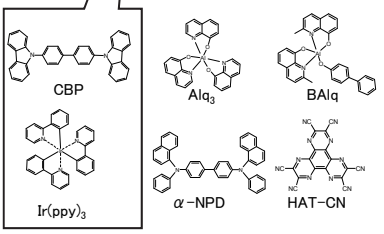
Degradation analysis of OLED
– Influence of trace level water in accelerated test –

Residual water in OLED device is thought to cause structural change in organic materials, which results in decrease of luminance after long term driving. Using GCIB-TOF-SIMS, we detected the increase in the amount of derivatives from host materials in Emission layer (EML).

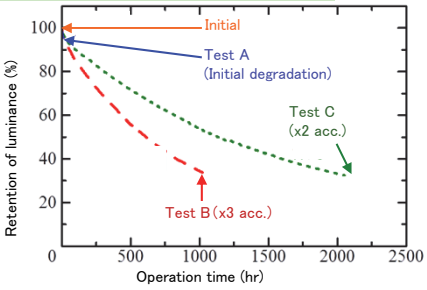
Sample structure and retention curve of luminance

OLED structure

Cathode	Al
EIL	LiF
ETL	Alq_3(30nm)
HBL	BAlq(10nm)
EML	CBP:$Ir(ppy)_3$[6%](30nm)
HTL	α-NPD(50nm)
HIL	HAT-CN(60nm)
Anode	ITO



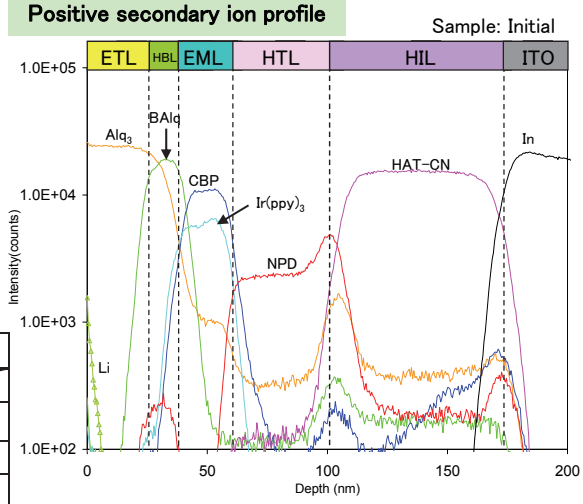
Retention curve of luminance



Sample	Retention of luminance	Current (mA)
Initial	100% (Before test)	
Test A	95% (Initial degradation)	0.74 (x3 acc.)
Test B	34% (Long term degradation)	0.74 (x3 acc.)
Test C	34% (Long term degradation, mild)	0.49 (x2 acc.)

Depth profile of Matrix (GCIB-TOF-SIMS)

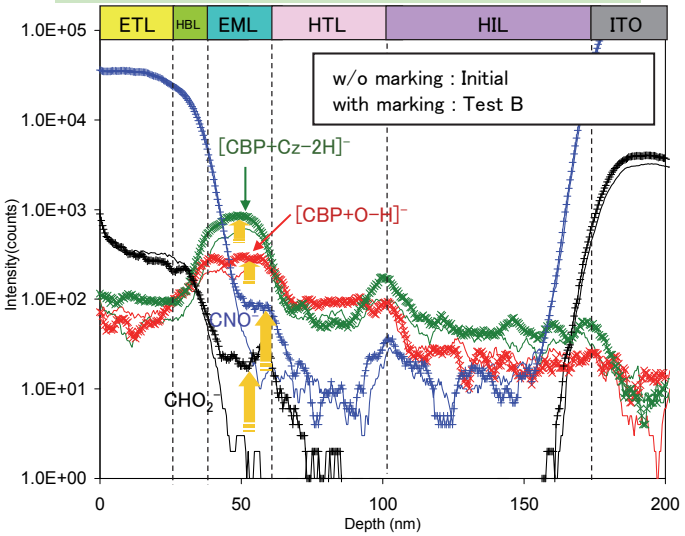
Positive secondary ion profile



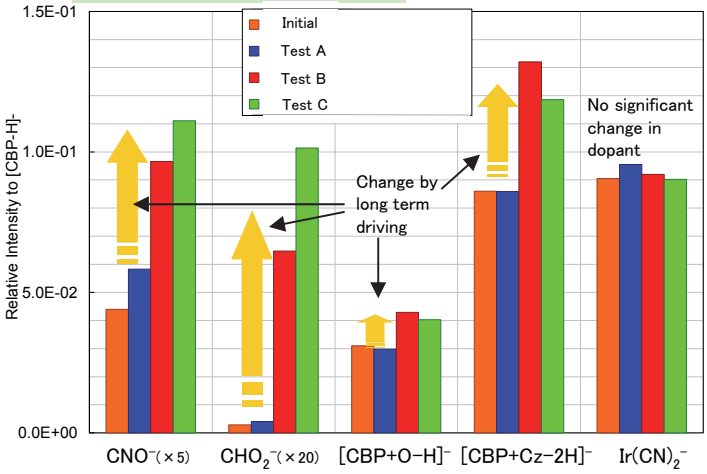
*No substantial change in matrix profile was observed after the test.

Comparison among samples by GCIB-TOF-SIMS

Negative ion profile (Derivatives from host materials)

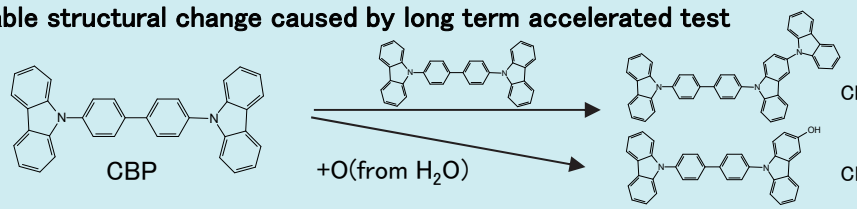


Negative ion intensity in EML



[CBP-H]⁻ : deprotonated CBP molecule
Cz : carbazole group

Probable structural change caused by long term accelerated test



- Trace level residual water in OLED or on ITO should be part of oxygen source; besides EML is presumed to include low molecular weight oxygen-containing compounds such as carboxylic acid.

[From examples by Chemical Materials Evaluation and Research Base (CEREBA) at 17th OLED Symposium, Niigata, 2013]