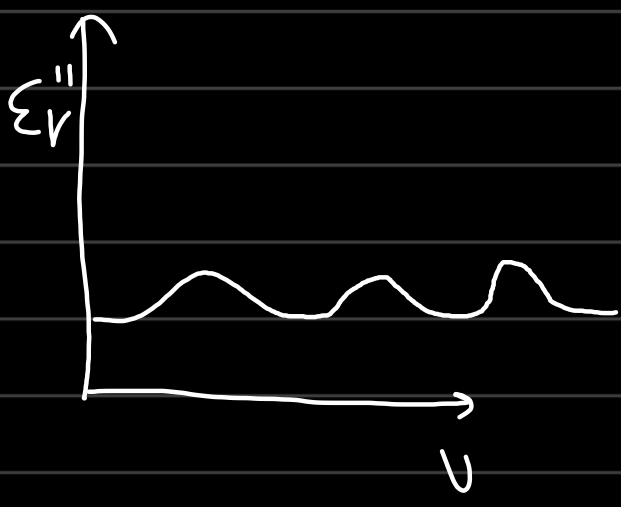
↳ The dielectric constant ε_r, is complex for varying electric field.

$$\varepsilon_r = \varepsilon_r' - j\varepsilon_r''$$

ε_r'' ↓ represents energy lost in the medium due to P re-orientation

Typical variation of complex dielectric const.





↳ Loss tangents peak at dielectric resonance