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Electronic Supporting Information

Multilayer thin film for the construction of active repulsive hydrogen barrier

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Experimental details

Materials:

PET films (thickness - 130 μ m, GMP), Nafion (D2021, 20 wt%, DuPont, USA), Poly(diallyldimethylammonium chloride) solution (20 wt% in H₂O, Aldrich), Poly(sodium 4-styrenesulfonate) solution (Mw ~70,000, 30 wt% in H₂O, Aldrich).

Modification of PET surface:

The PET films were sonicated with methanol, water, and acetone for 30 min, respectively, and then were cut into 4.5×4.5 cm sizes. After that, the surface of PET was modified by oxygen plasma treatment for 10 min to increase the hydrophilic nature.

The preparation of multilayer ARHB-tfims:

A positively charged PDDA aqueous solution (5 mg/mL) was prepared at pH 7. A negatively charged PSS aqueous solution (5 mg/mL) and NaCl solution (0.01 M) were also prepared. LBL assembly is as follows. Modified PET substrates were immersed into

the PDDA aqueous solution for 10 min, followed by thoroughly rinsing with NaCl solution for 3 min. And then it subsequently was immersed into the PSS aqueous solution for 10 min, followed by rinsing with NaCl solution for 3 min. All of this procedure was 1 cycle. After 20 times repeat, the desired number of bilayers were achieved. Note that LBL should be completed by the coating of PDDA at the last for electrostatic repulsion between proton and PDDA. Finally, it was dried in atmosphere. Nafion solution (20 wt%) was dropped on the LBL-coated film and then nafion layer was formed by spin coating in 2000 RPM for 40 s. Pd/Au layer was prepared through plasma coating process for 180 s.

Characterization:

The thermal stability study was conducted for thermogravimetric analysis (TGA, TA instrument, US/TA5000) at the scanning rate (10 °C/min) from 20 °C to 700 °C under nitrogen atmosphere. The morphology of the samples at each steps was observed using AFM (Bruker; model multimode-8) in tapping mode. FE-SEM study (Carl Zeiss, SUPRA-40VP) was conducted by sputtering osmium prior to examination. Hydrogen gas barrier properties of net PET and other samples were measured using a GDP-E (Brugger Feinmechanik GmbH) gas permeability machine. The sample size was 4.5 cm². The measurement temperature was 25 °C and pressure was at 100 kPa.



Fig. S1 TGA analysis of net PET film, nafion membrane, LBL-coated PET film and nafioncoated PET film.



Fig. S2 FE-SEM images of LBL samples at 1, 3, 5, 10, 15, and 20 bilayers, respectively.



Fig. S3 Photographs of WCA and AFM of the LBL samples at 5, 10, 15, and 20 bilayers, respectively.



Fig. S4 Photograph of GDP-E (Brugger Feinmechanik GmbH) gas permeability measurement instrument.



Fig. S5 Permeability coefficient of multilayer ARHB-tfilm before and after attaching the ground wire under different pressures.