Review paper
D. Yokoyama, “Molecular orientation in small-molecule organic light-emitting diodes”
J. Mater. Chem. 21, 19887 (2011) [Feature Article]

1. Characterization

Variable angle spectroscopic ellipsometry (VASE)

Analysis of $\Psi$ and $\Delta$ of elliptically polarized light

$\Psi = 245^\circ$–$1000^\circ$ nm
$\Delta = 45^\circ$–$75^\circ$ (5° stop)

Optical property of film

- $n$: Refractive index
- $k$: Extinction coefficient

Electronic property of molecule

- Molecular polarizability
- Transition dipole moment

Dependence on molecular length

General properties

- The larger the anisotropy of molecular shape is, the more significant the horizontal orientation is.
- The horizontal orientation occurs on any underlying layers and even in a doped film.

2. Control

Orientation can be controlled by deposition on a heated substrate even at a temperature lower than $T_E$


3. Effects on electrical properties

Control by terminal group

Orientation can also be controlled actively by intermolecular hydrogen bonds.


D. Yokoyama et al., Appl. Phys. Lett. 95, 243303 (2009)


4. Effects on optical properties

Dipole orientation of dopant emitter

Dual enhancement in fluorescent OLEDs

- 1.5 times outcoupling efficiency enhancement
- Dual enhancement in extremely high-efficiency fluorescent OLEDs


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5. Application to OPVs

ITO/DBP (20 nm)/C70 (40 nm) /BCP (10 nm)/Al -> PCE >4%


Horizontal orientation of amorphous materials can be effectively used also for OPVs.