# January 2024

Explain the GMR effect.

# January 2023

Describe electronic transport in graphene.

* Has problem with different Fermi level of the p-type and n-type.

How do LCAOs lead to band structures in crystals.

How does thermal conductivity effect the efficiency of thermal electric devices.

How can you tune the thermal transport properties?

Thermal conductivity?

Discuss the effective mass approximation in semiconductors.

Explain the role of thermal conductivity in thermoelectric materials (TE). How do we improve the efficiency of thermoelectric materials by changing the thermal conductivity?

Discuss the resistivity and scattering in metallic thin films and polycrystalline materials.

Explain conditions for superconductivity

Why is there still a vibration in the lattice even though you don't want any entropy (or something along those lines)

Explain how we introduce bandgaps in graphene

How is can one dope Bi2Te3?

* Antisite doping
* To make N-type and P-type by different fraction of Te
* How to stabilize the np Bi2Te3.

What is the Seebeck coefficient, give some ways of increasing it

Which organic semiconductor is more unstable in air, n-type or p-type. Why? Give some ways of stabilizing it.

Doping mechanism of PEDOT:PSS organic thermoelectric

Explain how we can create photonic crystal, main properties and application

Difficulty in synthesis of graphene FET and what is the alternatives for that?

How does em wave interact with metal

* Skin depth.
* Oscillating currents produced in response to the applied oscillating electric field.

Describe heterojuction with an example

How to increase efficiency of laser

How ferroelectric properties change with T

What are the types of polarization, how polarization and dielectric constant are related.

Explain the formation of bands starting from orbitals

What is Schottkey height and what is fermi level pinning

Describe the electrical characteristics of Schottkey contact, how to make an ohmic contact.

How to improve the efficiency if the LEDs?

What is the size effect of the magnetic materials?

* Single magnetized state becomes the lowest energy configuration.

What are the different approaches to conductivity in metals?

Explain the doping process for PEDOT:PSS

What is more stable in air, p-type or n-type organic semiconductors? Why? How can we increase the stability?

How is stability related to defects? And how can we increase that stability? (He wanted to hear small band gap)

What are the types of polarization, how are the polarization and the dielectric constant related?

I mentioned Claussius-Mossotti and he asked me how it was derived

What is the frequency dependency of the polarization? What about the imaginary part?

Discuss electronic and optical properties of graphene.

Why are electrons in graphene massless?

What problem occures when we want to use graphene in FETs?

Why is hybridization important and how does it lead to conjugation in organic molecules?

# January 2022

Explain the temperature dependence of a ferroelectric material.

Extra questions about BaTiO3 structure, first and second-order transitions.

How does an Er-doped fiber optic amplifier work?

Why is Er used for this?

How is the domain wall thickness defined in ferromagnetic materials.

Extra questions about underlying principles and formulas of the anisotropy and exchange energy.

Classical and semi-classical models of conductivity in metals

Discuss electrochromic devices.

Explain covalent bonding in a diatomic molecule.

Discuss the effective mass approximation in solids.

Explain the role of thermal conductivity in thermoelectric materials (TE). How do we improve the efficiency of thermoelectric materials by changing the thermal conductivity?

Discuss scattering in metallic thin films and polycrystalline materials.

Discuss effective mass approximation in semiconductors.

How can I make photonic crystals? What are the properties and applications?

What are the issues in production of graphene FETs? What are the alternatives to graphene FETs?

Discuss the differences/similarities for ferroelectric/piezoelectric/ pyroelectric materials

Explain the domain wall thickness by 2 contribution

Explain the electrical and mechanical properties of graphene

What is the importance of hybridization? How does it lead to conjugation?

What are the limitations of graphene FET and what are alternatives?

How do we create photonic crystal and what are its application?

What is dispersion graph? What are motivations of slow light?

Why is some carbon nanotube matellic and other semiconducting?

Explain population inversion

Extra questions about what kind of materials can have population inversion

Explain how STT-MRAM work and its advantages compared with standard MRAM

Discuss the LACO for the H2+ molecule.

Why do we use bulk heterojunctions in OPVs?

Discuss the opening of a bandgap in graphene.

Discuss the behaviour of carriers in intrinsic semiconductors.

Explain the interaction between light and metals.

What is the origins of magnetism?

* Electron spin: show the magnet.
* Spin imbalance.