

Emerging & Low Dimensional Materials: [PHYS-789]

M. Elijah Wangeman

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Contents

1	Wednesday, January 17:	1
1.0.1	Doping, Transistor Characteristics & FETs	1
1.0.2	Logic Gates	2
1.0.3	What are 2D & low dimensional materials?	2
2	Wednesday, January 24: Basic Properties and Synthesis Methods of 2D Nanomaterials	2
2.1	Graphene: What makes graphene so special?	2
2.2	Transition Metal Dichalcogenides (TMDs)	2
2.2.1	TMD Band Structure	2
2.2.2	TMD Optical Properties	2
2.3	2D Applications	2

1 Wednesday, January 17:

1.0.1 Doping, Transistor Characteristics & FETs

- Doping: adding impurities to a semiconductor to change its electrical properties.
 - n-type: add electrons (donor)
 - p-type: add holes (acceptor)
- Transistor: a semiconductor device used to amplify or switch electronic signals and electrical power.
 - BJT: bipolar junction transistor
 - FET: field-effect transistor
- FET: a transistor in which current flows through a semiconductor channel whose width is modulated by an electric field.

- MOSFET: metal-oxide-semiconductor field-effect transistor - Family of curves: I_D vs V_{DS} for different values of V_{GS} - Saturation: $V_{DS} > V_{GS} - V_{TH}$

1.0.2 Logic Gates

- Inverter: V_{out} = inverse of V_{in}

1.0.3 What are 2D & low dimensional materials?

Crystalline single layer materials with thickness of a few atoms.

0D, 1D, 2D, 3D materials.

- 0D:
- 1D: Carbon nanotubes, nanowires.
- 2D: Graphene, transition metal dichalcogenides (TMDs), black phosphorus, hexagonal boron nitride (hBN).
- 3D: Bulk materials.

2 Wednesday, January 24: Basic Properties and Synthesis Methods of 2D Nanomaterials

2.1 Graphene: What makes graphene so special?

2.2 Transition Metal Dichalcogenides (TMDs)

2.2.1 TMD Band Structure

2.2.2 TMD Optical Properties

2.3 2D Applications

- Tunable band structures
- Novel Heterostructures
- Quantum Emission
- Twisted Bilayer Moiré Superlattices