GRAPHENE IN SOLAR CELLS

AMANDA WEST

ECE 4083

GEORGIA INSTITUTE OF TECHNOLOGY

Overview

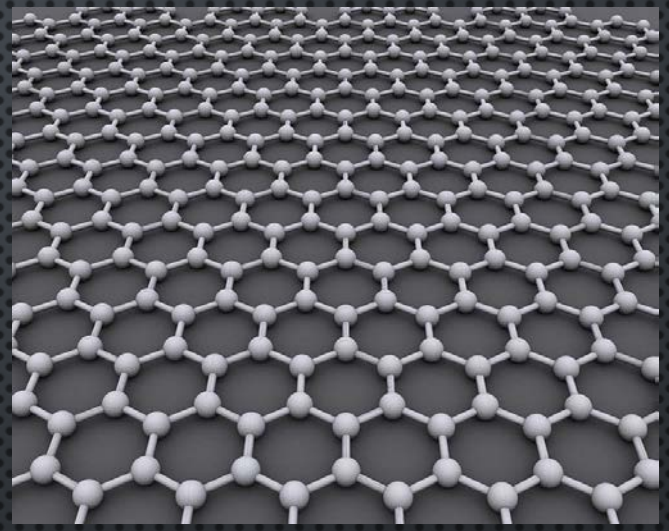
- Transparent Electrodes
- What is Graphene?
- Discovery
- Interesting Properties
- Types of Graphene
- Current Uses

Transparent Electrodes

- Indium Tin Oxide (ITO) widely used in the market
- Transparent
- Not very flexible
- Limited geographic availability
- Rising ITO prices
- Sheet Resistance, Transmittance
  - ITO ≈ 10 Ω/□, 85%
  - Thin Graphene ≈ 280Ω/□, 90%
  - Multi-layered graphene ≈ 10Ω/□, 90%

WHAT IS GRAPHENE?

- Single layer of pure carbon
- 207 times stronger than steel
- Nearly transparent
- Conducts electricity
- Flexible
- Almost weightless
- Work Function Modulation



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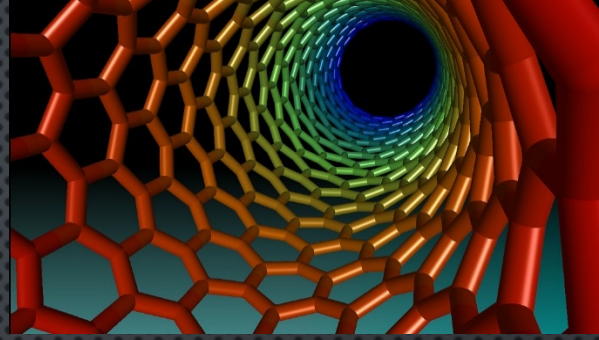

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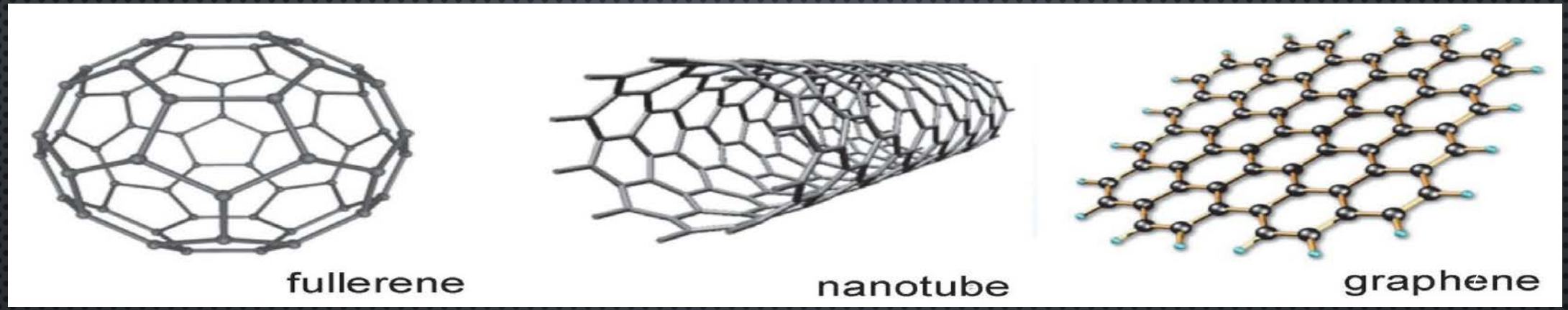
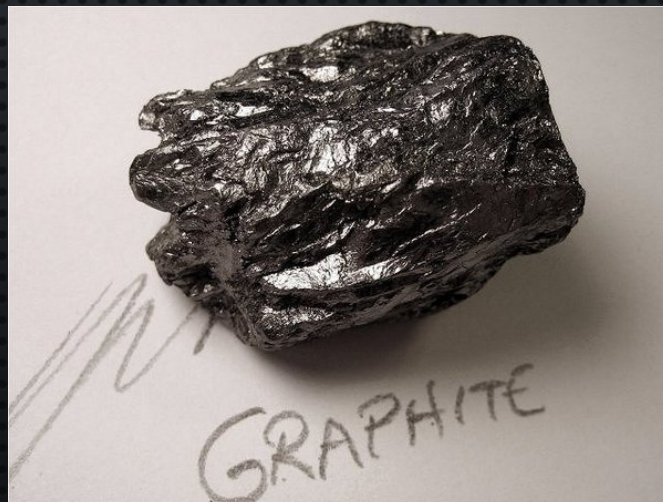
DISCOVERY

- Andre Geim and Kostya Novoselov, University of Manchester
- Geim wanted to experiment with unfolded carbon nanotubes
- Had ideas to use scotch tape to peel off top layer of graphite
- Put the tape into solution resulted with graphene that was 10 layers thick
- Geim published " Electric field effect in atomically thin carbon films" in October 2004[6]

STRUCTURAL PROPERTIES



- GRAPHITE, LAYERED PLANAR STRUCTURE OF GRAPHENE
  - HONEYCOMB LATTICE
  - ONE ATOM THICK(POSSIBLY THINNEST MATERIAL ON EARTH)
- CARBON'S 4TH VALENCE ELECTRON FORM CONDUCTING PI BOND
- FORMS HIGH-QUALITY CRYSTALLINE LATTICE
  - NO VACANCIES OR DISLOCATION
- ABLE TO RETAIN INITIAL STRUCTURE AFTER STRAIN

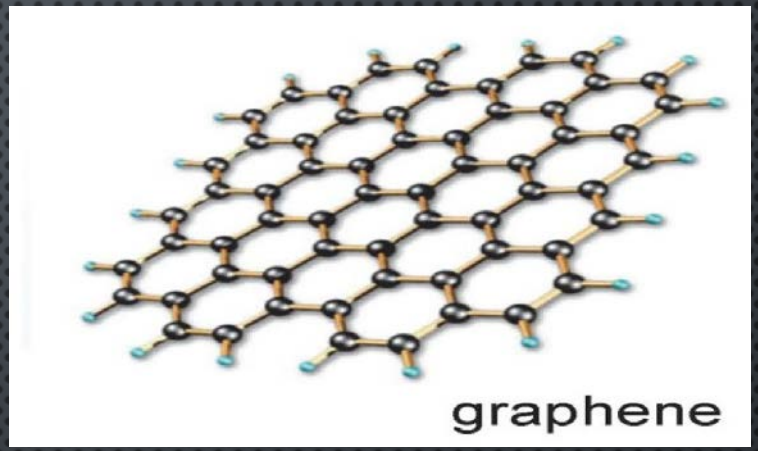


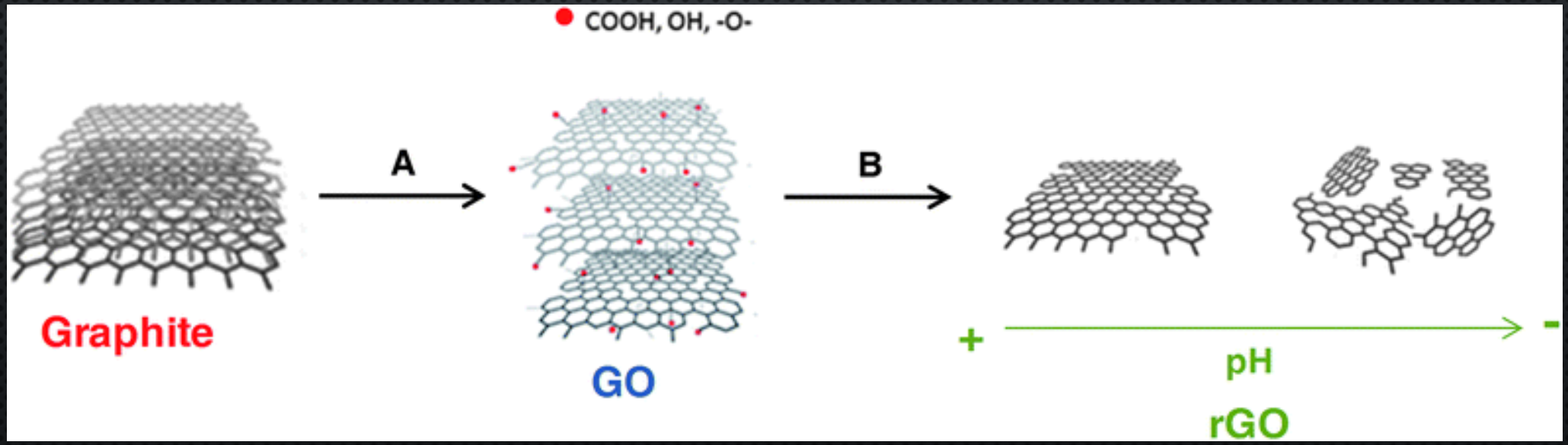
Electro-optical properties

- Zero band gap
- Ballistic Transport
  - Because of light weight, electrons able to move like photons
  - Micrometer distance without scattering
- Absorbs 2.3% of white light
- Increasing layers of graphene, increases absorption of white light by approximately 2.3%

TYPES OF GRAPHENE

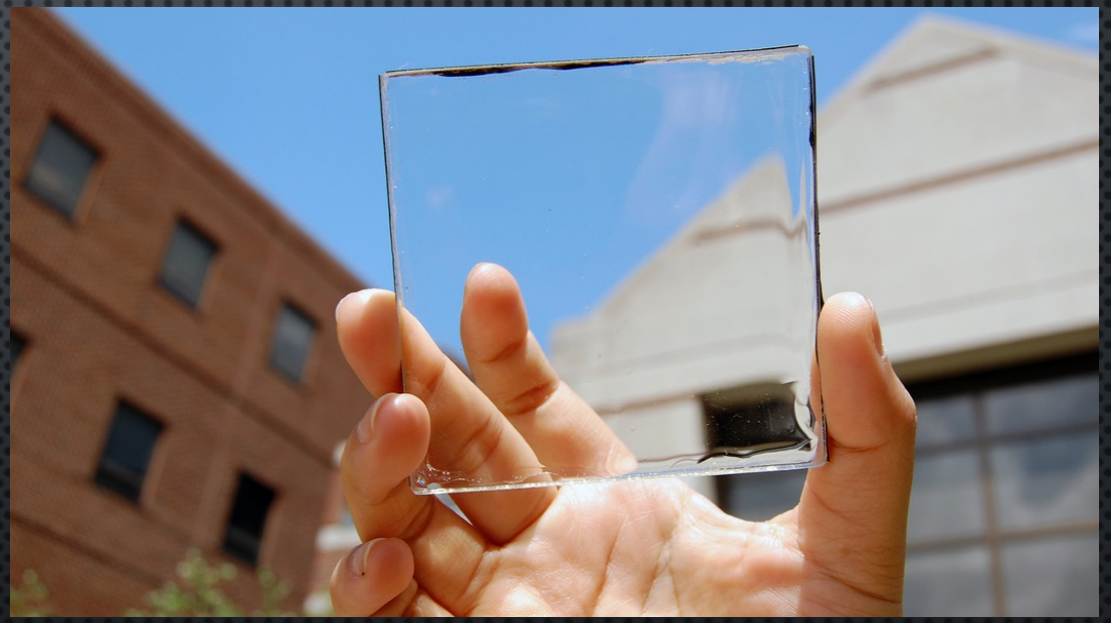
- PURE GRAPHENE
- GRAPHENE OXIDE
- REDUCED GRAPHENE OXIDE

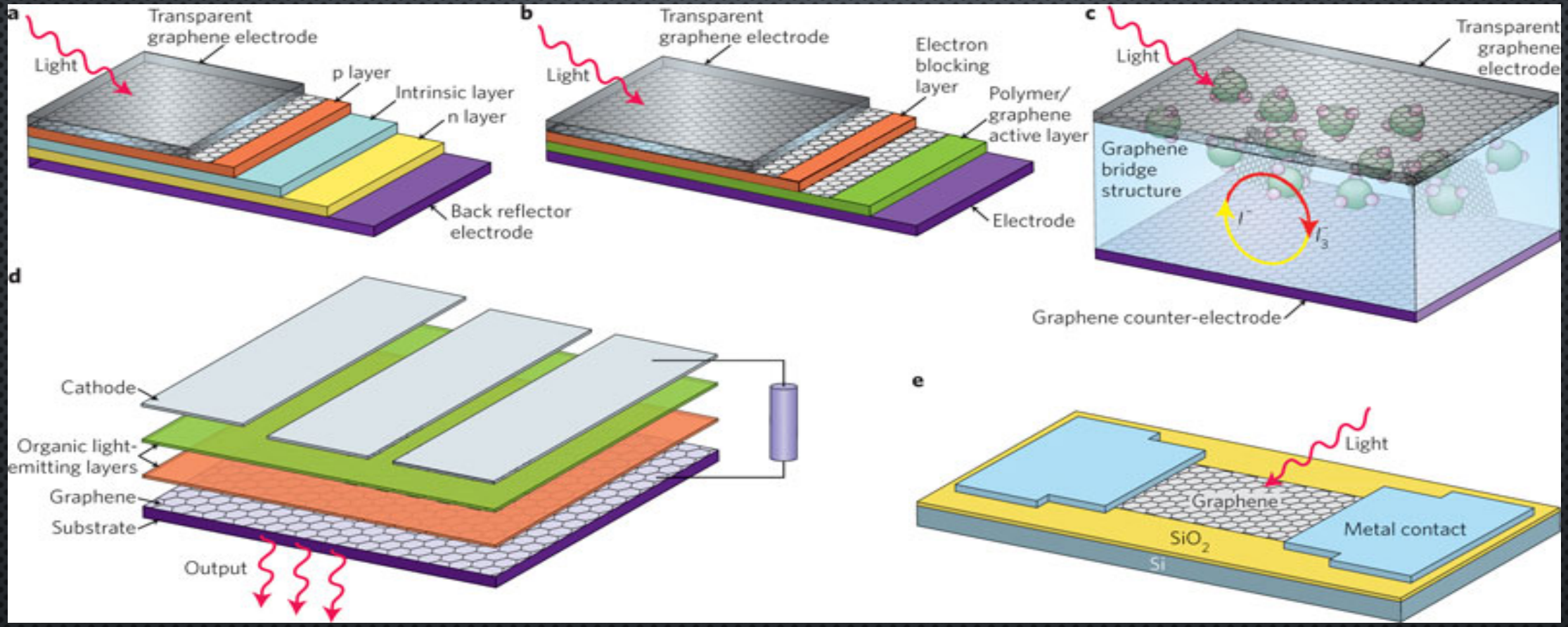




APPLICATIONS IN SOLAR CELL DEVICES

- Low temperature processing
- Transparent electrode in solar cells
- Flexible substrates
- Tandem cell interlayer
- Graphene Oxide within the bulk heterojunction active layer





A–C, SCHEMATICS OF INORGANIC (**A**), ORGANIC (**B**) AND DYE-SENSITIZED (**C**) SOLAR CELLS. I^- AND I^-_3 ARE IODIDE AND TRI-IODIDE, RESPECTIVELY. THE I− AND I−3 IONS TRANSFER ELECTRONS TO THE OXIDIZED DYE MOLECULES, THUS COMPLETING THE INTERNAL ELECTROCHEMICAL CIRCUIT BETWEEN THE PHOTOANODE AND THE COUNTER-ELECTRODE. **D**,**E**, SCHEMATICS OF AN ORGANIC LED (**D**) AND A PHOTODETECTOR (**E**). THE CYLINDER IN **D** REPRESENTS AN APPLIED VOLTAGE.

QUESTIONS?

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