

# Supporting information

## **Permselective SPEEK/Nafion Composite-Coated Separator as a Potential Polysulfide Crossover Barrier Layer for Li-S Batteries**

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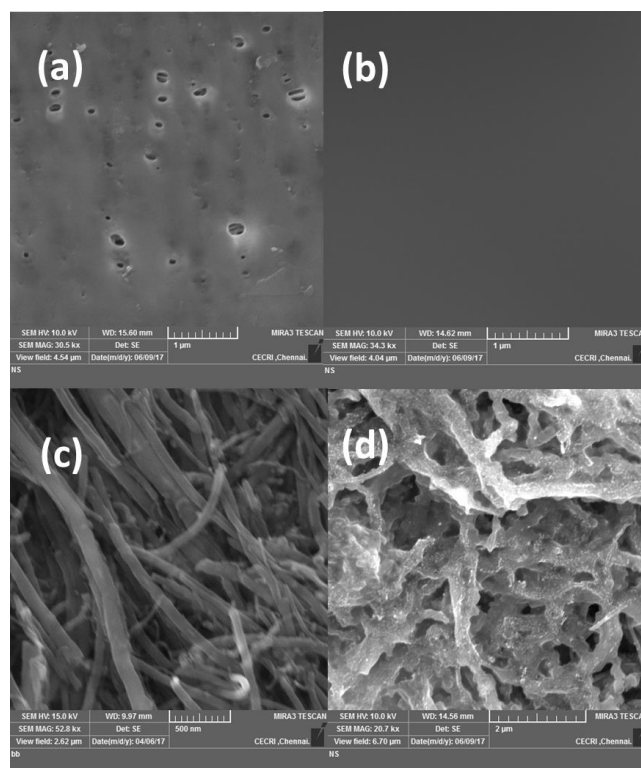
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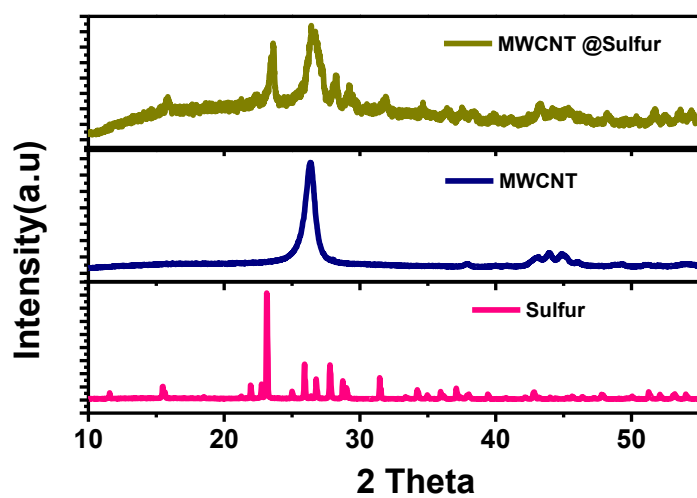
### **Author information**

Corresponding Authors

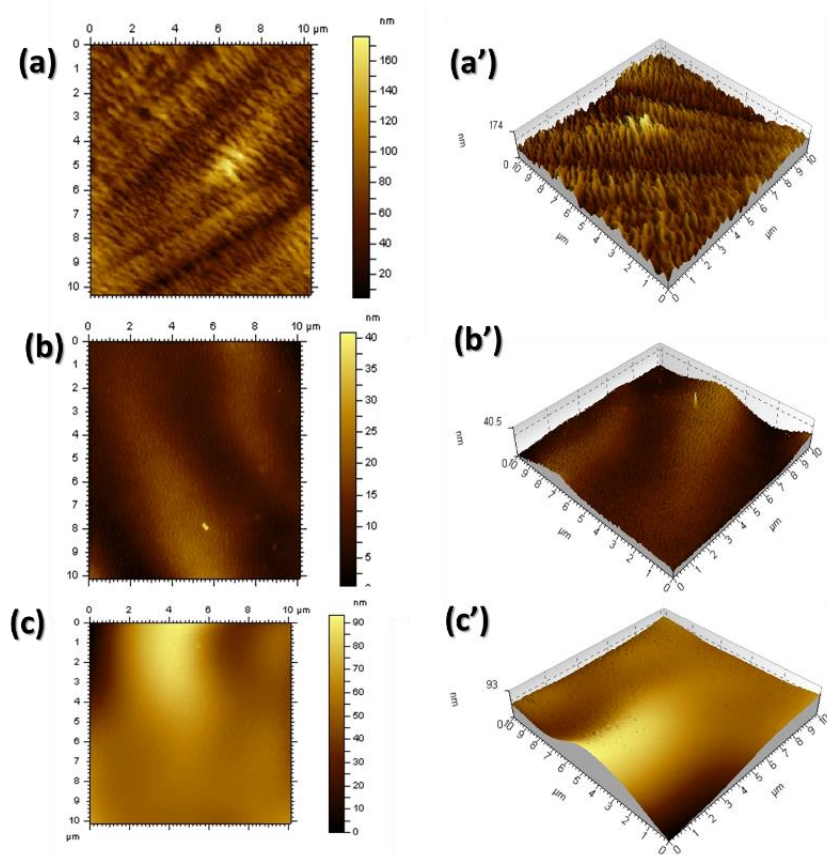
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**Figure S1 :** (a ) SPEEEK-25 coated separator (b) SPEEEK- 75 Coated separator (c ) S@MWCNT paper composite (d) Cycled S@MWCNT paper composite.



**Figure S2.** XRD of sulfur, MWCNT and MWCNT@ Sulfur composite.



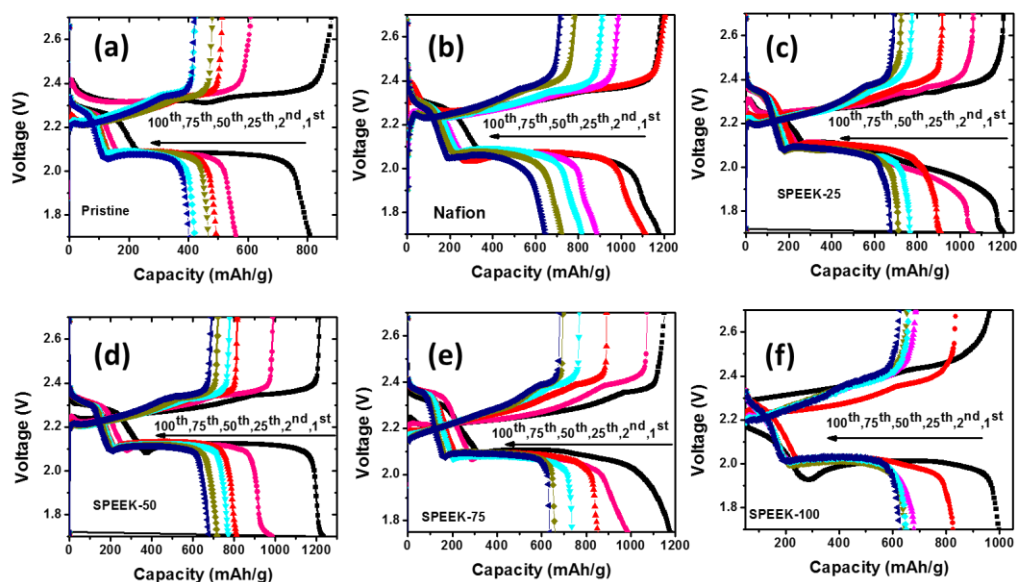
**Figure S3:** AFM 2D and 3D- morphological images of separator (a, a') Pristine (b, b') Nafion (c, c') SPEEK-100.

## Structural Characterizations

X-Ray Diffraction (XRD) analyses were performed on Bruker D8 advance Davinci diffractometer equipped with Cu K $\alpha$  radiation source ( $\lambda = 1.5418 \text{ \AA}$ ) at a generator voltage of 40 kV and current of 30 mA with a scanning speed of  $2^\circ/\text{min}$  ( $2\theta$ ). The morphology of samples characterized by using field-emission scanning electron microscope (FESEM MIRA3 LMU) with EDX attachment for elemental composition analysis, TESCAN instrumentation. AFM imaging is carried out with the help of Nanoscope E-3138J instrumentation. Contact angle measurement is taken with Data Physics OCA35, Germany. XPS analysis is performed by Thermo Scientific ESCALAB 250 xi MULTILAB 2000.

## Electrochemical Measurements

The as prepared S@MWCNT paper is used as cathode with the thickness of  $120 \mu\text{m}$ , lithium metal acts as a both reference and counter electrode with the thickness of  $700 \mu\text{m}$  and modified celgard (2400) separator is used for the separation of both the electrode with the thickness of  $25.7 \mu\text{m}$ . The electrolyte is 1 M bis (trifluoromethane) sulfonamide lithium salt (LiTFSI, Sigma-Aldrich) in 1, 2-dimethoxyethane (DME, Sigma-Aldrich) and 1,3Dioxalane (DOL, Sigma-Aldrich) in 1:1 V /V%. Coin cell were assembled in argon filled glove box (where  $\text{O}_2$ ,  $\text{H}_2\text{O}$  levels restricted to  $\leq 1\text{ppm}$ ). The cells were galvanostatically cycled in the voltage range of 1.7- 2.7V. The cycling voltammetry is performed at 0.01mV scan speed within 1.7- 2.7V and electrochemical impedance studies were performed over a frequency range of 400 kHz to 50 mHz. All experiments are carried out in VMP3Z Biologic multichannel galvanostat/ potentiostat. The capacities are calculated based on mass of sulfur in the electrode.



**Figure: S4** Discharge-charge profile of Li-S cell with various composite ionomer coated separators at 0.2C rate (a) pristine (b) Nafion (c) SPEEK-25 (d) SPEEK-50 (e) SPEEK-75 (f) SPEEK-100.