# Evaluation of Water-vapor-barrier Properties for Flexible OLEDs.

*Akira Suzuki[1], Atsushi Uehigashi[1], Hisashi Takahagi[1], and Shigeki Hara[2]*
**[1] Chemical Materials Evaluation and Research Base (CEREBA), Ibaraki 305-8565, Japan.**
*Tel.:81-29-875-7626, E-mail: a-suzuki@cereba.or.jp*
**[2] National Institutes of Advanced Industrial Science and Technology (AIST), Ibaraki 305-8565, Japan.**

Degradation resulting from the ingress of water vapor into devices is particularly a serious problem for those using flexible organic light emitting diodes (OLEDs) [1]. It is generally held that it is necessary to assure a water vapor transmission rate (WVTR) of less than $10^{-5}$ g·m$^{-2}$·day$^{-1}$ to attain an OLED service life in excess of 10,000 h [2]. This estimate, however, has not yet been proven because it is difficult to quantify the amount of water vapor ingress into a device. We focused on the development of a reliable technique for evaluating a barrier film, which is a key material for the encapsulation of flexible OLEDs.

The variables affecting WVTR measurements were investigated because the results of such evaluations typically vary widely [3]. Threfore, a series of films have been developed in order to eliminate differences between individual barrier films and enable the comparison of WVTR as detected by different systems [3,4]. The films consist of aluminum foil attached to a 100-μm PET film with adhesive layer (AL-PET®). An artificial pinhole is created in the center of the A1 layer by etching. A low WVTR value could be achieved by controlling the pinhole size. Comparative measurements were performed using two equal-pressure systems (atmospheric pressure ionization mass spectrometry (API-MS) and cavity ring-down spectroscopy (CRDS)) and a differential pressure system (DELTAPERM). The WVTR in steady state as a function of the opening area of the pinhole are shown in Figure 1.

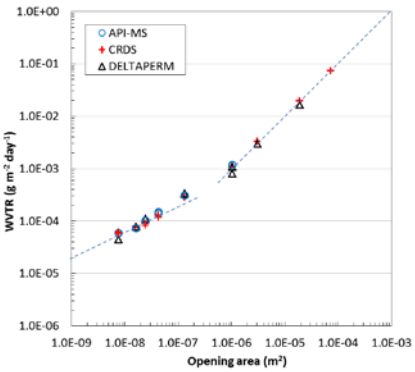


**Fig. 1. Comparative measurements of the WVTR as a function of the opening area of the films.**

Consistency between the systems in terms of the WVTR is achieved to a level of $10^{-5}$ g·m$^{-2}$·day$^{-1}$ at 40°C and 90% relative humidity. These results prove the reliability of not only our evaluation but also of these three systems, provided the measurements have been undertaken correctly.

**Acknowledgment**

This development was partly carried out under "Development of Fundamental Evaluation Technology for Next-generation chemical Materials" commissioned by the New Energy and Industrial Technology Development Organization (NEDO), Japan.

**References**

1. M. Schaer, F. Nüesch, D. Berner, W. Leo, and L. Zuppiroli, Adv. Funct. Mater. 11, 116 (2001).
2. P. E. Burrows, G. L. Graff, M. E. Gross, P. M. Martin, M. K. Shi, M. Hall, E. Mast, C. Bonham, W. Bennett, and M. B. Sullivan, Displays 22, 65-69 (2001).
3. S. Hara, A. Suzuki, and H. Takahagi, Proc. of the International Display Workshop 2013 (2013).
4. A. Suzuki, H. Takahagi, A. Uehigashi, and S. Hara, SID Symp. Dig. Tech. Papers, 45, 108 (2014).