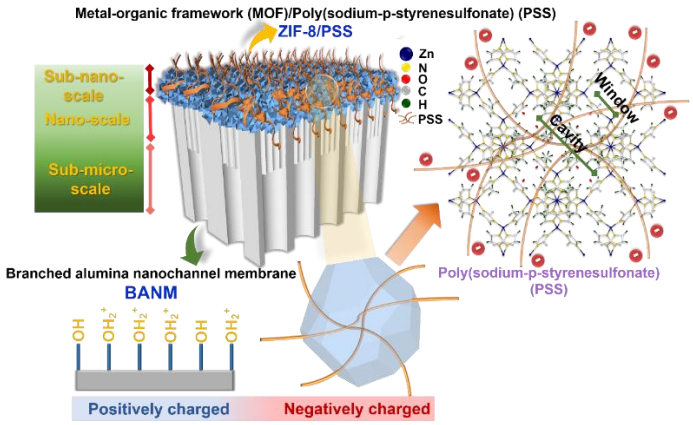
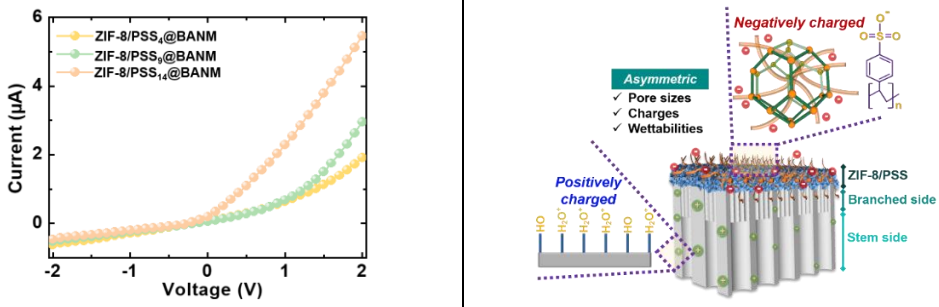
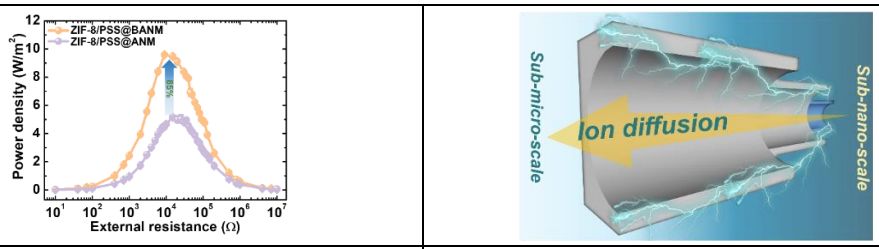


Fig. 1. Schematic depiction of the MOF-based heterogeneous membrane with high-geometry gradient and high space charge density, which is composed of a thin layer of zeolitic imidazolate framework-8 (ZIF-8)/ polystyrene sulfonate (PSS) and a branched alumina nanochannel membrane (BANM).



(a) (b)

Fig. 2. Unidirectional and controllable ion transport property of ZIF-8/PSS$_x$@BANM in LiCl-methanol. (a) The scanned I-V curve as a function of PSS loading amount. (b) Multiple broken symmetry structures of ZIF-8/PSS@BANM induce the ionic diode feature.



(a) (b)

Fig. 2. (a) The salinity gradient energy generation superiority of the high geometry gradient and high space charge density membrane of ZIF-8/PSS@BANM, to the conventional heterogeneous membrane structure of ZIF-8/PSS@ANM in 1 mM LiCl-methanol was confirmed by measuring the harvested power density in 10 mM/500 mM LiCl-methanol. (b) In the unique geometry gradient channel structure of ZIF-8/PSS@BANM, the ion will diffuse from the sub-nano-scale channel to the sub-micro-scale channel leading to excellent osmotic power performance.