

Supporting Information

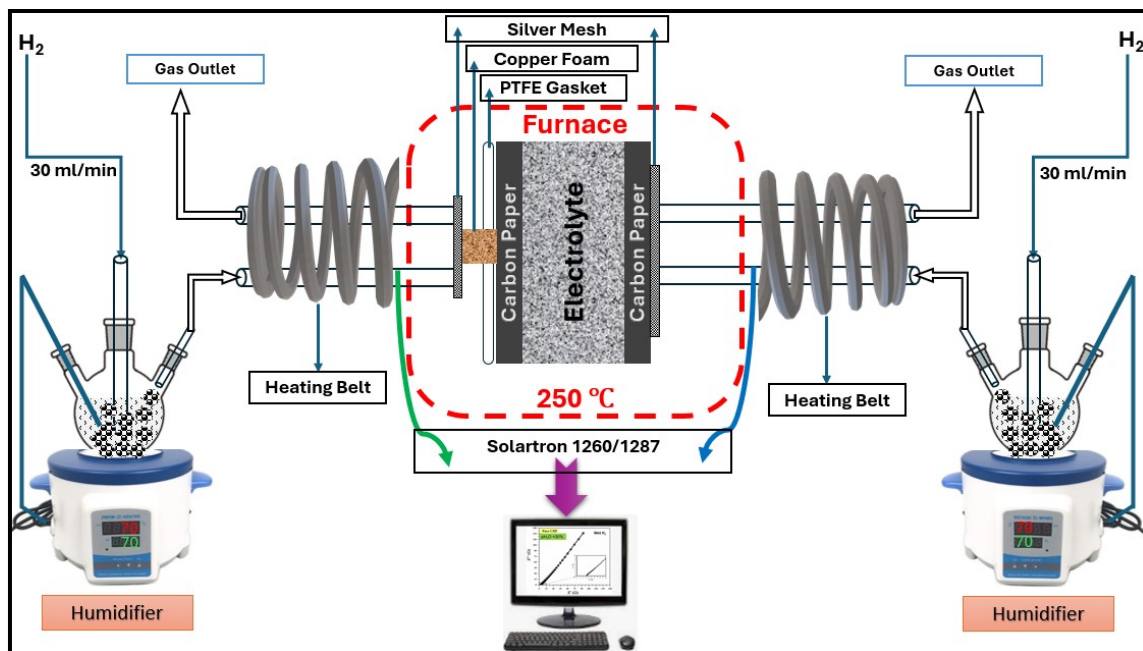
**SnO<sub>2</sub> Modified CsH<sub>2</sub>PO<sub>4</sub> (CDP) Protonic Electrolyte for Electrochemical  
Hydrogen Pump**

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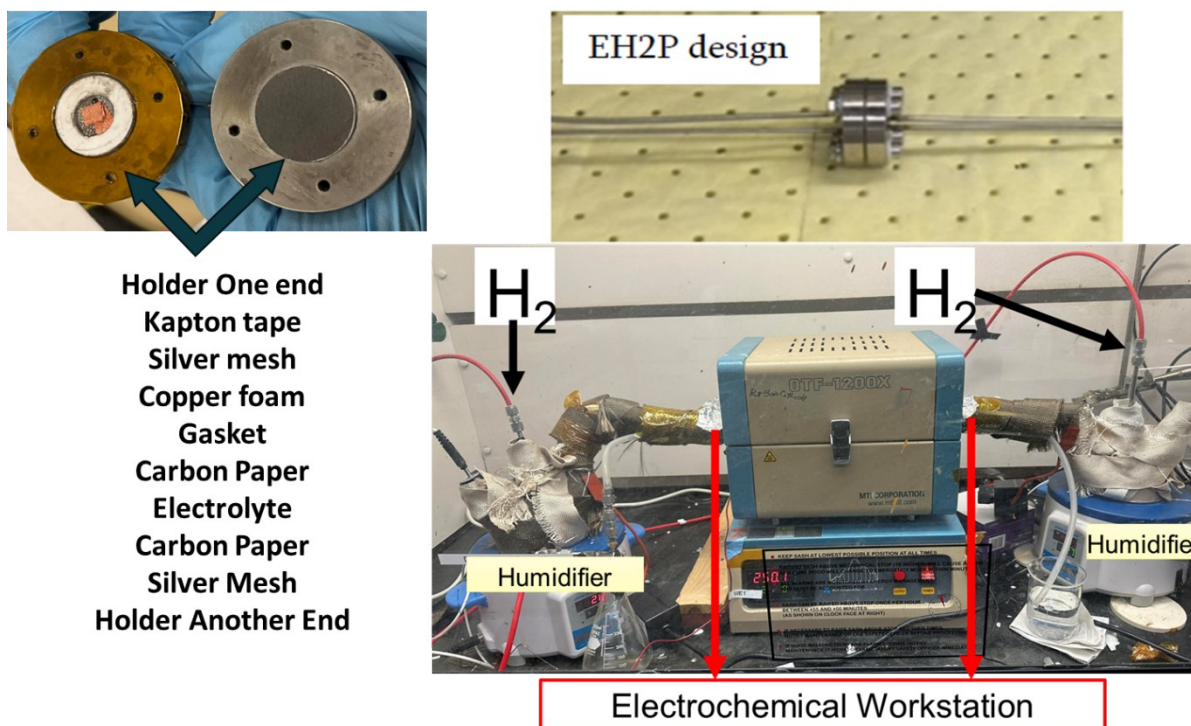
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**Figure S1: Experimental setup for ionic conductivity measurement.**



**Figure S2: The testing setup and MEA assembly used in this study.**

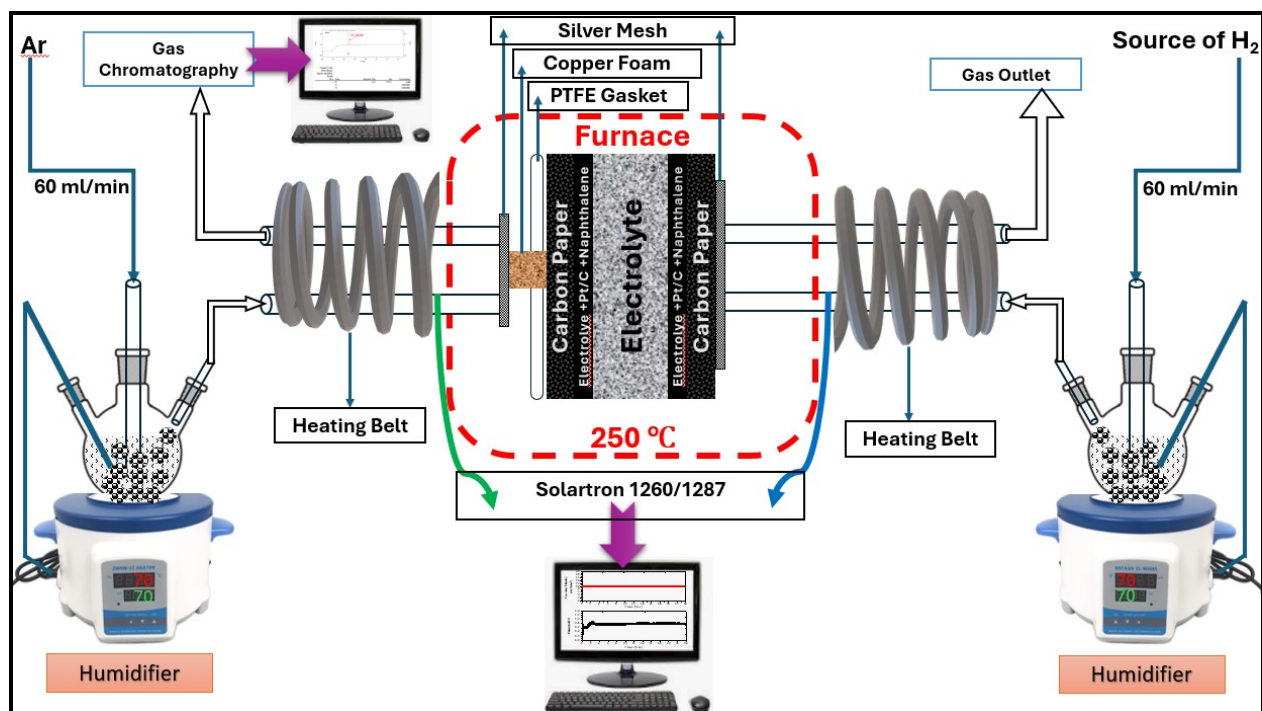
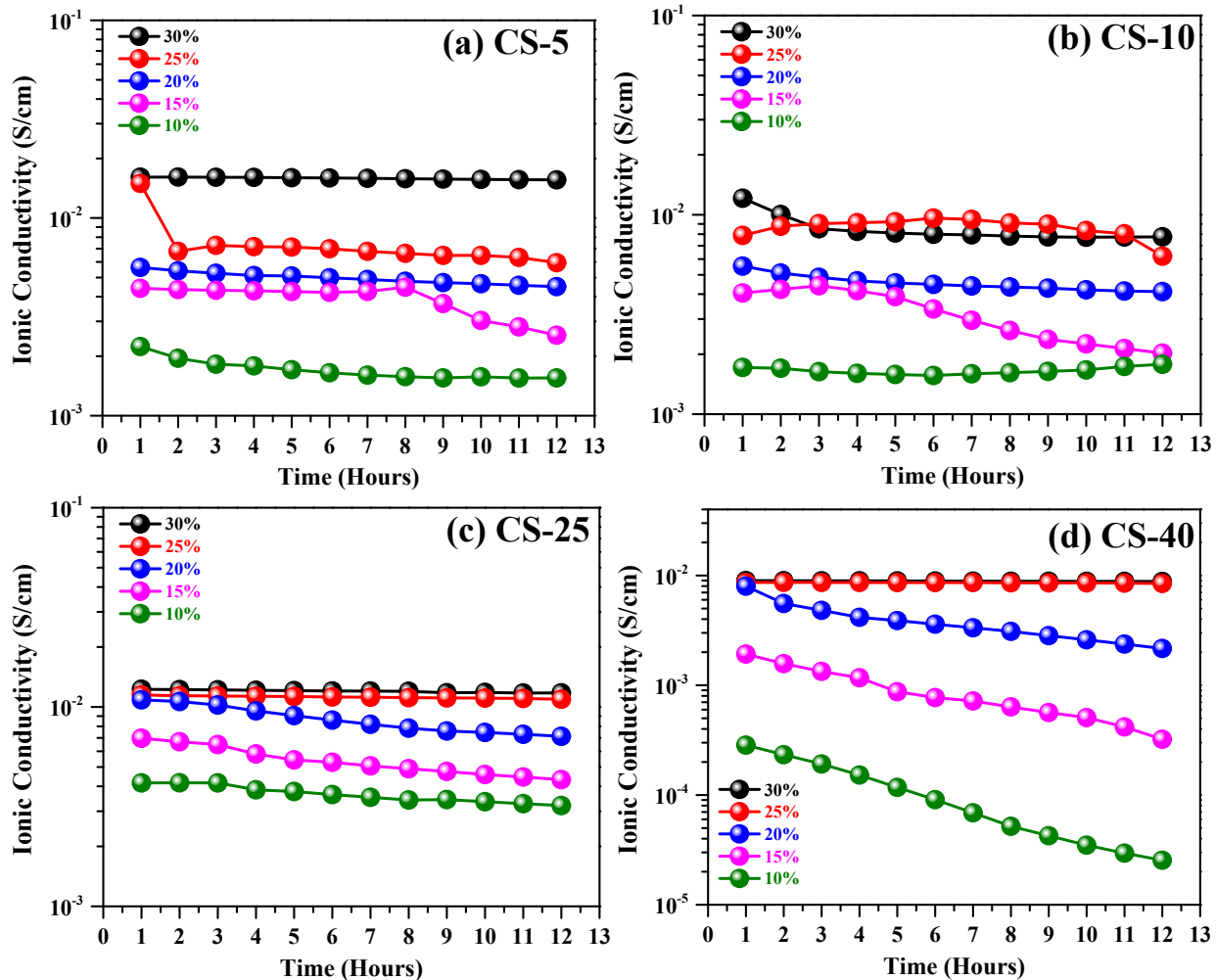


Figure S3: Experimental setup for electrochemical hydrogen pump.



**Figure S4: Time-dependent conductivity of composite electrolytes at 25 °C in wet H<sub>2</sub> atmosphere with 30 mL/min flow rate on both the sides at different water partial pressure: (a) CS-5, (b) CS-10, (c) CS-25, (d) CS-40**

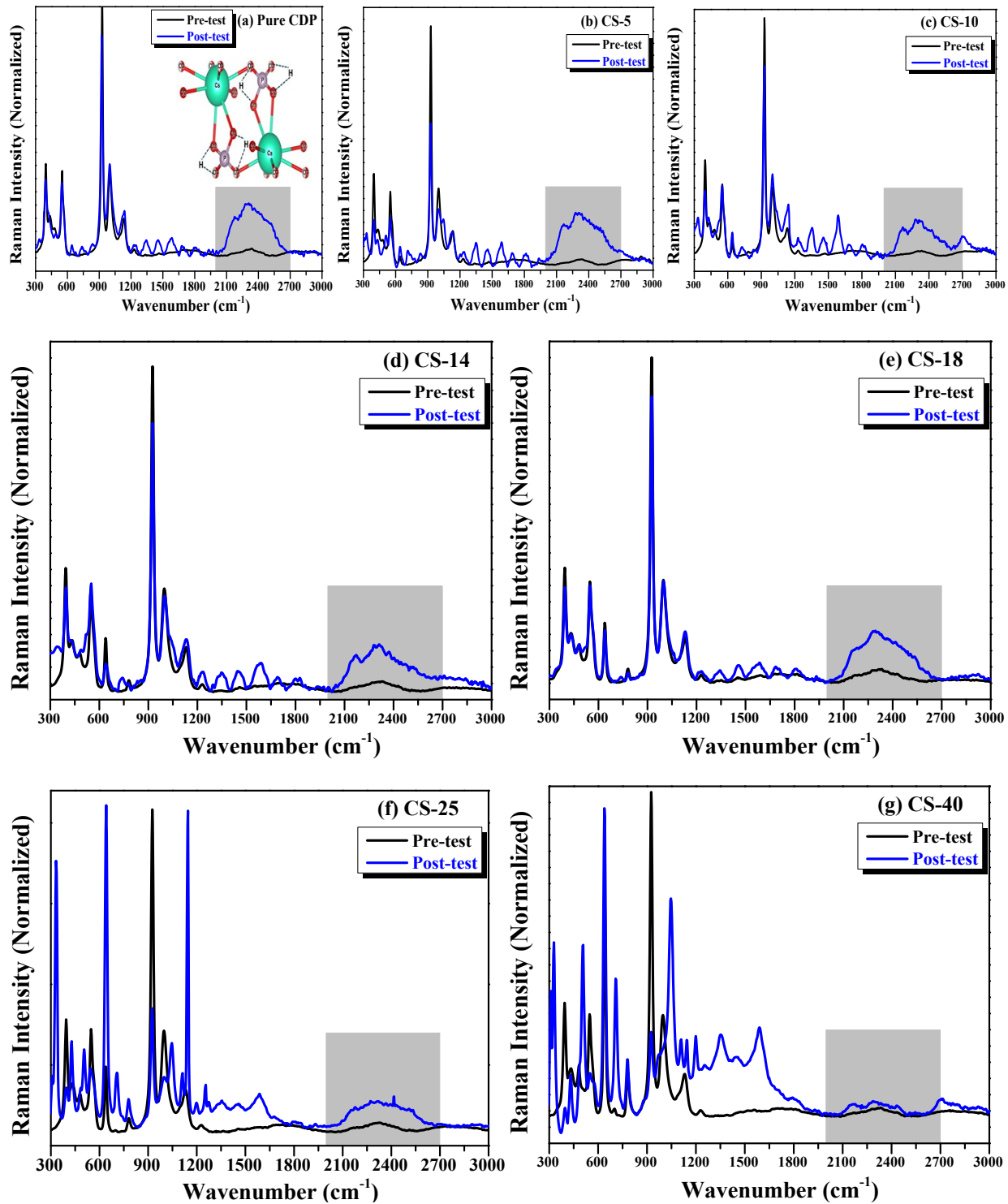


Figure S5: Pre- and post-test Raman data; (a) CDP, (b) CS-5, (c) CS-10, (d) CS-14, (e) CS-18, (f) CS-25, (g) CS-40.

**Table S1:** Water partial pressure and bubbler temperature relationship <sup>29</sup>

Heat Bubbler Temperature (°C)	Water Partial Pressure (atm.)	Water Partial Pressure (P <sub>H2O</sub> ) (%)
70	0.307448	~30
66	0.257983	~25
61	0.205755	~20
55	0.155237	~15
47	0.104719	~10

**Table S2:** Crystallographic information used to perform the Rietveld refinement for CS-25 pre-test XRD data considering P21/m (11) and P42/mmm (136) space group for CDP and SnO<sub>2</sub>, respectively.

CsH <sub>2</sub> PO <sub>4</sub> (CDP)			SnO <sub>2</sub>		
Lattice Parameters			Lattice Parameters		
a	b	c	a	b	c
4.8806	6.3867	7.9113	4.7385	4.7385	3.1867
Wyckoff Position (Cs)			Wyckoff Position (Sn)		
0.0367	0.2500	z=0.2656	x=0	y=0	z=0
Wyckoff Position (P)			Wyckoff Position (O)		
x=0.5172	y=0.7500	z=0.2302	x= 0.2988	y= 0.2988	z=0
Wyckoff Position (O1)					
x=0.3981	y=0.7500	z= 0.3953			
Wyckoff Position (O2)					
x=0.8403	y=0.7500	z=0.30746			
Wyckoff Position (O3)					
x=0.4432	y=0.9544	z=0.1379			