Supporting Information

Bio-Inspired Polyethersulfone Membrane Design via Blending with Functional Polyurethane

S1. Anti-Fouling Property of Membranes

For antifouling property studies, 1.0 mg/mL BSA solution (PBS, pH=7.4) was used. The test membranes were pre-compacted at the pressure of 100 mm Hg for 10 min by PBS solution flow to reach a steady state; then the pressure was decreased to 60 mm Hg for the flux measurement. After 30 min filtration, the feed solution was switched to 1.0 mg/mL BSA solution (pH 7.4), and the flux for BSA solution was measured. Finally, the membranes and the solution reservoir were fully emptied and refilled with DI water. The membranes were cleaned with DI water for 10 min, and then the PBS solution flux was measured again. Both the fluxes for PBS solution and BSA solution were calculated by equation (1).

$$Flux = \frac{V}{S*t*P} \quad (1)$$

where V is the volume of the permeated solution; S is the effective membrane area; t is the time of the solution collecting; and P is the pressure applied to the membranes.

In order to evaluate the fouling-resistant ability of the membranes, flux recovery ratio (F_{RR}) was calculated using equation (2).

$$F_{RR} = \left(\frac{F_{W2}}{F_{W1}}\right) \times 100\% \quad (2)$$

where Fw_1 and Fw_2 (mL / (m^2 ·h ·mmHg)) are the PBS solution flux before and after protein ultrafiltration.

S2. Blood Compatibility of Membranes

S2.1. Protein Adsorption

The protein adsorption behavior of PES membranes was carried out according to our previous study [1]. Briefly, the membrane with an area of 1 ×1 cm^2 was incubated in phosphatic buffer solution (PBS) for 12 h prior to use. Subsequently, the membrane was immersed in 1.0 mg/mL protein (BSA or FBG) solution at 37 ℃ for 2 h; then rinsed slightly with PBS solution and DI water for three times. Afterwards, the membrane was immersed in 2 mL 2 wt. % sodium dodecyl sulfate (SDS) aqueous solution at 37 ℃ for 1 h to remove the adsorbed proteins. The protein concentration in the SDS solution was determined by using the Micro BCA™ Protein Assay Kit (Thermo Scientific), and then the adsorbed protein amounts were calculated. At least three measurements were averaged to obtain a reliable value.

S2.2. Platelet Adhesion

The platelet adhesion behavior of PES membranes was also based on a previous report [1]. In brief, healthy fresh human blood (man, 25 years old) was collected using vacuum tubes containing sodium citrate as an anti-coagulant; the concentration of the sodium citrate was 3.8 wt. %, and the ratio of the anticoagulant to blood was 1:9 v/v. The blood was centrifuged at 1000 r.p.m. for 15 min to obtain platelet-rich plasma (PRP) or at 4000 r.p.m. for 15 min to obtain platelet-poor plasma (PPP).

The membrane was immersed in PBS solution and equilibrated at 37 ℃ for 1 h. The PBS was removed and then 0.5 mL fresh PRP was added. The membrane was incubated with PRP at 37 ℃ for 1 h, subsequently rinsed slightly with PBS solution for three times. Finally, the membrane was treated with 2.5 wt. % glutaraldehyde in PBS at 4 ℃ for 1 day. The sample was washed through a series of graded alcohol-PBS solutions (0, 25, 50, 75 and 100 %) and dried at room temperature. The platelet adhesion was observed using a FE-SEM (JSM-7500F, JEOL, Japan).

S2.3. Clotting Time

The activated partial thromboplastin times (APTTs) and thrombin times (TTs) for the membranes were measured by a semi-automated blood coagulation analyzer (CA-50, Sysmex Corporation, Kobe, Japan) to evaluate the contact activation pathway and the abnormality in the conversion of fibrinogen to fibrin in coagulation, respectively. Briefly, the membranes (0.5×0.5 cm^2, three or four pieces) were incubated with 0.1 mL PPP in a transparent plastic tube at 37 ℃ for 30 min, and then the APTT and TT were measured. The test was repeated three times for each sample to get a reliable value.

S2.4 Enzyme-Linked Immune Sorbent Assays (ELISA)

Commercial ELISA was used to investigate the platelet activation (Human Platelet Factor 4 (PF-4), Cusabio Biotech, China), coagulation activation (thrombin-antithrombin III complex (TAT), Enzygnost TAT micro, Assay Pro, USA), and complement activation (C3a and C5a, Cusabio Biotech, China). Briefly, the blood was centrifuged for 20 min at 2000 rpm (4 ℃) to obtain plasma. The plasma was then

mixed with specific inhibitors for each assay and centrifuged according to the respective instruction manuals. The control experiment was conducted simultaneously using the same methods without adding the test samples. All the experiments were repeated three times to get a reliable value. All the blood related experiments were approved and performed by West China hospital, Sichuan University, and all experiments were performed in compliance with the relevant laws and national guidelines of China.

References

1. Wang R, Xiang T, Zhao WF, Zhao CS. A facile approach toward multi-functional polyurethane/polyethersulfone composite membranes for versatile applications. Materials Science & Engineering C-Materials for Biological Applications 2016;59:556-564.