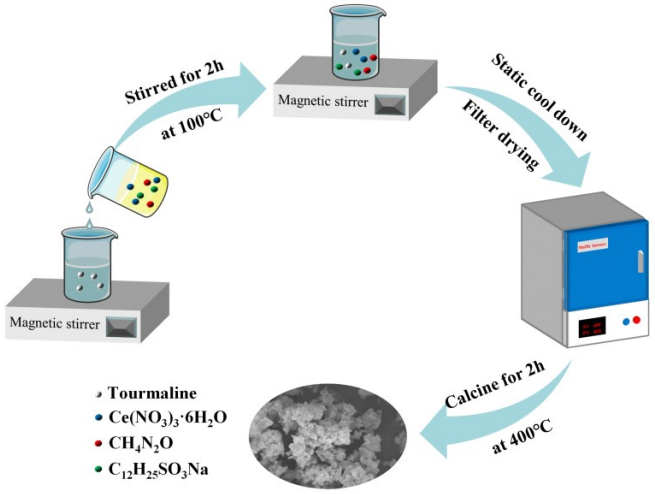
Electronic Supplementary Material (ESI) for Inorganic Chemistry Frontiers.


# $CeO_2$ stabilized by tourmaline as a novel inorganic filler to simultaneously increase the conductivity and durability of proton exchange membranes

contents




Scheme S1. The synthetic process of Tourmaline-$CeO_2$.

Table S1. IEC, hydration number at 80°C of membranes.

| Samples | IEC (mmol/g) | $H_{80}(n(H_2O)/n(SO_3^-))$ |
|---|---|---|
| Pristine PFSA | 1.050 | 13.889 |
| PFSA/TM-$CeO_2$ (0.5wt%) | 1.037 | 15.107 |
| PFSA/TM-$CeO_2$ (1wt%) | 1.021 | 17.401 |
| PFSA/TM-$CeO_2$ (1.5wt%) | 1.029 | 18.492 |
| PFSA/TM-$CeO_2$ (2wt%) | 0.984 | 20.562 |

Table S2. Comparison of proton conductivity and fuel cell performance for pristine PFSA and PFSA/TM-$CeO_2$ (1wt%) composite membranes.

| Samples | Proton conductivity ($mS\ cm^{-1}$) | Power density ($mW\ cm^{-2}$) | OCV degradation rates (mV/h) |
|---|---|---|---|
| Pristine PFSA | 143.91 | 906 | 2.18 |
| PFSA/TM-$CeO_2$ (1wt%) | 155.51 | 1006 | 0.29 |

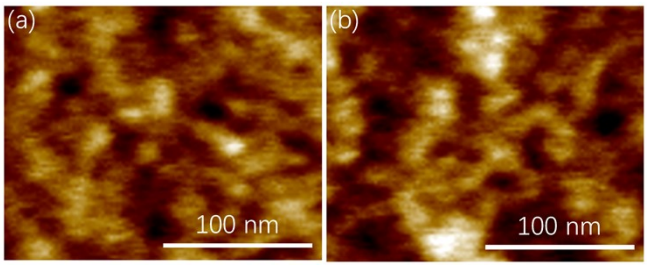



Fig. S1. AFM images of (a) pristine PFSA and (b) PFSA/TM-$CeO_2$ (1wt%).

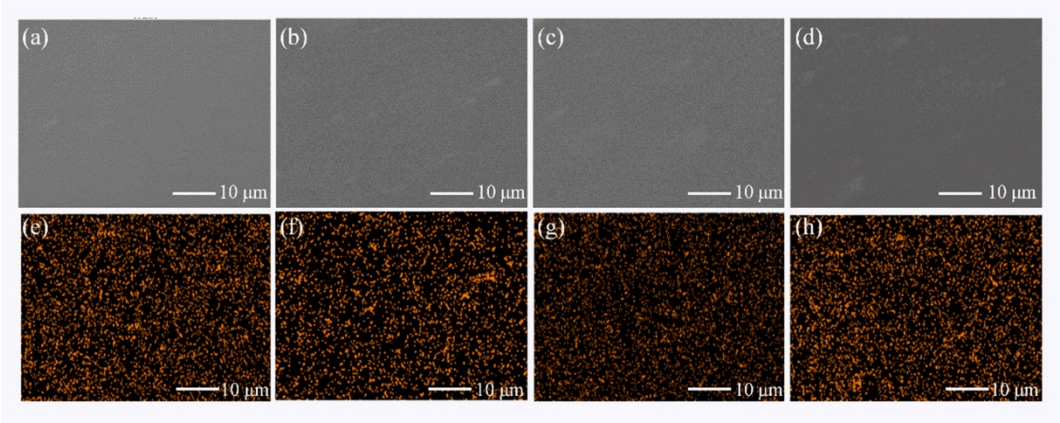



Fig. S2. Surface SEM-EDS mappings of Ce element distribution for the various composite membranes. (a, e) PFSA/TM-$CeO_2$ (0.5wt%); (b, f) PFSA/TM-$CeO_2$ (1wt%); (c, g) PFSA/TM-$CeO_2$ (1.5wt%); (d, h) PFSA/TM-$CeO_2$ (2wt%).

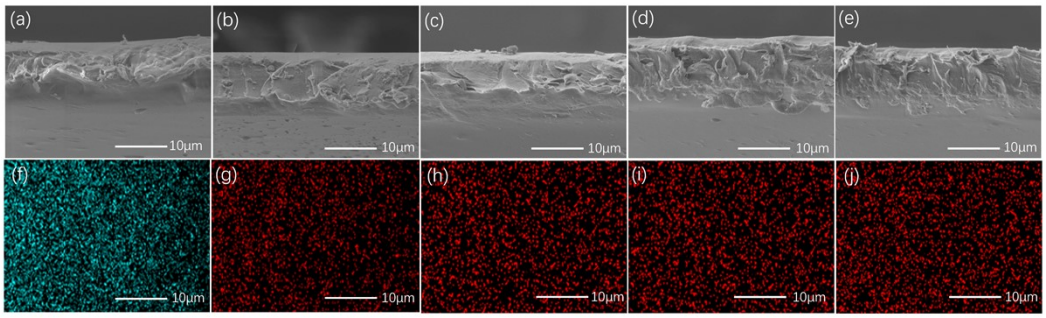



Fig. S3. Cross SEM-EDS mappings of O or Ce element distribution for the various composite membranes. (a, f) pritine PFSA; (b, g) PFSA/TM-$CeO_2$ (0.5wt%); (c, h) PFSA/TM-$CeO_2$ (1wt%); (d, i) PFSA/TM-$CeO_2$ (1.5wt%); (e, j) PFSA/TM-$CeO_2$ (2wt%).

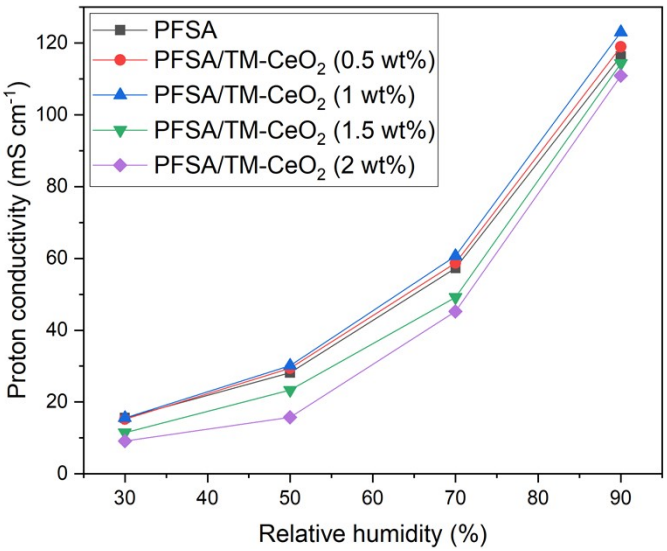



Fig. S4. HFR of Proton conductivity of pristine PFSA and various PFSA/TM-$CeO_2$ (X wt%) composite membranes at different relative humidity under 80℃.

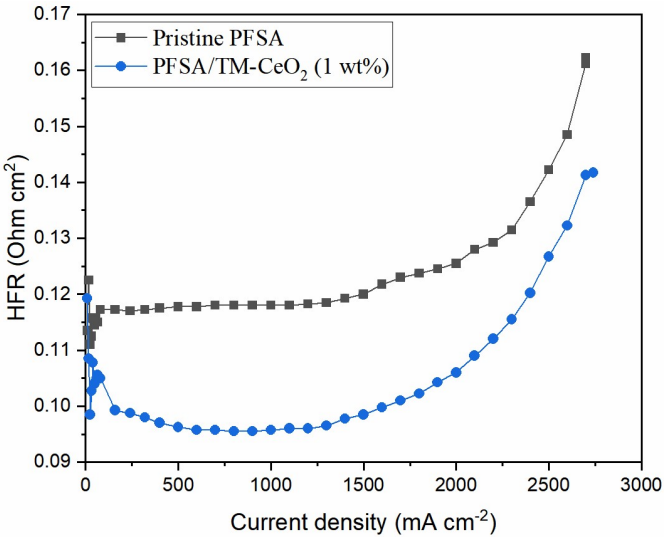



Fig. S5. HFR of MEAs corresponding to pristine PFSA, PFSA/TM-$CeO_2$ (1wt%) composite membranes.

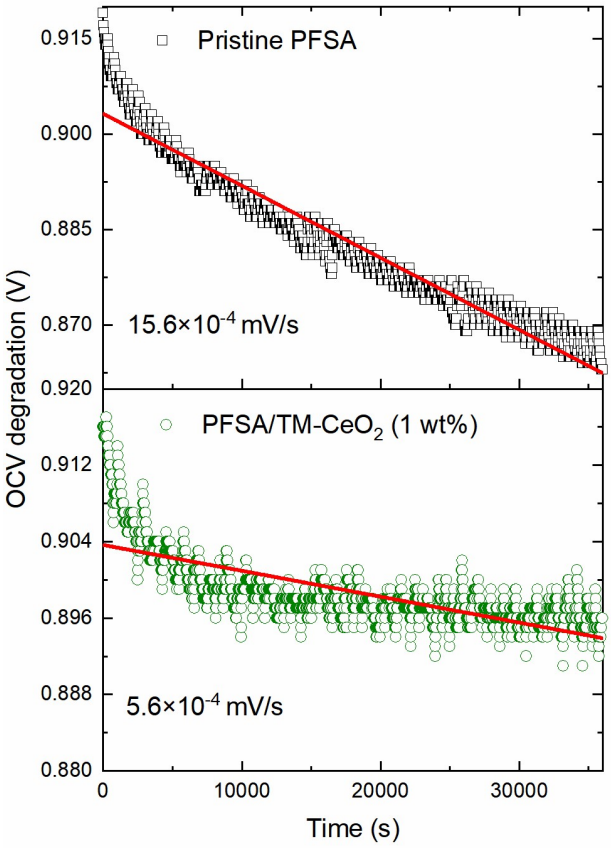



Fig. S6. Durability curves of pristine PFSA and PFSA/TM-$CeO_2$ (1wt%) membranes at 90°C and 30% RH.

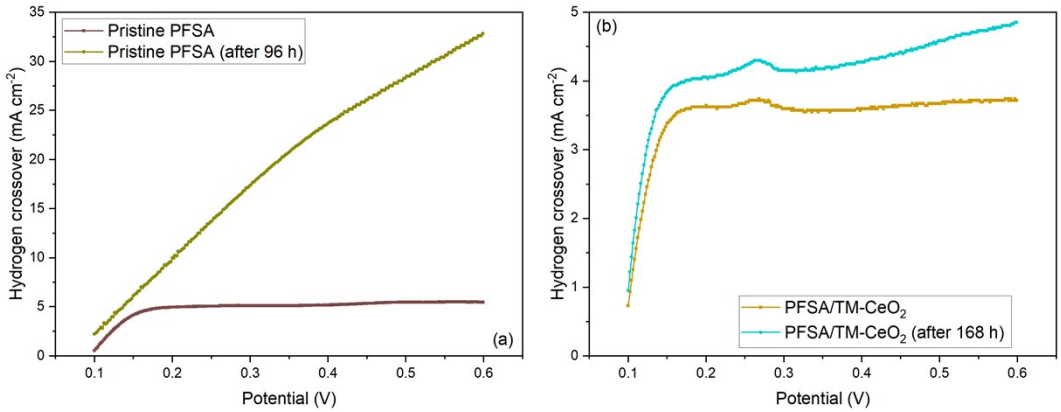



Fig. S7. Hydrogen crossover of the pristine PFSA, PFSA/TM-$CeO_2$ (1wt%) composite membranes before and after OCV.