New evaluation methods on various gas barrier performances using functional oxide films (2); Hydrogen gas barrier properties.

T. Kurihara[1], M. Suzuki[1], M. Kim[1], K. Yamada[2], H. Machinaga[2] and *Y. Shigesato[1].
[1] *Graduate School of Science and Engineering, Aoyama Gakuin University, Kanagawa, Japan.*
[2]*Thin Layer and Printed Circuit Technology Research Center, Nitto Denko Corp., Osaka, Japan.*
*yuzo@chem.aoyama.ac

1. Background

Hydrogen energy is considered to be the promising energy source due to its environmental benefits and relatively simple production processes. Whereas, several challenges, such as leakage and hydrogen embrittlement, must be addressed. Therefore, the development of hydrogen gas barrier performance to prevent hydrogen transmission should be quite important. In this study, Pd-capped amorphous WO_3 films were used to evaluate the hydrogen gas barriers performance quantitatively for the various films using gasochromic behaviour of WO_3.

2. Experimental Procedures

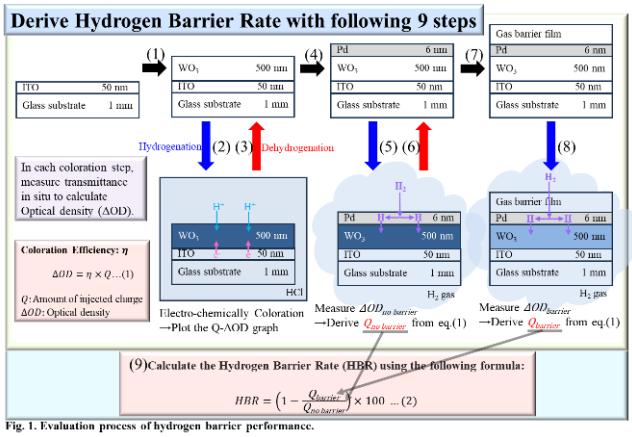

Fig. 1. Evaluation process of hydrogen barrier performance.

The schematic illustrations for this hydrogen barrier rate (HBR) analyses are shown in Fig. 1. All the films in this study were deposited using reactive sputtering. Gas barrier films (GBF) of amorphous SiO_2, Al_2O_3, and SiN_x with various thicknesses were deposited on the Pd-capped a-WO_3 films. The hydrogen transmission flux (HTF) defined as the slope of the plot of hydrogen amount per unit area and time (/cm^{2}sec) was also estimated.

3. Results

Figure. 2 shows the transmittance spectra before and after hydrogen exposure for both GBF-coated and uncoated samples. As for the example, the results on the SiO_2 films as GBF with various thicknesses are presented. HBR for three different gas barrier materials are shown in Fig. 3. The thicker films clearly exhibited higher HBR. The order of barrier performance was SiN_x > Al_2O_3 > SiO_2. The plot of hydrogen amount per unit area versus time, used to derive the HTF, is shown in Figure. 4, and the HTF values for each barrier film are summarized in Figure. 5.

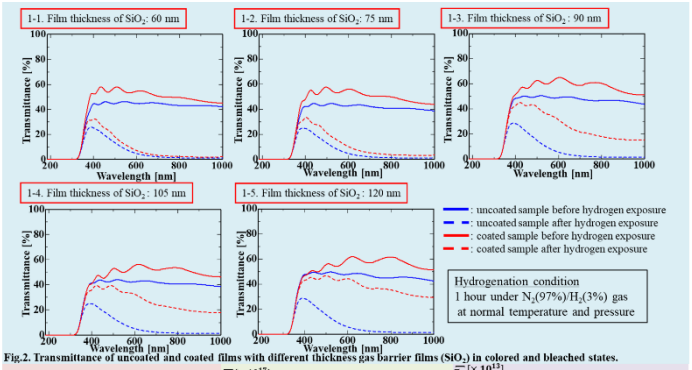

Fig.2. Transmittance of uncoated and coated films with different thickness gas barrier films (SiO_2) in colored and bleached states.

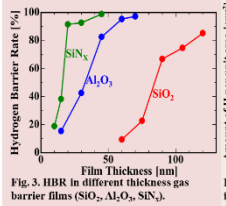

Fig. 3. HBR in different thickness gas barrier films (SiO_2, Al_2O_3, SiN_x).

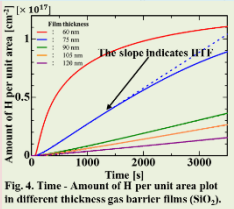

Fig. 4. Time - Amount of H per unit area plot in different thickness gas barrier films (SiO_2).

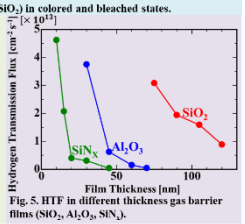

Fig. 5. HTF in different thickness gas barrier films (SiO_2, Al_2O_3, SiN_x).