ECEN 5015
Optical Properties of Materials

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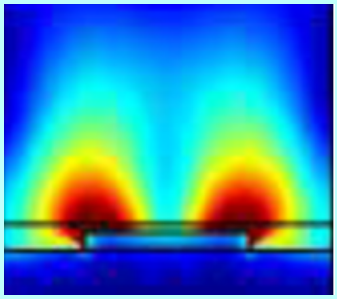
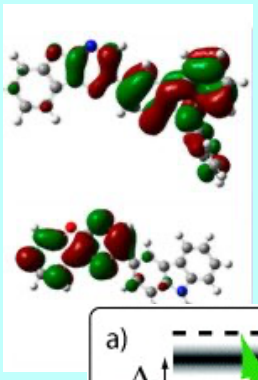
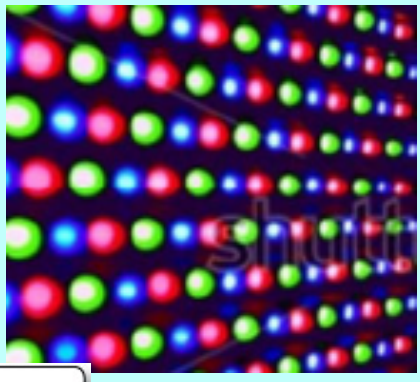
This course will cover optical properties of a variety of materials including dielectric, semiconductor, metal, organic and quantum materials. It will start with the fundamental electrodynamic framework for light-matter interaction and discuss various optical phenomena and some applications.

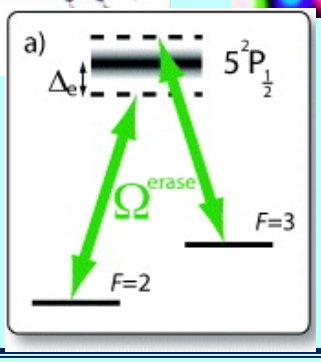
Topics to be covered include (more detailed list in the next page)

1. Fundamentals of light-matter interaction
2. Free electron response
3. Interband transition
4. Exciton
5. Molecular (organic) materials
6. Optically active impurities and defects
7. Scattering of light
8. Magneto-optical properties









Detailed list of topics

1. Fundamentals of light matter interaction
    a) Classical oscillator model
    b) Quantum theory of optical transition
2. Free electron response
    a) Metal
    b) Doped semiconductor
    c) Plasmon
3. Interband transition
    a) Energy band structure of semiconductor
    b) Joint density of states
    c) Direct vs indirect transition
    d) Effects of external electric and magnetic fields
    e) Luminescence
4. Exciton
    a) Wannier excitons in semiconductor
    b) Frenkel excitons in ionic and molecular materials
5. Molecular materials
    a) Molecular orbitals
    b) Organic semiconductors
    c) Electron-vibration coupling
6. Optically active impurities and defects
    a) Shallow impurities and band-to-impurity transitions
    b) Deep impurities and defects
        i. Coupled electron-lattice system
        ii. Configuration coordinate model
    c) Applications in quantum photonics
        i. Vacancy in diamond
        ii. Rare earth ion in crystal
    d) Energy transfer
        i. Dipole-dipole interaction & applications in sensing
7. Scattering of light
    a) Spontaneous scattering: Rayleigh, Raman and Brillouin
    b) Stimulated scattering: Raman and Brillouin
8. Magneto-optical properties