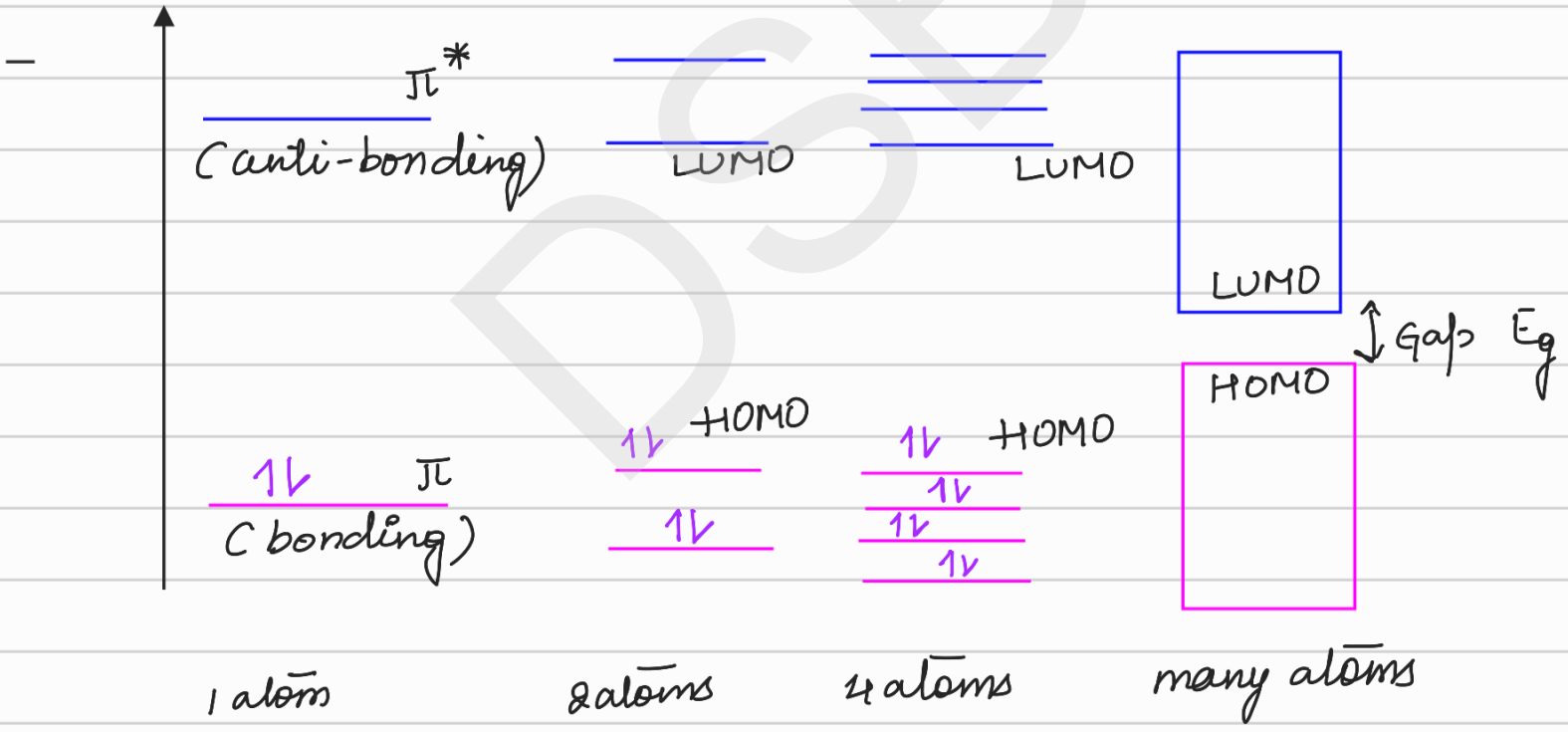
Optical processes in organic semiconductors

→ Organic semiconductors are one such class of materials in which semiconductor behaviour is intrinsic i.e. electronic properties are hard wired into each molecule.

→ This renders them significantly more tolerant to impurities, packing defects or grain boundaries.

→ Organic semiconductors consists of either oligomer or polymer chain molecule.



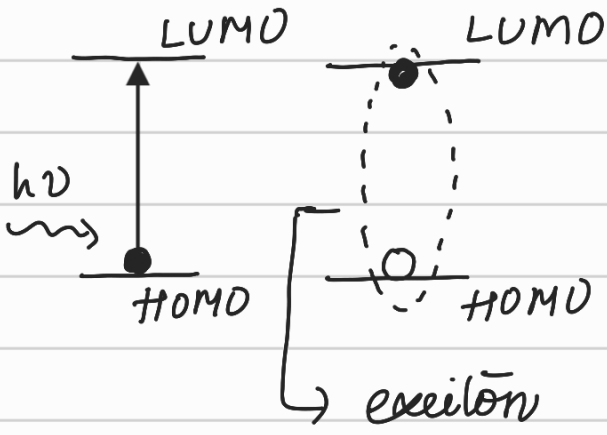
HOMO is highest occupied molecular orbital.
LUMO is lowest unoccupied molecular orbital.

Electronic transitions take place when e⁻ moves from HOMO to LUMO or LUMO to HOMO. Unlike e⁻-h pair as in case of conventional semiconductor, in organic

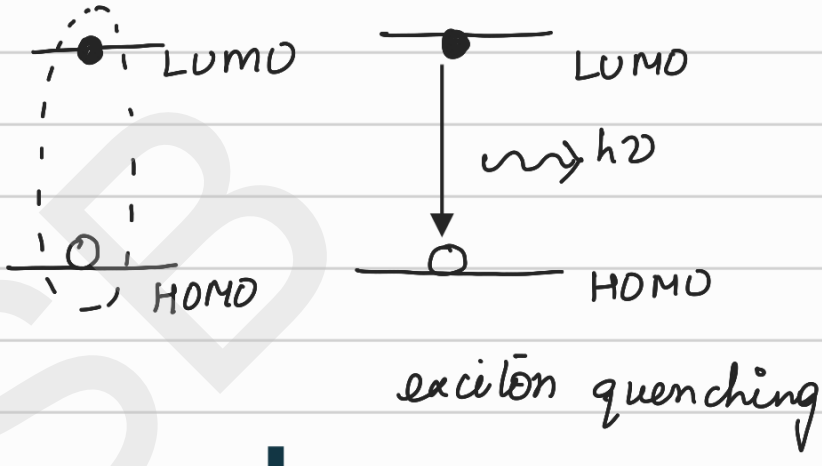
semiconductor an e⁻ - h pair is generated which are still attracted to each other leading to the formation of EXCITON

OPTICAL PROCESS

Absorption



emission



Organic solar cell

1. Light absorption
2. Exciton generation
3. Exciton dissociation
4. charge extraction

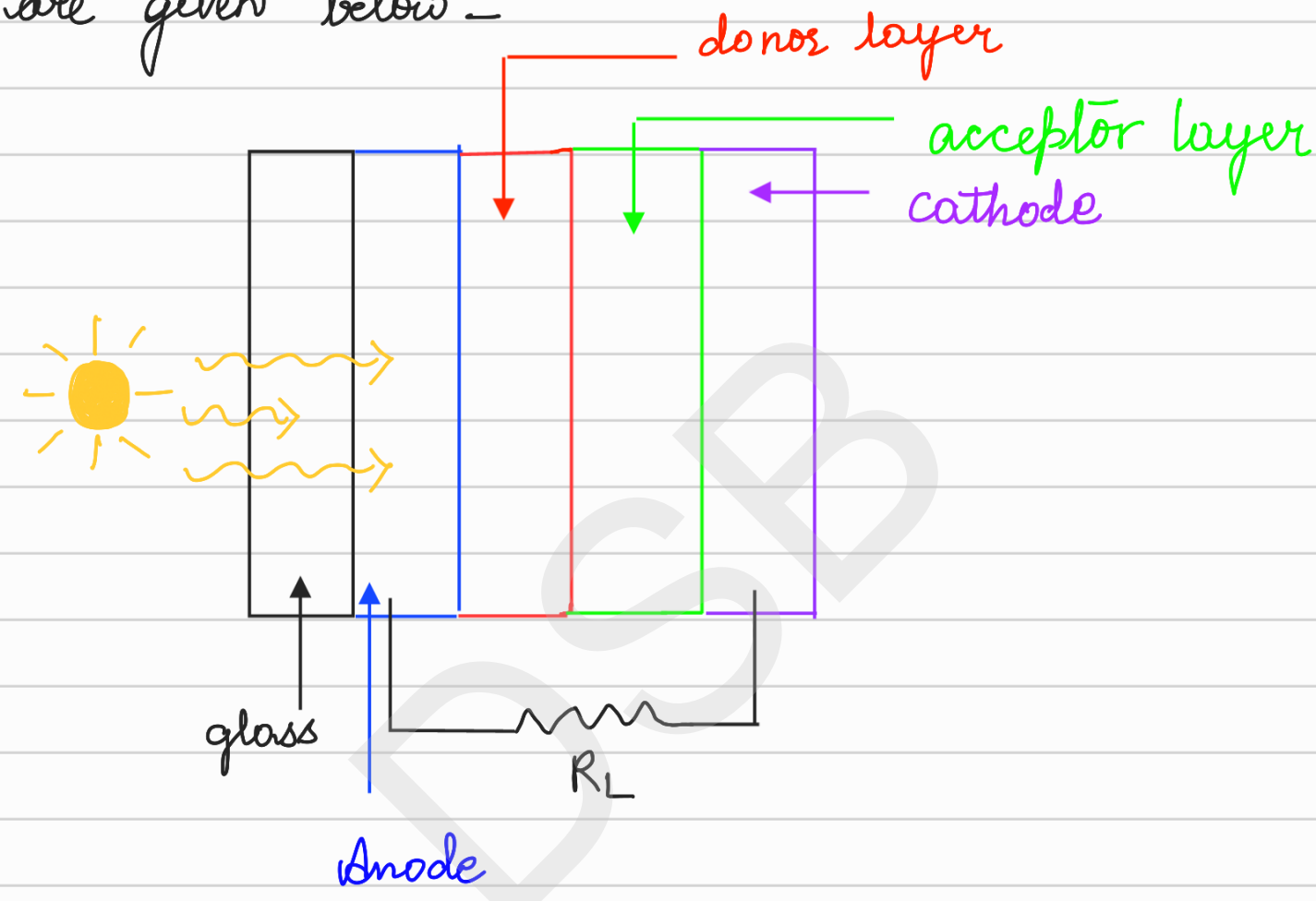
Organic light emitting diode.

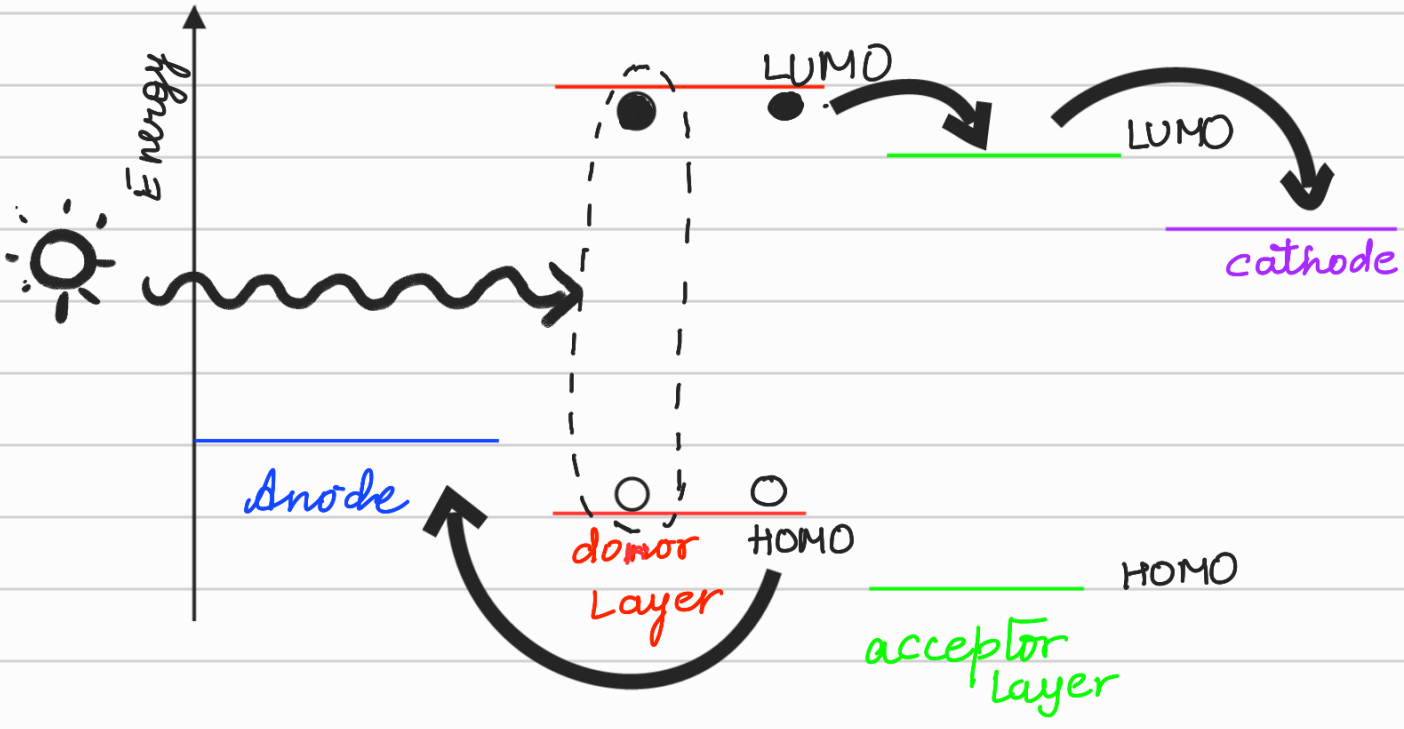
1. charge injection
2. charge transport
3. Exciton quenching
4. Light emission

ORGANIC SOLAR CELL (OSCs)

OSCs work on the principle of photovoltaics.

Basic structure of OSC and energy level diagram are given below –





1. When light falls on donor layer consisting of organic molecules, it is absorbed and an exciton pair is created.

2. Exciton dissociation takes place and e^- moves from LUMO of donor layer to LUMO of acceptor layer.

3. Hole from HOMO of donor layer moves to anode and e^- from LUMO of acceptor layer moves to cathode.

4. Electron is transferred to external circuit and later is gained by hole of the opposite electrode.

Advantages

1. Light weight, flexible
2. Environmental friendly
3. 1000 times thinner than Si solar cell.
4. Short energy payback time
5. Easy to integrate

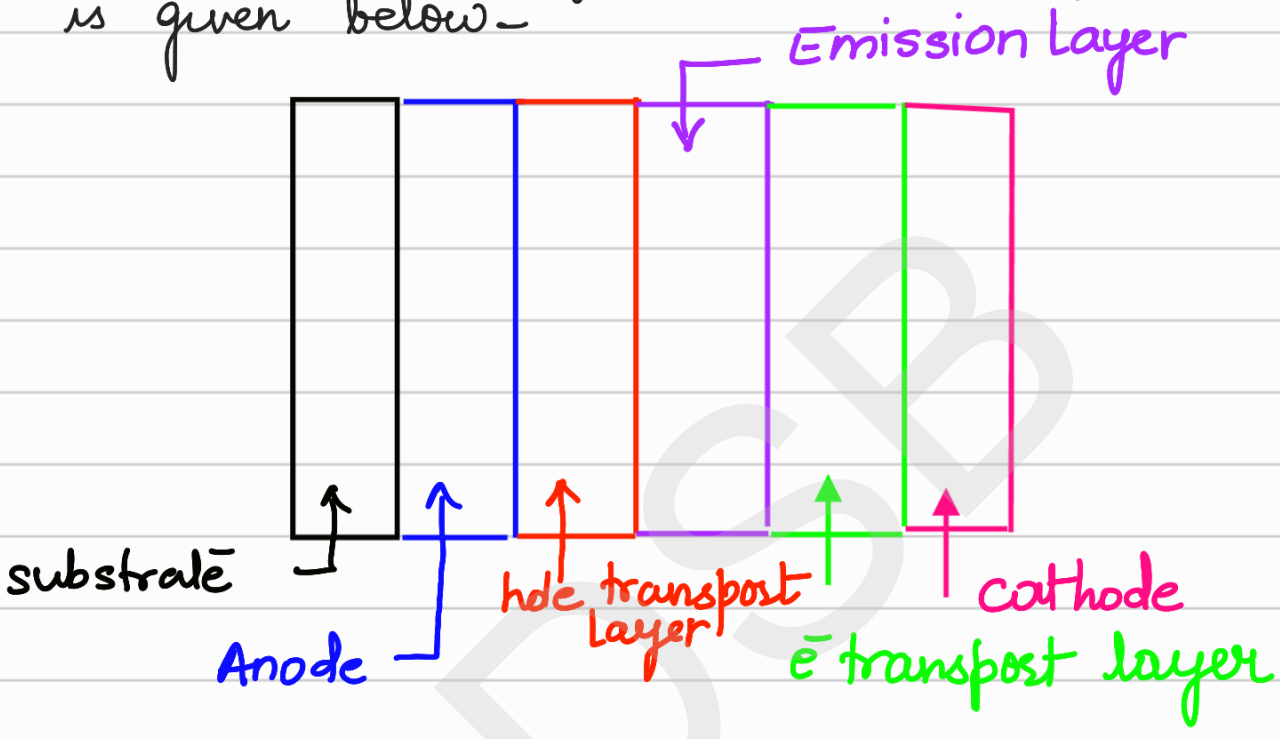
disadvantages.

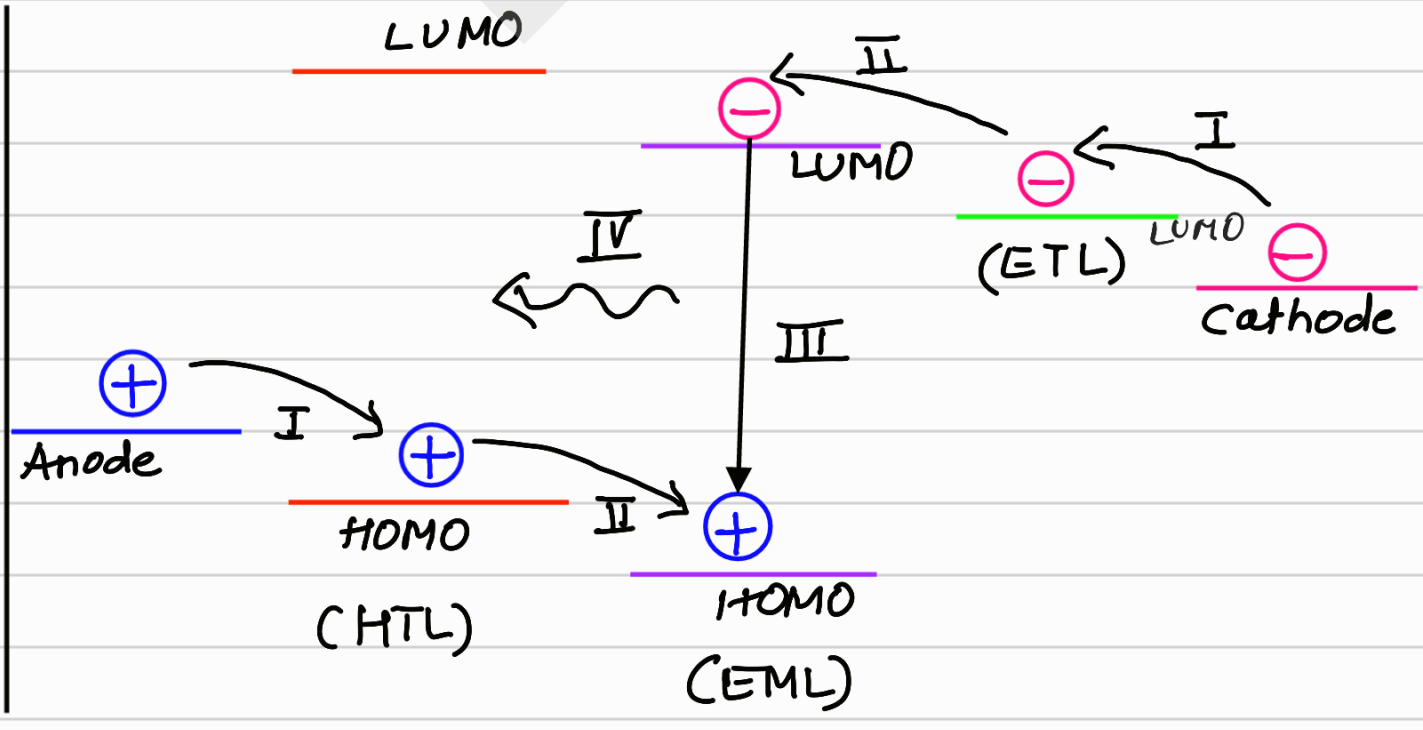
1. Low efficiency
2. Its lifetime is less compared to inorganic solar cell.
3. Moisture and air degrades its performance.

ORGANIC LIGHT EMITTING DIODE

OLED works on the principle of radiative recombination resulting due to exciton quenching.

Basic structure of OLED and energy level diagram is given below-





Working

1. **Charge injection :**
When an external voltage is applied, e^-s are injected through the cathode into the LUMO of its adjacent layer and holes are injected through the anode into the HOMO of the adjacent layer.

2. **Charge transport :**
The injected electrons and holes then migrate into the active layer (EML), where they form an exciton state.

3. **Exciton quenching**
e^- and hole recombine with each other in EML.

4. **Photon emission**
The relaxation of exciton from excited state to ground state emits a photon. i.e emission of light

Advantages	disadvantages
1. Flexible	Shorter lifetime
2. OLED consumes less power	Expensive compared to LCD.
3. Remarkable color fidelity, high efficiency, and operational stability.	Susceptible to water