Physical Properties of Materials

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text book: Electronic Properties of Materials

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PART I
Fundamentals of Electron Theory

PART II
Electrical Properties of Materials

PART III
Optical Properties of Materials

PART IV
Magnetic Properties of Materials

PART V
Thermal Properties of Materials

Introduction

The electron theory of solid is capable of explaining the optical, magnetic, thermal, as well as the electrical properties of Materials.

Magnetic Property:-

electric generator,
magnetic lens,
motor,
loudspeakers,
transformers,
tape recorder tape,
magnetic disk

Optical Property:-

Laser
optical communication
window
lens
optical coating
solar collector
reflector

Thermal Property:-

refrigeneration
heating device
heat dissipation in LED
heat shield for spacecraft

Electric Property:-

conductor
insulator
semiconductor

Electron Theory

- Continuum theory: macroscopic observation

refinement

- Classical electron theory: electron drifts through lattice atoms (Drude model, Newtonian Mechanics)

further refinement

- Quantum theory: Newtonian mechanics does not work in atom scale (~ lack vivid visulization of phenomena)

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Required priori knowledge

Newton's law: force equals mass times acceleration ($F = ma$); (1.1)

Kinetic energy: $E_{\text{kin}} = \frac{1}{2}mv^2$ (v is the particle velocity); (1.2)

Momentum: $p = mv$; (1.3)

Combining (1.2) and (1.3) yields $E_{\text{kin}} = \dfrac{p^2}{2m}$; (1.4)

Speed of light: $c = \nu\lambda$ (ν = frequency of the light wave, and λ its wavelength); (1.5)

Velocity of a wave: $v = \nu\lambda$; (1.6)

Angular frequency: $\omega = 2\pi\nu$; (1.7)

Einstein's mass–energy equivalence: $E = mc^2$. (1.8)