ISO/TC61/SC11/WG3 – Pre NWIP

Plastic films for organic electric devices - Determination of water vapour transmission rate - Instrumental method

Japan Barrier Society

Agenda

- ✓ Background
  - Features and market trend of flexible electronics devices
  - High-barrier film as substrate of flexible electronics devices
- ✓ Conventional ISO standard of barrier testing method
- ✓ Testing method of high-barrier film
- ✓ Advantage of ISO standardization for high-barrier testing methods
- ✓ Summary

Flexible electronics devices

Portable/ Rollable display

UDC

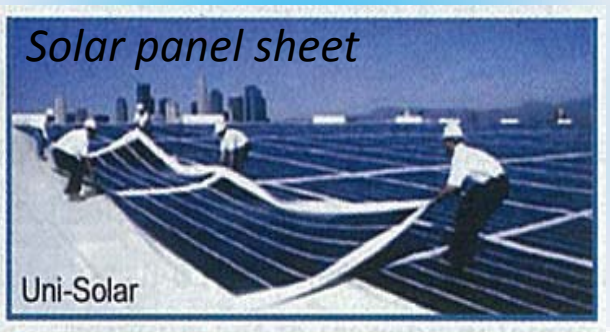
OLED display
(Organic Light-Emitting Diode)

Screen display

New devices with flexible technologies

OLED Lighting

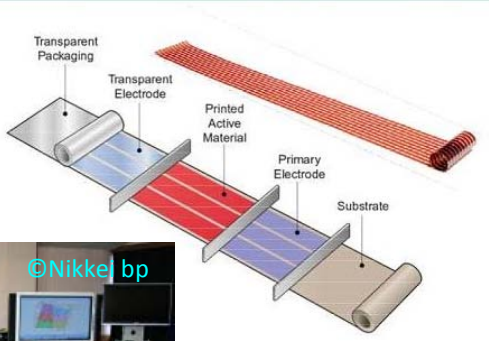
OPV
(Organic Photovoltaic cell)



Features of flexible electronics devices

✓ Low-price

- High productivity by Roll-to-Roll process
- Low shipping cost due to light weight
- 100 $ PC and electrical coursebooks for children



©Konarka

✓ Portability

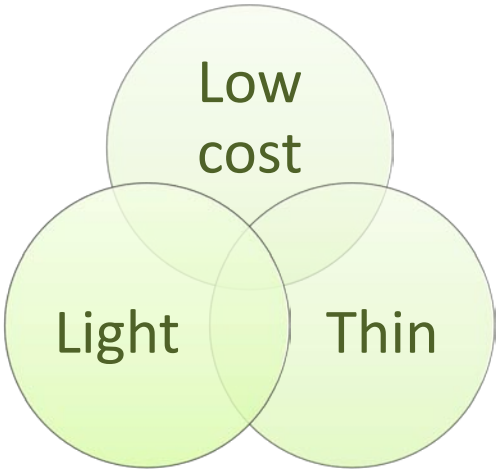
- Rollable or bendable device
- Without electric facilities,
  operation of portable PC, TV, and lighting
  by portable PV

Electrical devices for everyone, in everywhere

Future aspect with flexible devices

✓ Renewable Energy

Low cost and light weight solar cell



✓ Education

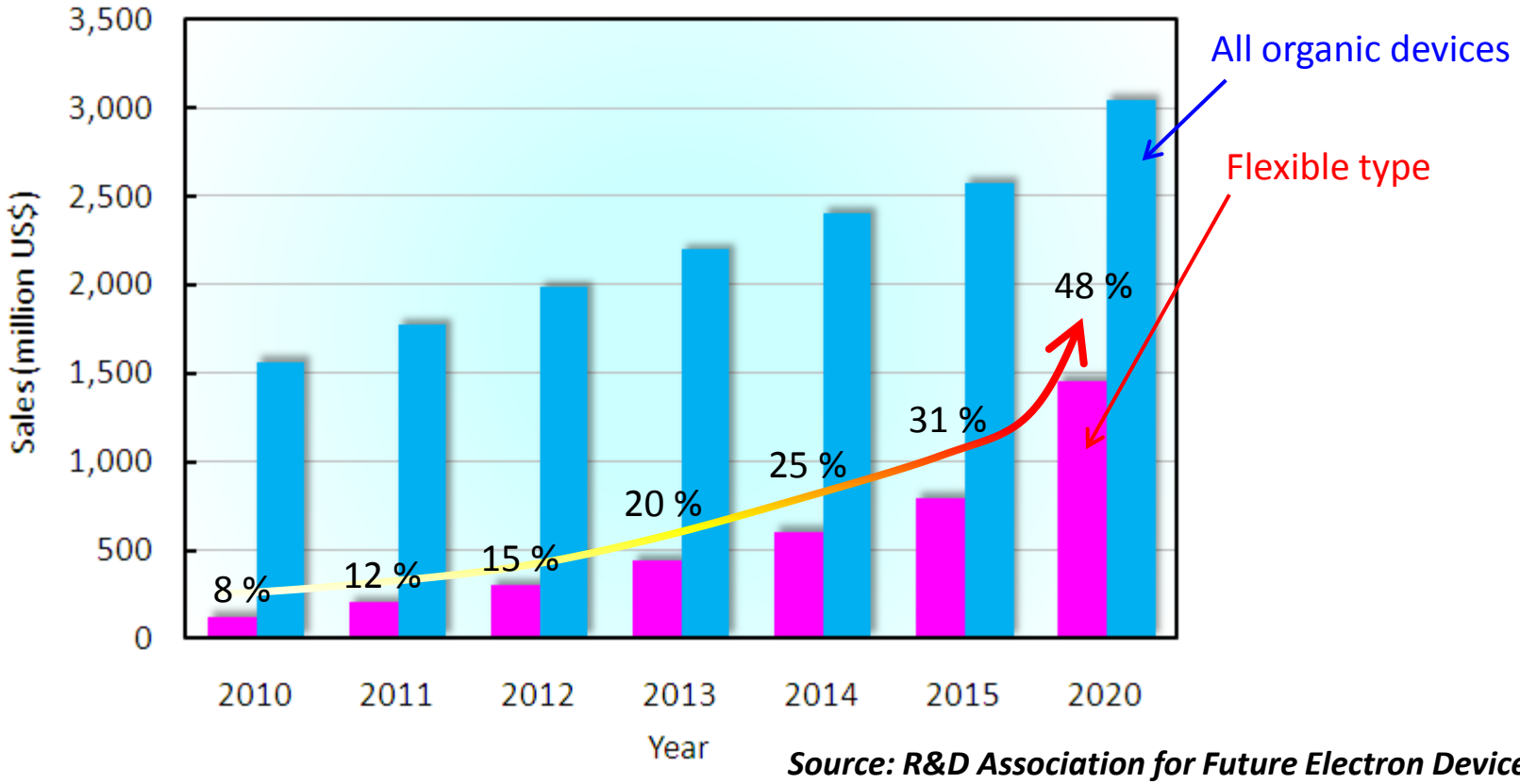
Low cost electrical coursebook for every children

✓ Low CO_2 emission

Light and thin products save transport cost and energy

Global market forecast for organic devices

Global market sales（$ million) of organic devices in 2010-2020E
- Organic devices: OLED display, OLED lighting, E-paper, and organic solar cell -



Source: R&D Association for Future Electron Devices (2006)

✓ Full-fledged market expansion of flexible display is predicted after 2015
✓ In 2020, half of all organic devices are going to be flexible devices

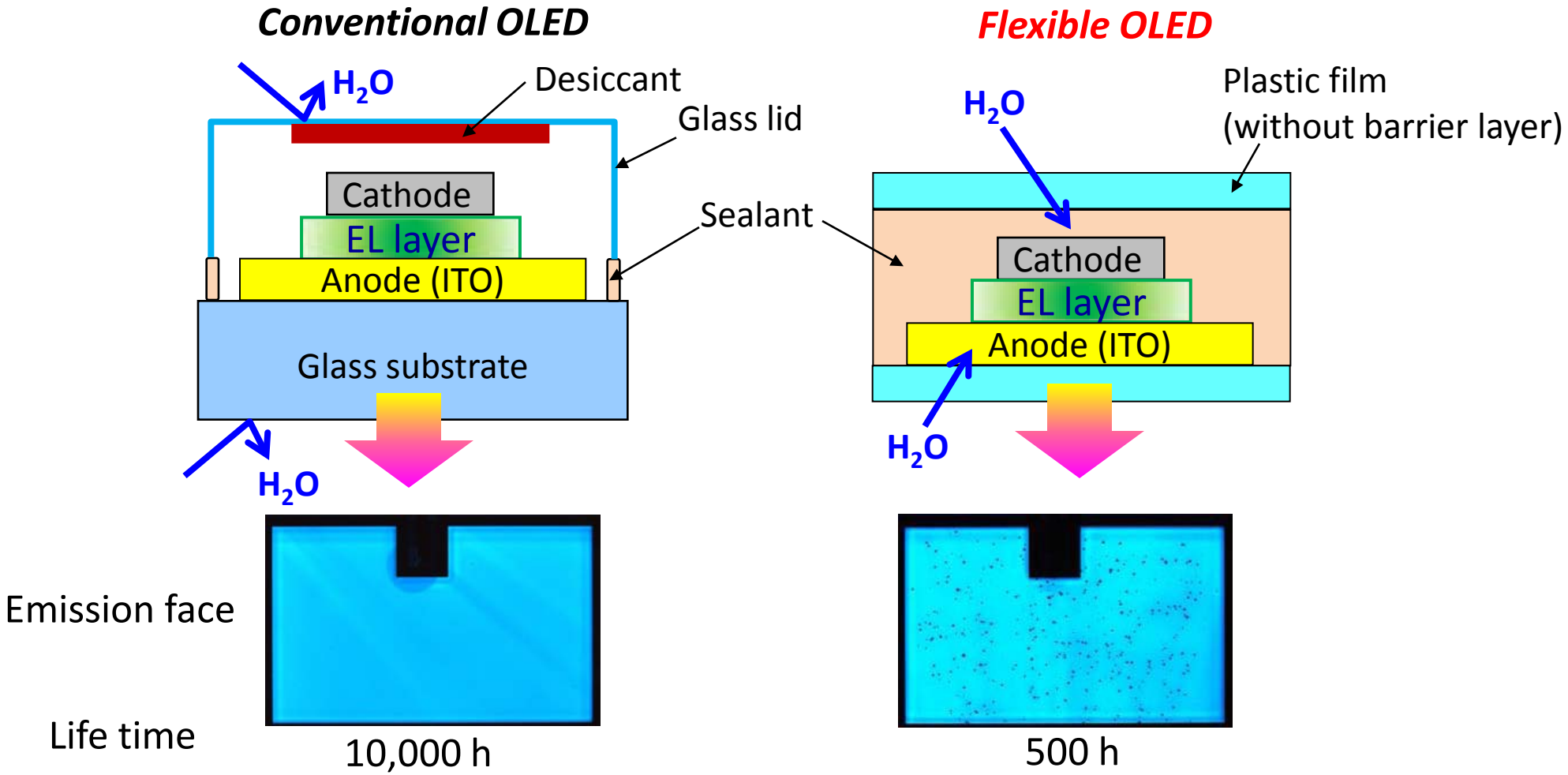
“Glass” to “Plastic”

Required properties for substrate of electronics device

	Glass	Plastic
Flexibility	- -	+ + +
Impact resistance	-	+ +
Water-vapour barrier	+	- - - -
Heat-resistance	+	- -
Dimensional stability	+ +	- -
Light weight	-	+ +
Production cost	-	+ +
Thinness	-	+

Plastic substrate requires water-vapour barrier property

Why does OLED require high-barrier substrate?

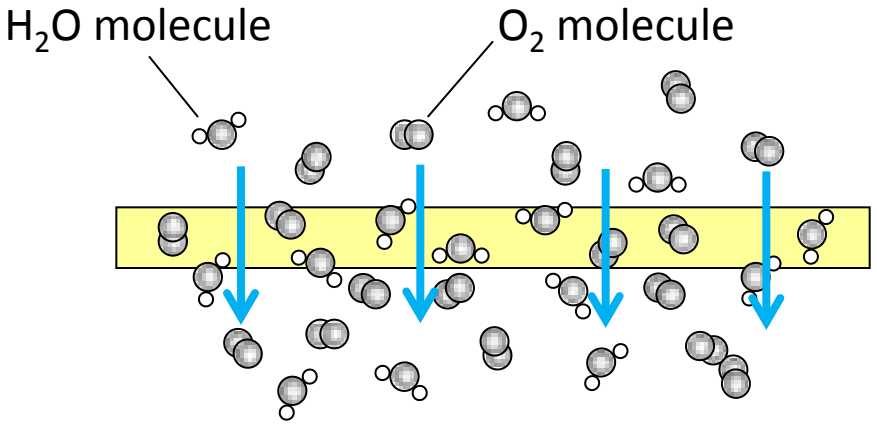


Deterioration of EL material and electrode (cathode like Ca, Mg, Ba)
by reaction with H_2O

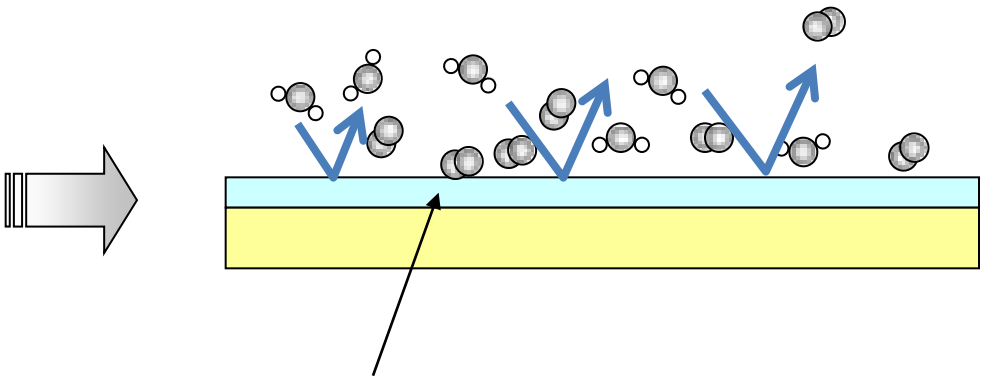
Shortage of life time for luminance of OLED

High-barrier film

Plastic film

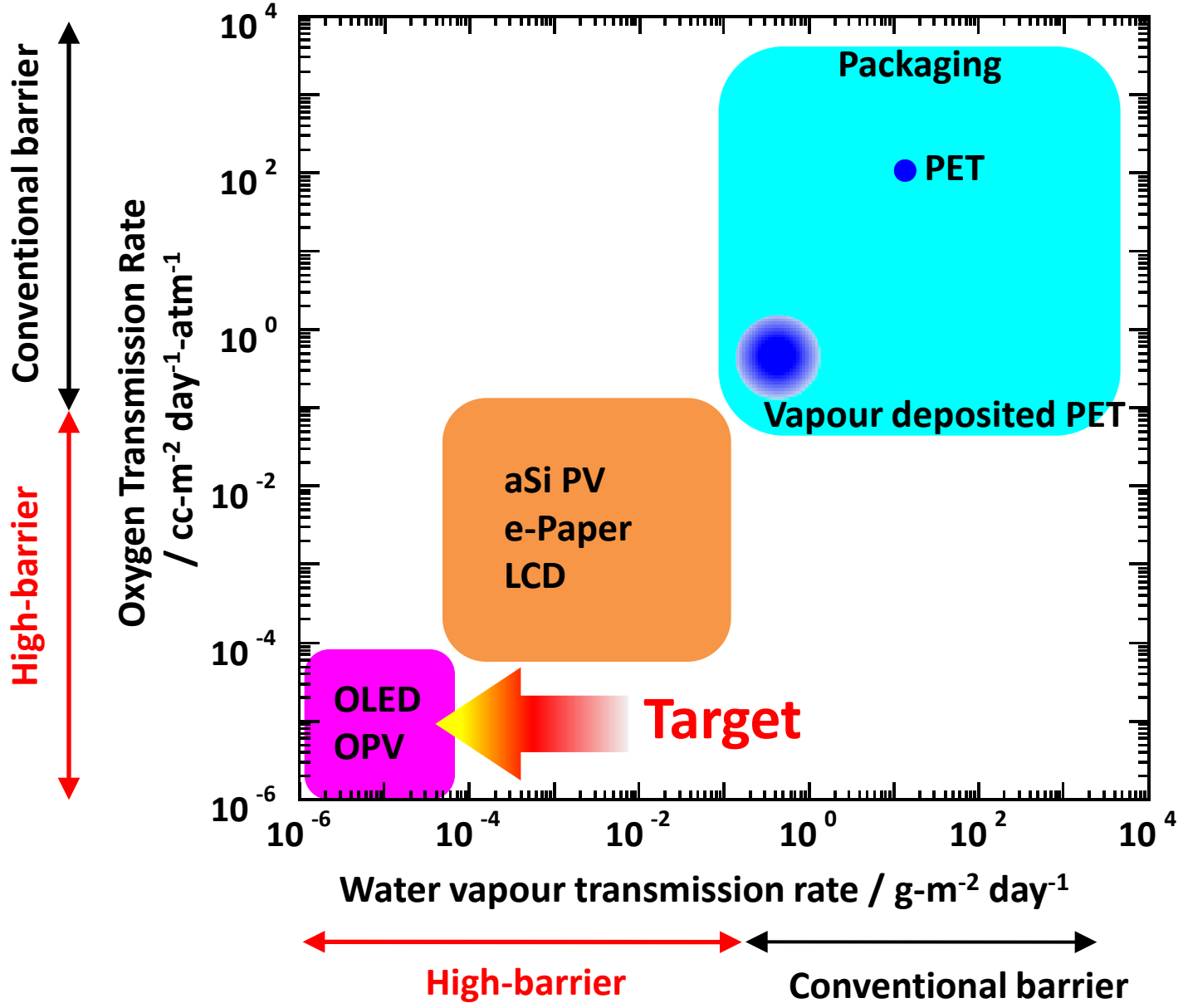


High-barrier film



Gas Barrier Layers (Nanometer scale ～)
ex）AlOx, SiOx …

Requirement of barrier properties



Conventional ISO standards

- ✓ **ISO-02528**
  Cup method

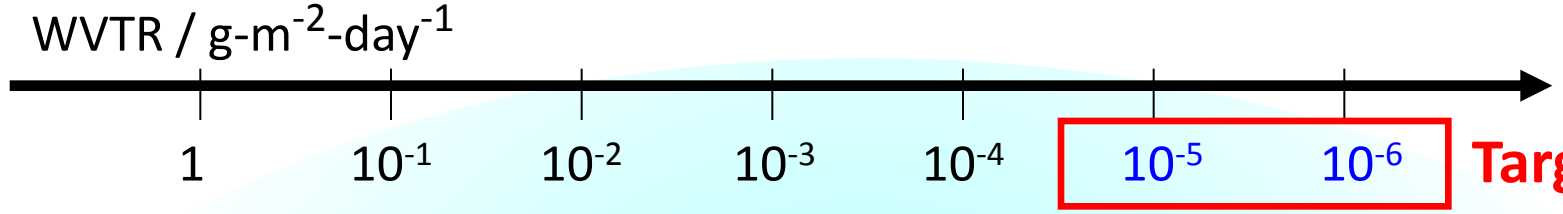
- ✓ **ISO-15106-1**
  Humidity detection sensor method

- ✓ **ISO-15106-2**
  Infrared detection sensor method

- ✓ **ISO-15106-3**
  Electrolytic detection sensor method

- ✓ **ISO-15106-4**
  Gas-chromatographic detection sensor method

Current methods for high-barrier measurement



ISO-15106-1 : L80-5000 (Lyssy /Moisture sensor) ref.1)

ISO-15106-2 : PERMATRAN (MOCON/ IR sensor) ref.2)

ISO-15106-4 : GTR-1000S
(GTR-TECH /Gas Chromatograph) ref.3)

ISO-15106-3 : AQUATRAN (MOCON), MODEL7001 (Illinois)
/Coulometric sensor) ref.4)

DELTAPERM (TECHNOLOX/Pressure gauge) ref.5)

API-MS (NIHON-API / MS) ref.6)

Super detect SKT (TI/ QMS)ref.7)

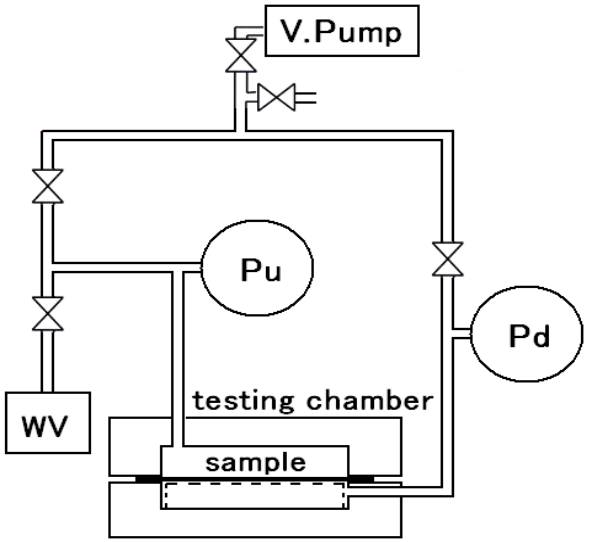
Ca test (Various / Ca film) ref.8)

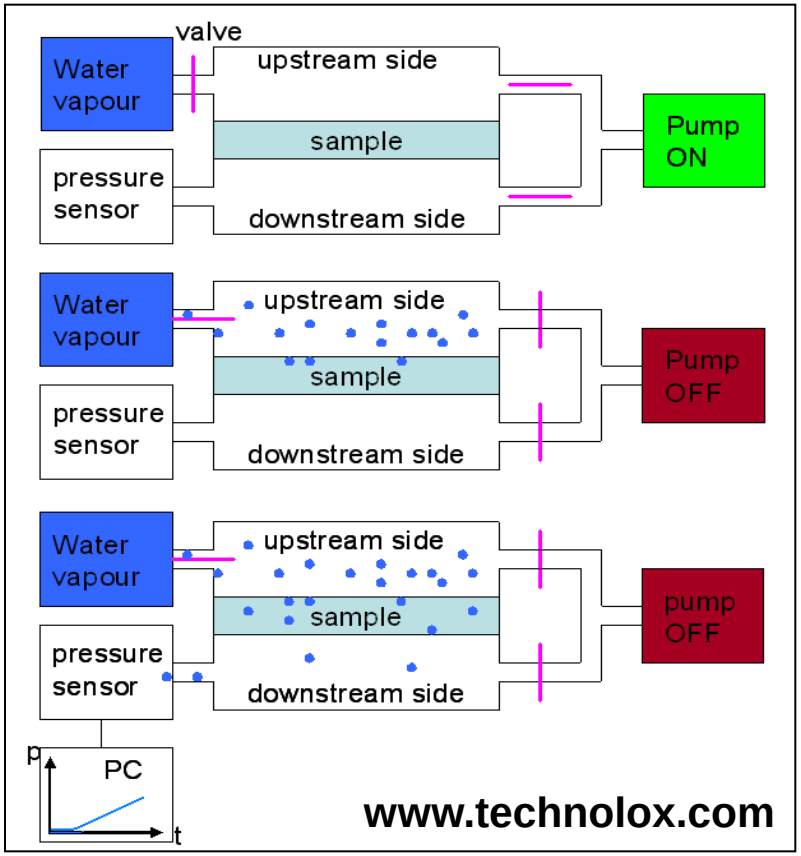
Tritium test ref.9)
(GENERAL ATOMIC)

Ex.1: High sensitive pressure gauge method

WVTR can be calculated by water vapour pressure through barrier film

- Differential pressure method
- Slope of P(t) is proportional to WVTR
- Calibration by standard sample is unnecessary





H. Norenberg
Proc. of the International Display Workshop 2008, p.1435 (2008)

Ex.2: Calcium test

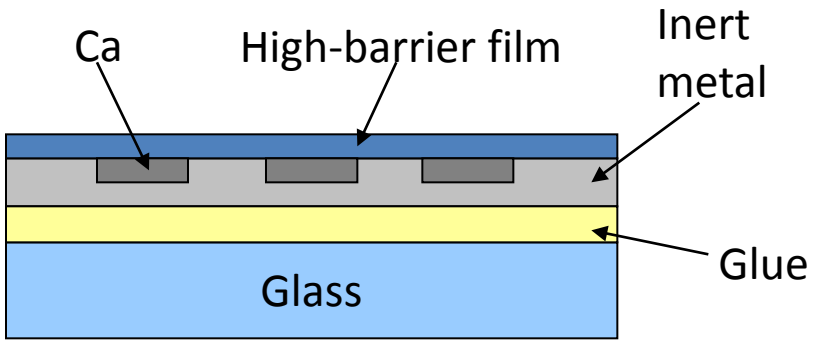
WVTR can be calculated by reacted Ca metal amount

$Ca + 2H_2O \rightarrow Ca(OH)_2$

Metal → Hydroxide

Side view

Measurement sample example



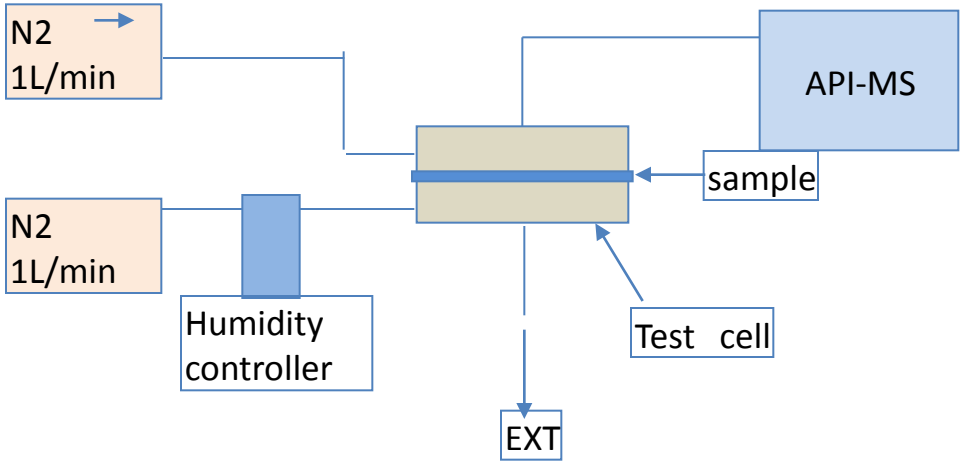
G. Nisato et al.
Proc. of the International Display Workshop/Asia Display, 2001, 1435 (2001)

Ex.3: Atmospheric Pressure Ionization Mass Spectrometry

WVTR can be calculated by water vapour pressure through barrier film

- Equal-pressure method
- High sensitive detector API-MS
-API-MS sensitivity can detect

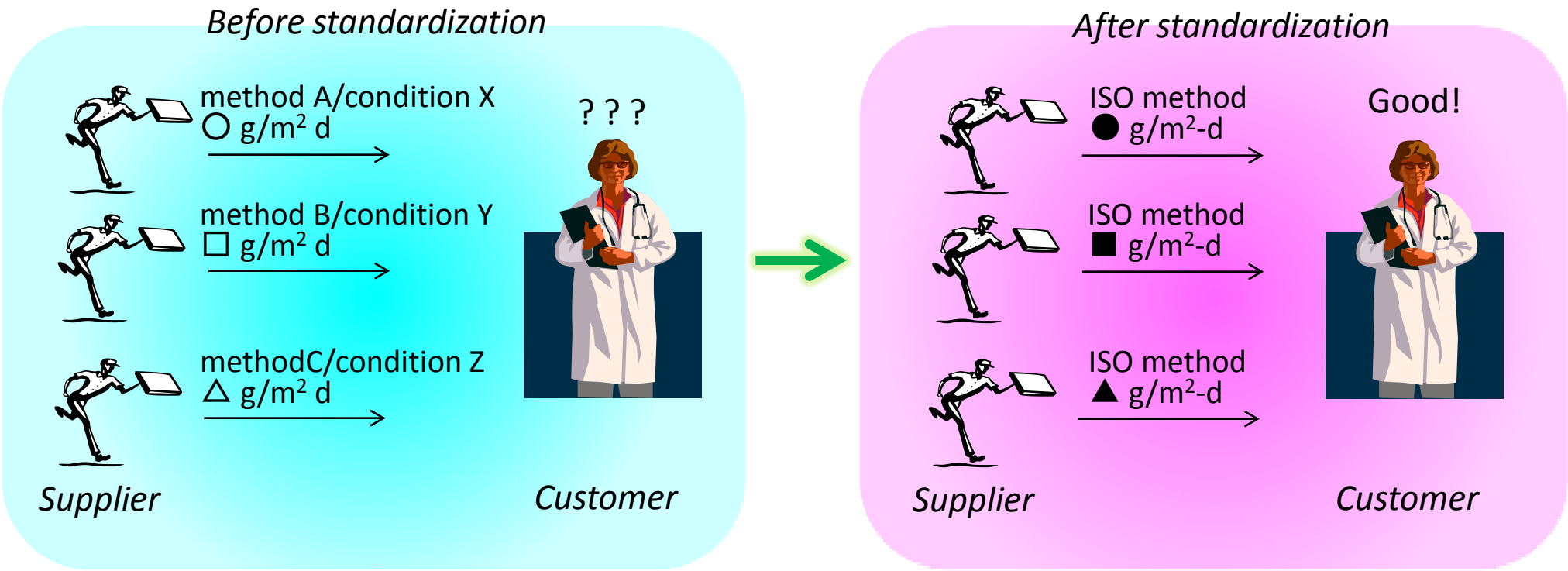
0.0015ppb of H_2O in N_2 gas



Specification brochure in NIHON API
www.apinet.co.jp

Advantage of standardization for WVTR testing

High-barrier films are objectively enabled to evaluate



✓ Customer : Re-evaluation is unnecessary

✓ Supplier : Original method/condition development is unnecessary

Summary

- ✓ Flexible electronics device markets begin to grow up by 2015
- ✓ High-barrier films are key material for flexible electronics devices
- ✓ ISO-15106 series do NOT cover WVTR of high-barrier films
- ✓ Various testing methods for high-barrier films have been proposed

ISO standardization for the high-barrier testing method is required*!!*

References

1) Specification brochure in Illinois Instruments Inc. www.systecillinois.com

2) Specification brochure in Mocon Inc. www.mocon.com

3) Specification brochure in GTR Tec Corporation www.gtr-tec.com

4) Specification brochure in Mocon Inc. www.mocon.com

5) H. Norenberg, *Proc. of the International Display Workshop 2008* (2008)

6) Specification brochure in NIHON API Co.,Ltd www.apinet.co.jp

7) Y.Takahashi et al., *IEICE Technical Report* , OME2010-19, 11(2010)

8) A.G.Erlat et al., *Proc. Soc.Vac.Coaters.*, p.654 (2004)

9) T.Clausen et al., *DOE Solid State Lighting Manufacturing Workshop* (2009)

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