

Supporting Information

Ion-Exchange Functional Group-Containing Poly(ether ether ketone)s: Preparation and Use as Binder in Fabrication of Carbon Electrodes to Improve Capacitive Deionization Efficiency

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이온교환 작용기를 갖는 Poly(ether ether ketone): 제조 및 축전식 탈염 효율을 향상시키기 위한 탄소전극 바인더로서의 활용

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Section 1. APEEK.

APEEK was prepared as shown in Scheme 1a, by following the procedures reported in the literature.¹ PEEK (5 g) was dissolved in a 500 mL three-neck flask containing 400 mL of methanesulfonic acid, followed by the addition of 0.425 g paraformaldehyde, 1.66 g trimethylchlorosilane, 0.25 mL tin(IV) chloride, and sulfuric acid. The resulting mixture was reacted at 45 °C for 36 h. Excess water was poured into the reaction mixture to cause a white precipitate. The precipitate was then washed with distilled water several times, and dried in a vacuum oven at 60 °C for 1 h, to give 5.31g of chloromethylated PEEK (CMPEEK). The isolated CMPEEK (5.0 g) was dissolved in 500 mL DMF, followed by the addition of 13 g of trimethylamine. The resulting solution was allowed to react at room temperature for 24 h. The reaction mixture was poured into excess diethyl ether to cause a white precipitate, which was then washed with ether several times, and dried in a vacuum oven at 60 °C for 1 h, to give 5.11g of APEEK.

Section 2. SPEEK.

PEEK powders (14.0 g) were dissolved in 500 mL of sulfuric acid at room temperature for 16 h (Scheme 1b), by following the procedures reported in the literature.² The solution was heated to 65 °C, and stirred for 1.5 h. After being cooled to room temperature, the reaction mixture was slowly poured into ice water. The precipitate was washed with distilled water several times, until the pH became neutral, dried in a vacuum oven at 80 °C for 12 h and at 130 °C for 5 h, to give 13.6 g of SPEEK.

Section 3. Ion-exchange capacity (IEC).

The IEC values of APEEK and SPEEK were estimated using the titration method.³ APEEK or SPEEK was immersed in 0.05 M NaOH or HCl, respectively, treated with ultra-sonication for 30 min, and 1 day was allowed for complete substitution of functional groups with ions. After the addition of a few drops of phenolphthalein, the remaining solutions were titrated with either 0.05 M HCl or 0.05 M NaOH solution. The IEC values were calculated by the following equation:

$$\text{IEC (meq/g)} = \frac{(C_T \times V_T)}{W_{\text{dry}}}$$

where, C_T is the concentration of the titrant solution, V_T is the volume of the titrant solution, and W_{dry} is the weight of dried APEEK or SPEEK.

Section 4. Water uptake (WU).

The prepared polymers (1.0 g) were dissolved in 10 mL DMF, and the resulting solution was cast on a glass plate, and dried at 60 °C for 12 h, and 100 °C for 6 h. The prepared membranes were peeled off from the glass plates, weighed, and immersed in water at room temperature for 24 h. The membranes were then taken out of the water,

wiped with a tissue paper, and weighed. The WU of each membrane was calculated by the following equation:

$$WU(\%) = \frac{W_{wet} - W_{dry}}{W_{dry}} \times 100$$

where, W_{dry} and W_{wet} are the weights of polymer membranes before and after the water immersion, respectively.¹

References.

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