OLED(Organic Light-Emitting Diode)

융복합섬유팀

목차

OLED 원리

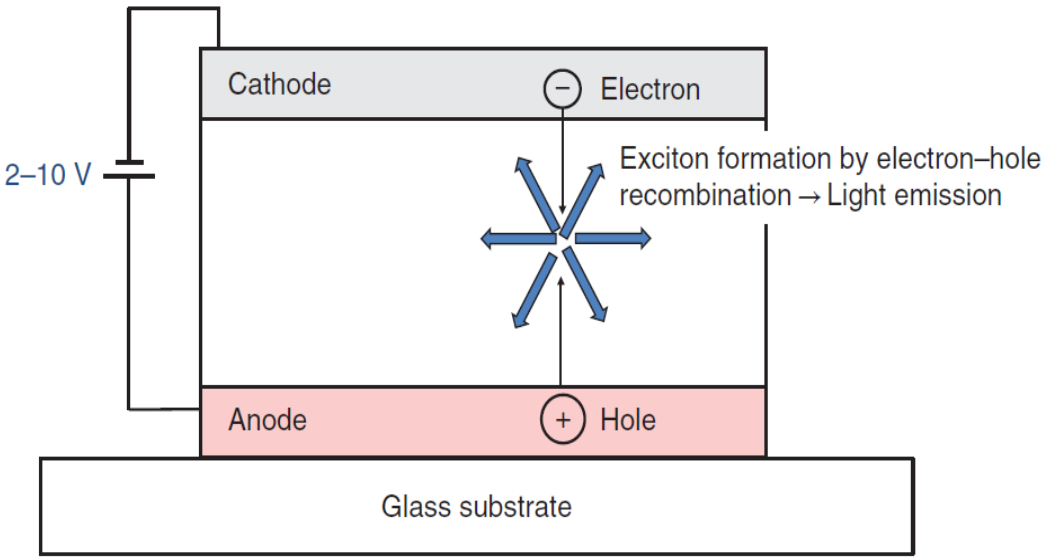

그림 1. OLED의 원리

- Emission from all OLED devices can be explained by the same principle. Through electron–hole recombination, a high-energy molecular state is formed.
- This state is called an exciton, as it behaves like a single molecule with high energy. This exciton emits light after an exciton life time period.
- The wavelength of this light emission corresponds to the exciton energy, so it is possible to control the color of the emission by adjusting the molecular design of the color center.
- This feature is quite advantageous for OLED display applications.

OLED 원리

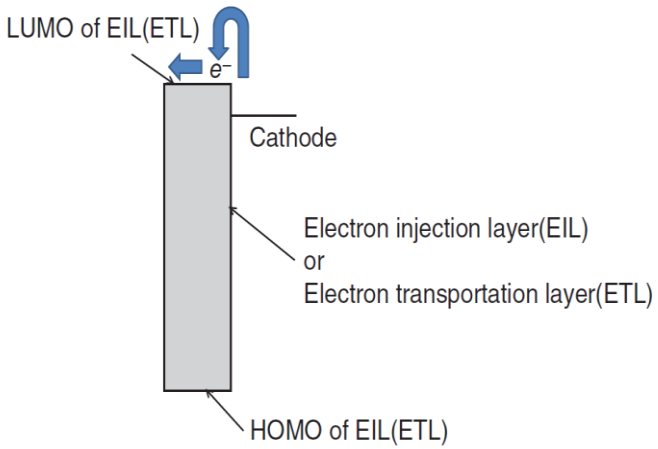

그림 2. 음극을 통해 LUMO 수준의 ETL(EIL)로 주입되는 전자

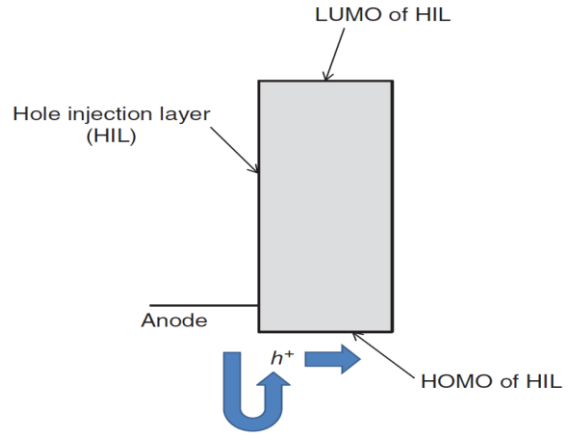

그림 3. 양극을 통해 HOMO 수준의 HIL로 주입되는 정공

- Although an OLED device requires recombination of electrons and holes to emit light, normal OLED materials actually have very high resistance under weak electric fields and thus can be regarded as insulators
- It was so successful because they introduced a very thin film to create strong electric fields and also chose structures and materials suitable for charge injection
- By means of a strong electric field, electrons are injected from a cathode to the LUMO level of the electron transport layer(Figure 2) and holes are injected from an anode to the HOMO level of the hole transport layer (HTL)(Figure 3)

OLED 원리

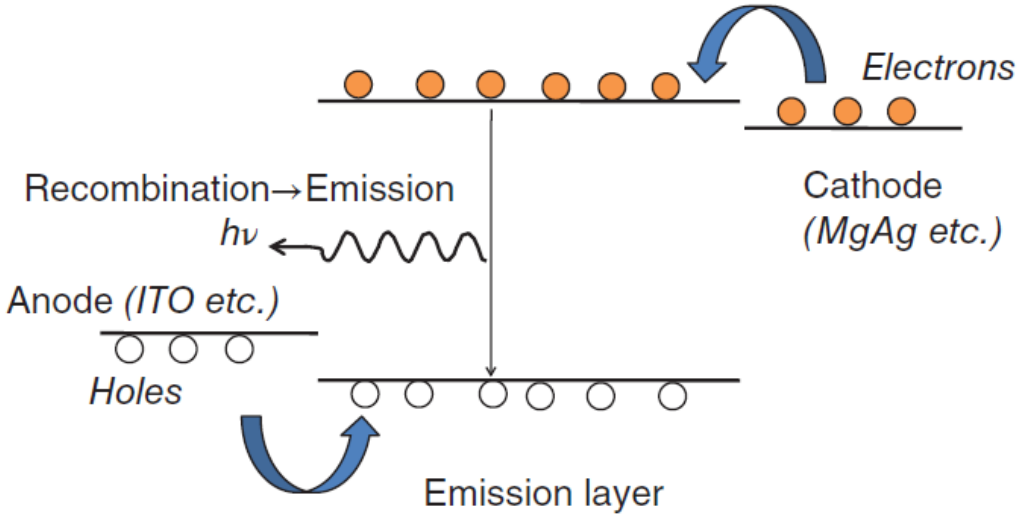

그림 4. 발광층에서의 정공-전자 거동

- As shown in figure 4, injected electrons and holes are transferred through their own charge transport layers in an OLED device.
- When an electron meets a hole, the electron and hole recombine and an excitonis formed. An excitongenerates a photon whose wavelength corresponds to the energy gap after completion of its excitonlifetime or loses its energy due to internal conversion.

OLED 원리

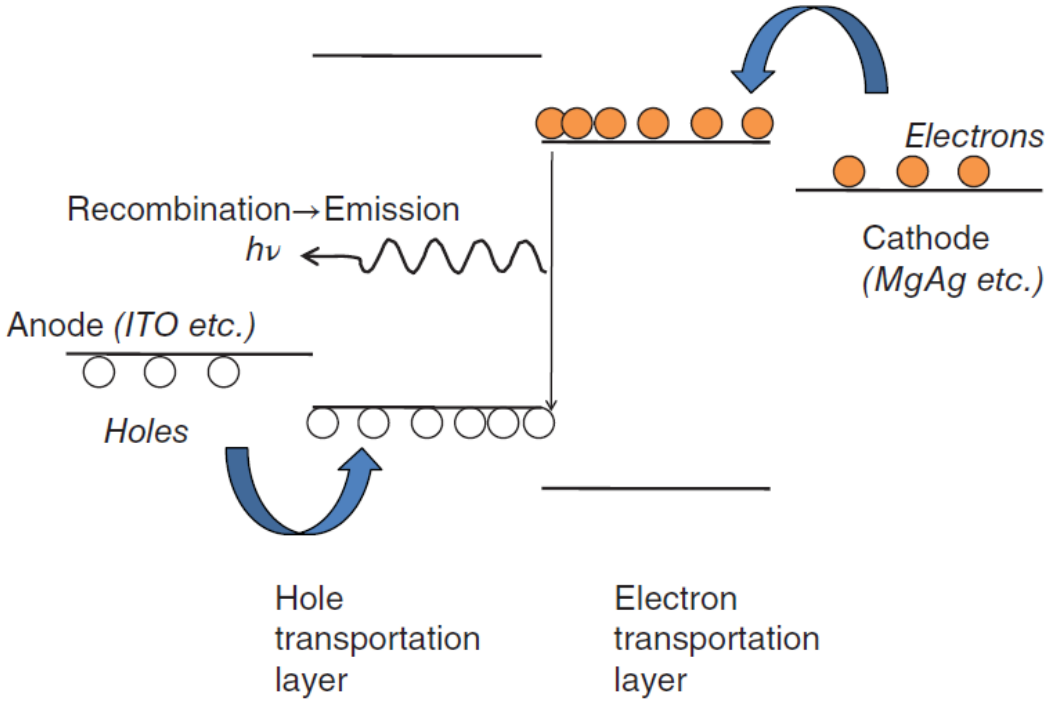

그림 5. 발광층에서의 정공-전자 거동(2)

- If the probability of electron–hole recombination can be increased, more photons will be generated.So if electron and hole transport can be blocked by the HOMO/LUMO band energy change at an interface between different material layers as shown in figure, the location of their recombination can be controlled.

- As the charge carriers cannot easily pass through the entire device to reach the electrode, the recombination probability can be enhanced, and high efficiency can be achieved.

OLED 구조

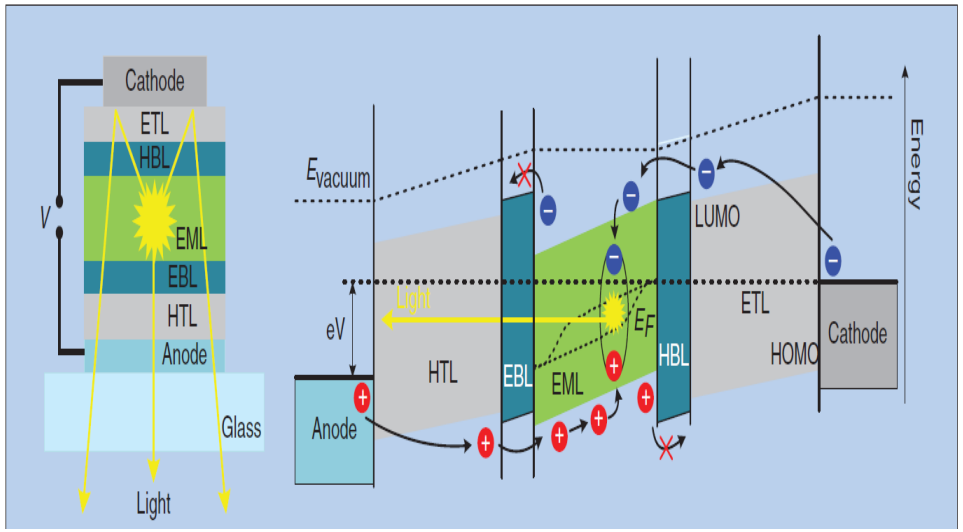

그림 6. 대표적 다중층 OLED

- The basic structure of these OLEDs was reported by Tang and Van Slyke in 1987
- As OLED devices are studied and the efficiency of the devices is improved, a multi-layered structure is developed in which a functional layer is added between each electrode and the emission layer
- The multi-layer structure represents advanced concepts that remain valid today:

1. Significant enhancement of the recombination efficiency by using a layered structure using multiple different materials (heterostructure).
2. Fabrication of low-voltage, high-quality devices through evaporation.
3. Appropriate choice of electron and hole injection materials and of workfunctionsfor cathode/anode electrodes.
4. High electric field obtained by ultrathin-film formation.

OLED 구조

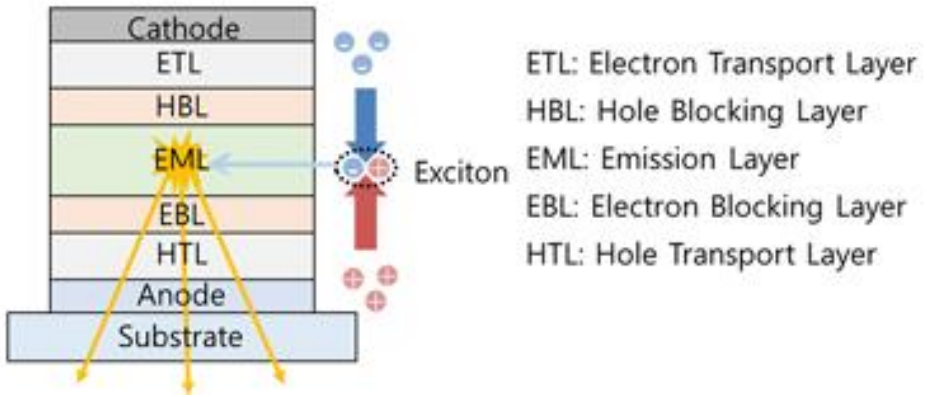

그림 7. 다중층 OLED의 구조

Recently developed OLED devices normally use structures that apply advanced modifications to this charge blocking principle to achieve efficient carrier recombination.

1. Electron transportation layer (ETL) : for electron injection from cathode electrode and transportation of electron
2. Hole blocking layer (HBL) : for blockage of hold transport
3. Emission layer (EML) : electron/hole transportation and their recombination to form an exciton, which generates light emission
4. Electron blocking layer (EBL) : for blockage of hold Electron
5. Electron injection layer (EIL) : for electron injection from cathode electrode

참고문헌

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