Electronic Materials

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Reference: Principles of Electronic Materials and Devices by Safa Kasap

Grading:

10% on the 4th week
20% on the 7th week
10% on the 10th week
20% on the 12th week
40% on the 16th week

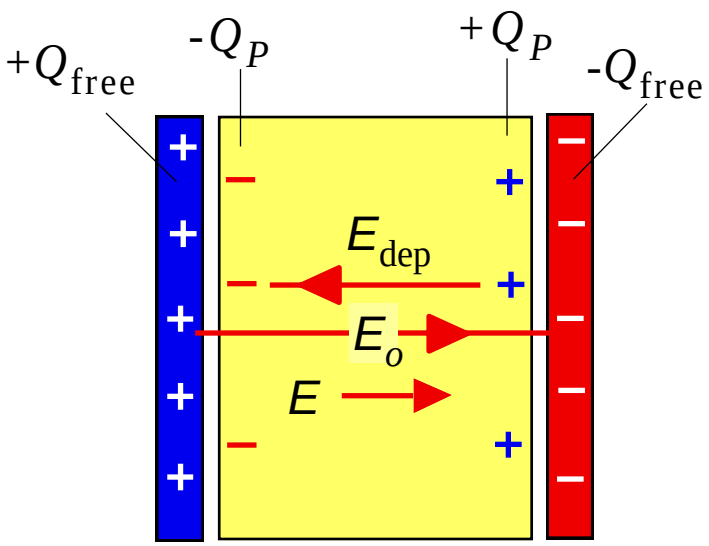


Fig. 7.47: The field E inside the dielectric can be considered to be the sum of the field E_0 due to the free charges (Q_{free}) and a field due E_{dep} to the polarization of the dielectric, called the depolarization field.

From *Principles of Electronic Materials and Devices, Second Edition*, S.O. Kasap (© McGraw-Hill, 2002) http://Materials.Usask.Ca

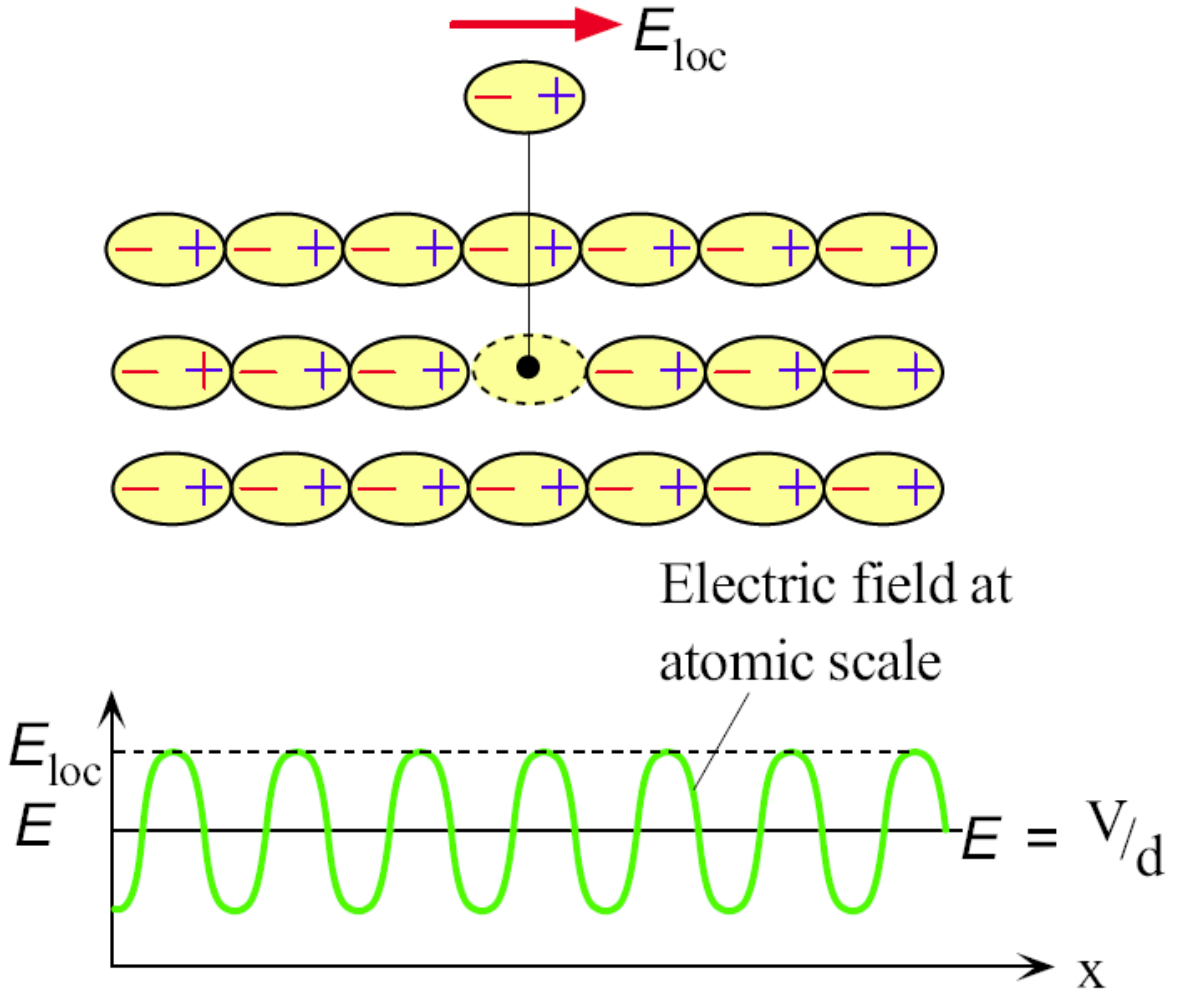
$$E = E_o - \frac{P}{\in_o}$$

P : polarization vector

$$|P| = \delta_p \; c/m^2$$

$$P = \in_o (E_o - E) = \in_o (\in_r E - E) = \in_o (\in_r -1) E = \in_o E \chi_e$$

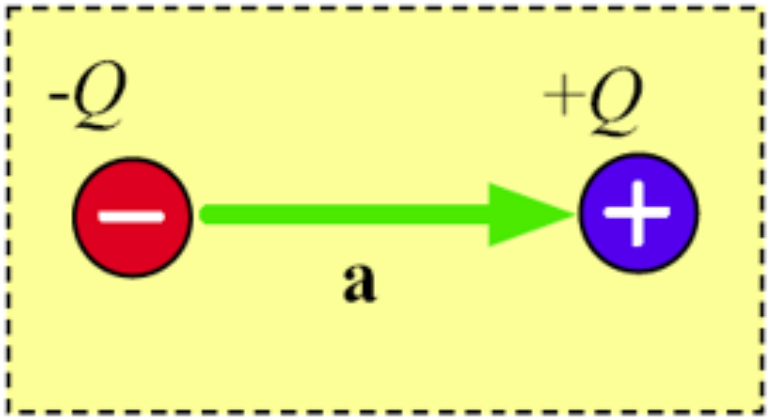
χ_e : electric susciptibility



The electric field inside a polarized dielectric at the atomic scale is not uniform. The local field is the actual field that acts on a molecules. It can be calculated by removing that molecules and evaluating the field at that point from the charges on the plates and the dipoles surrounding the point.

E	E_{local}
Macroscopic field	Microscopic filed
Average field in dielectric	Field acts on an atom
Constant throughout medium	Has a calculated value at the position of atoms

Definition of Dipole Moment



$$P_{in} = (Ze)d$$

P_{in} = magnitude of the induced electronic dipole moment, Z = number of electrons orbiting the nucleus of the atom, d = distance between the nucleus and the center of negative . Hydrogen atom Z=1.

From *Principles of Electronic Materials and Devices, Third Edition*, S.O. Kasap (© McGraw-Hill, 2005)

Fig 7.2

Definition of Polarizability

$$P_{in} = \alpha_e E_{local}$$

α_e : electronic polarization : The ability of the material to be polarized.

$$P = \frac{\text{dipole moments}}{\text{volume}}$$

$$P = \frac{P_{in} + P_{in} + ...}{\text{volume}} = \frac{\text{atoms} \times P_{in}}{\text{volume}} = N \times P_{in} = \frac{n}{a^3} \times P_{in}$$

a : lattice constant

n : atoms per unit cell

An atom is said to be polarized when there is a separation between the centers of –ve and +ve charge.

E_{local}

Isolated atom	Gas	Solid
$E_{\text{local}} = E_o$	$E_{\text{local}} = E_o - \frac{P}{\in_o} = E$	$E_{\text{local}} = E + \frac{P}{3\in_o} = E_o - \frac{P}{\in_o} + \frac{P}{3\in_o} = E_o - \frac{2P}{3\in_o}$ $E_o \succ E_{\text{local}} \succ E$