Supporting Information

Electrochemical and *In Situ* Spectroscopic Evidences towards Empowering Ruthenium Based Chalcogenides as Solid Acid Fuel Cell Cathodes

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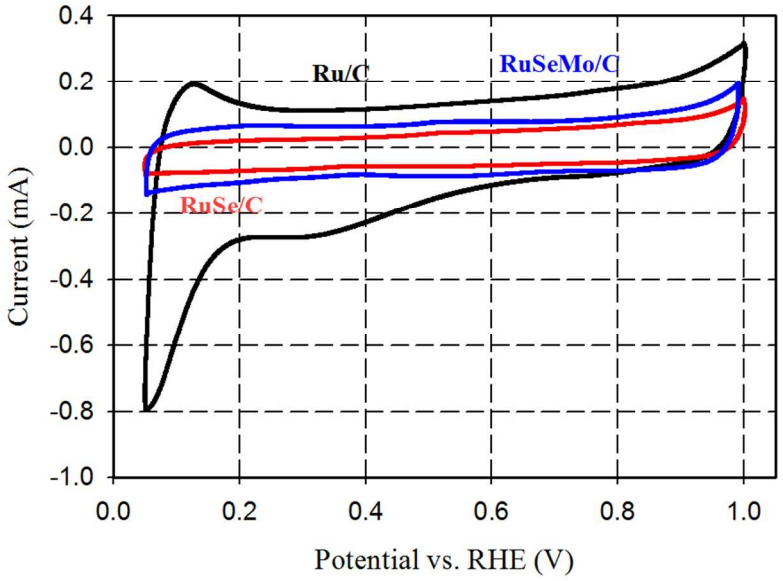

Figure S1. Cyclic voltammogram of Ru/C, RuSe/C and RuSeMo/C (all HT) in Ar purged 0.1M $HClO_4$ at 20 mV/sec sweep rate.

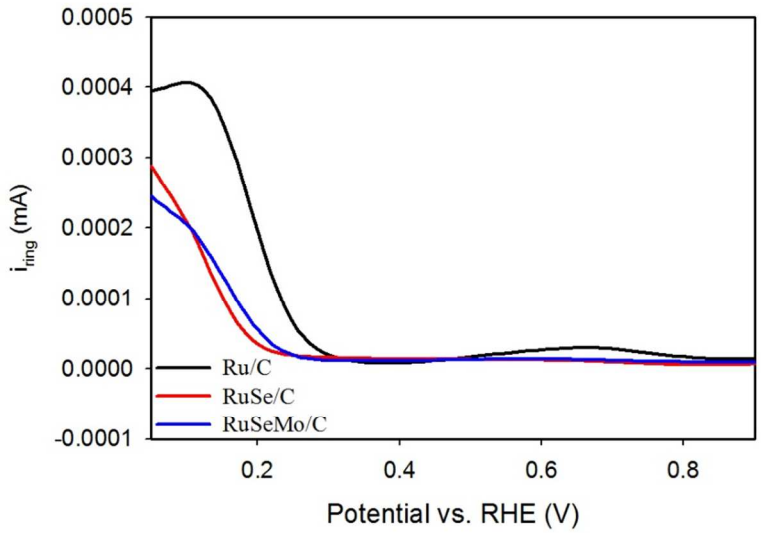

Figure S2: Ring current response for Ru/C, RuSe/C and RuSeMo/C in O_2 purged 0.1M $HClO_4$ collected at 1600 rpm at a scan rate of 20 mV/sec.

Ring data calculations:

The following equations were used to calculate the number of electrons transferred and H_2O selectivity:

$$n_e = \frac{4I_D}{I_D + \frac{I_R}{N}}$$

$$\text{selectivity } H_2O = \frac{I_D - \frac{I_R}{N}}{I_D + \frac{I_R}{N}} * 100$$

Table S1. Summarization of results obtained from RDE and RRDE measurements and comparison between Ru/C, RuSe/C and RuSeMo/C (all HT) catalysts

Catalysts	n_e from K-L analysis	n_e from RRDE @ 0.2V vs. RHE	Selectivity H_2O @ 0.2V vs. RHE
Ru/C	2.95	2.47	80%
RuSe/C	3.17	3.23	92.5%
RuSeMo/C	3.5	3.6	96.8%

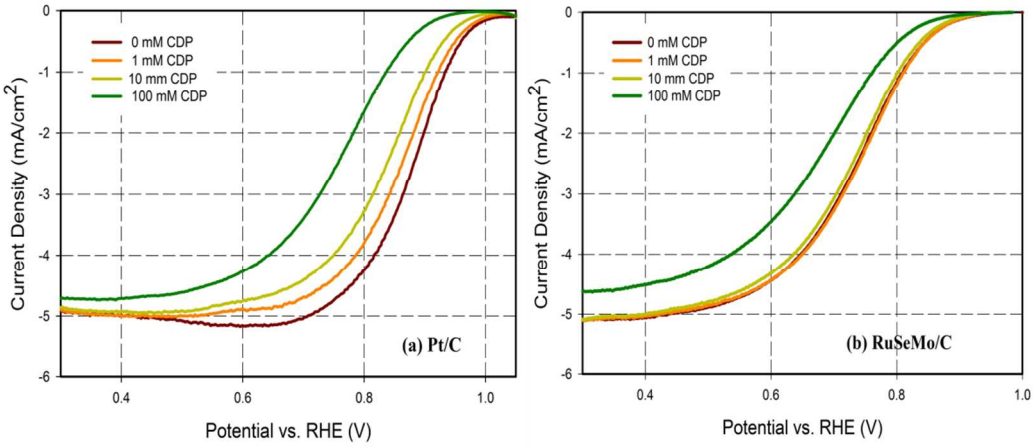

Figure S3. Oxygen reduction reaction on (a) Pt/C and (b)30% RuSeMo/C (all heat treated) in O_2-saturated 0.1M $HClO_4$ electrolyte in presence of cesium dihydrogen phosphate collected at 1600 rpm and 20 mV/sec scan rate.

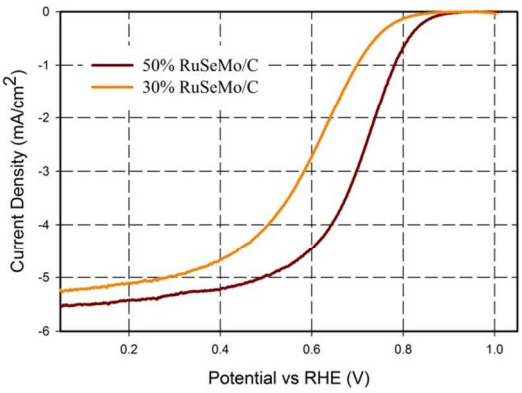

Figure S4. Oxygen reduction reaction on 30% RuSeMo/C and 50% RuSeMo/C (all heat treated) in O_2-saturated 0.1M $HClO_4$ electrolyte, collected at 1600 rpm and 20 mV/sec scan rate.

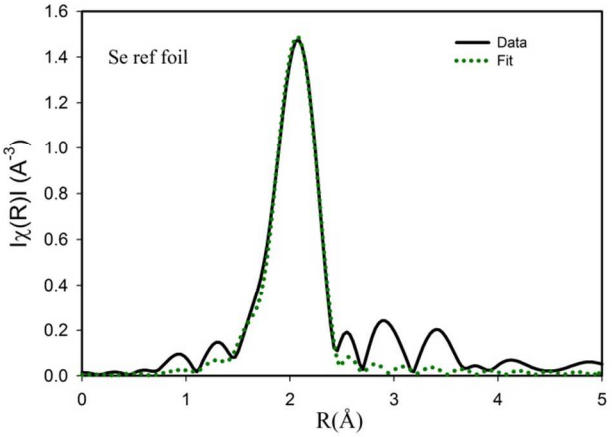

Figure S5. FT EXAFS for Se reference foil

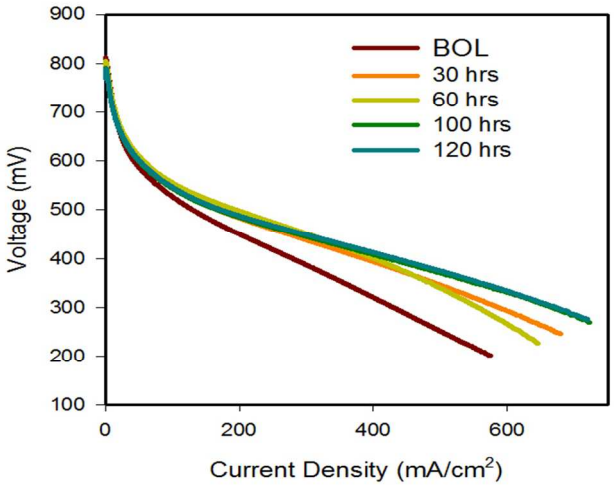

Figure S6. Durability test for 30% RuSeMo/C catalyst in SAFC operated at 250^{o}C, with H_2 and air as anode and cathode gas feeds, respectively. Loading of Ru in the MEA: 1.2 mg/cm^2

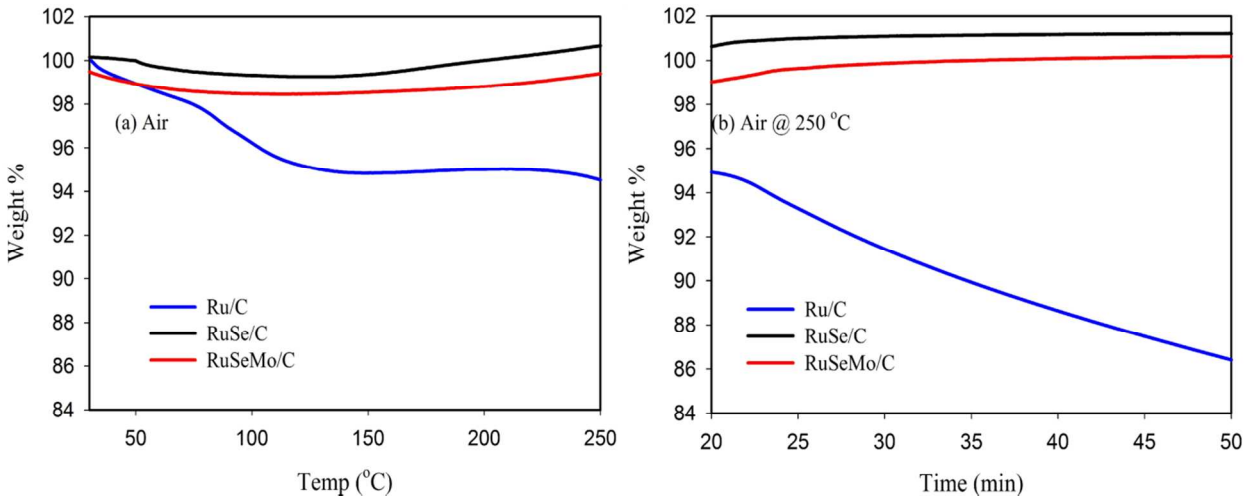

Figure S7: TGA profiles of Ru/C, RuSe/C and RuSeMo/C catalysts when heated till 250°C under air. (a) Catalytic weight loss/gain when heated till 250ºC and (b) Catalytic weight loss/gain when held at 250ºC for 30 minutes