Polymer LEDs

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Origin of PLEDs

- Subcategory of OLEDs
- OLEDs are based upon electroluminescence
  - Ability to convert electric energy into photons
- The first efficient OLED was build by Tang and Van Syke in 1987
- Three years later, in 1990 the first OLED was invented that used an polymeric emitter layer
  - The origin of Polymer LEDs
- An emitting layer is placed between a metal cathode and a transparent anode
- $e^-$ are transferred into LUMO by cathode
- $h^+$ are pushed into HOMO by anode
- Recombination under radiation of photons
- Poor efficiency and lifetime
Reasons for poor efficiency

- Charge transport is a key factor in PLED performance
- Significantly higher hole conductivity than electron conductivity in conjugated polymers
  - Formation of excitons close to the cathode
- Excitons close to the cathode tend to relaxate nonradiatively via energy transfer
Advanced PLED Setup

- Introduction of hole and electron transfer layers
- Shifting the recombination zone away from cathode
- Less energy transfer to the cathode $\Rightarrow$ Better efficiency
Luminescent Polymers

- Nearly any semiconducting polymer with a fitting energy distance between HOMO and LUMO
- Most popular is PPV and its derivatives
- Conjugated $\pi$-electrons
- By combination of two or more phosphors, the color can be controlled
  - Resulting in multilayered or in single layer setups
Idea: A copolymer consisting of blue, red and green phosphors

- Very good CRI (~90)
- Poor power efficiency (max. 16 lm/W)
- Stability problems
Fabrication Processes

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Spin-Coating

- applying the solvent solution → rotating → drying → repeating to prepare multilayer structure
Ink-Jet Fabrication

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Advantages:
- Bright, homogeneously shining LEDs
- Great variability in emission wavelength
- Great color rendering index
- Nearly no limit in screen size
- No dependency in viewing angle
- By using polymer substrates flexible displays can be build up
- No backlight is needed, in contrast to LCD
- Ink-Jet fabrication is a promising technique (30 panels/h)
Disadvantages:
- Display pixels have to be encapsulated from air to inhibit degradation by Oxygen
- Poor lifetime in general is the biggest issue
- Additionally different color phosphors have different durability → Color shift (blue is degraded faster)
- Not suitable for dimmable white lighting (color shift while voltage is decreased)
Till nowadays, no commercial breakthrough

BUT: When durability is improved, PLED displays will be a strong competitor to LCD

Application, mainly in multimedia devices and large area lighting
References


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