Flexible and printable organic optical devices

Hirotake KAJII¹
¹ Center for Advanced Science and Innovation, Osaka University

CASI, Osaka Univ.
At present, research and development of organic electro-optical devices has been rapidly performed on a global scale with the aim of creating new soft electronics based on organic molecules with π bonds.
Motivation and Research themes

Viewpoints of frequency response

- ms order:
  - Liquid crystal
- μs order:
  - Organic EL devices
- ns order:
  - Optical sensor

Application

- Organic Light Emitting Devices
- Organic Photodetectors

Organic devices
- Printable, flexible

Optical link devices

+Si devices
**Organic LEDs (OLEDs)**

- Simple structure
- Thin and lightweight
- Fabricated by wet processing (solution process)

---

**Fig. Typical OLED structure**

**Broad emission spectrum**

By mixing different materials, 

**easy to realize white emission**

---

**Fig. Flexible OLED device**
Mechanism of OLED emission

- Singlet state → fluorescence (short lifetime, fast response)
- Triplet state → phosphorescence (long lifetime, slow response)

Table. Comparison of emissive materials

<table>
<thead>
<tr>
<th>Material type</th>
<th>Emission process</th>
<th>response</th>
<th>Material in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluorescent material</td>
<td>Fluorescence</td>
<td>~ ns</td>
<td>PFO, DCJTI, etc.</td>
</tr>
<tr>
<td></td>
<td>Delay fluorescence</td>
<td>10 ~ 100μs</td>
<td>Eu(dbm)₃phen, etc.</td>
</tr>
<tr>
<td>Phosphorescent material</td>
<td>Phosphorescence</td>
<td>~ μs</td>
<td>Ir(ppy)₃, Ir(piq)₃, Flrpic</td>
</tr>
</tbody>
</table>
Application I

- White emission by blending two or three colors.
  - Ex. Red + Green + Blue → White
  - Red + Blue → White

- Evaluation of response characteristics of emitters.

Application for “Color-tunable OLEDs”

Color adjustment for full-color displays
Color-tunable lighting devices

Fig. Changes of the CIE coordinates at pulse drive
Application II

Signal Generation Units
(Organic Light Emitting Devices)

Optical signal Processing Units

Ribbon Optical Fibers

Signal Receiving Units
(Organic Photodetectors)

• Organic Light Emitting and Receiving Devices (OLED/LD/PD)
• Polymeric Waveguide
• Plastic Optical Fiber (POF)

Flexible Electro-Optic Integrated Devices
[Goal]
Flexible and printable organic electro-optical devices

Fabrication and characteristics of flexible and printable OLEDs and OPDs
H. Kajii (Osaka Univ.)
T. Morimune (Takuma NCT)

Integrated circuit design based on Si technology for organic electro-optical devices
T. Matsuoka, M. Kirihara (Osaka Univ.)

Measurement of fundamental characteristics in organic optical link devices
R. Hidayat (Institut Teknologi Bandung)

Fundamental properties

systemize