

Supplementary Information for:

**High performance robust F-doped tin oxide based oxygen evolution electro-  
catalysts for PEM based water electrolysis**

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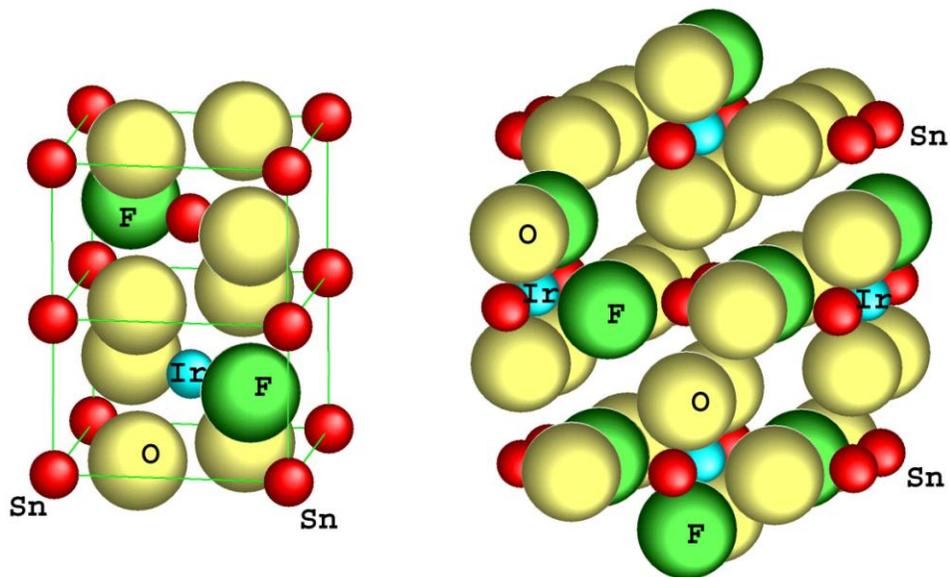
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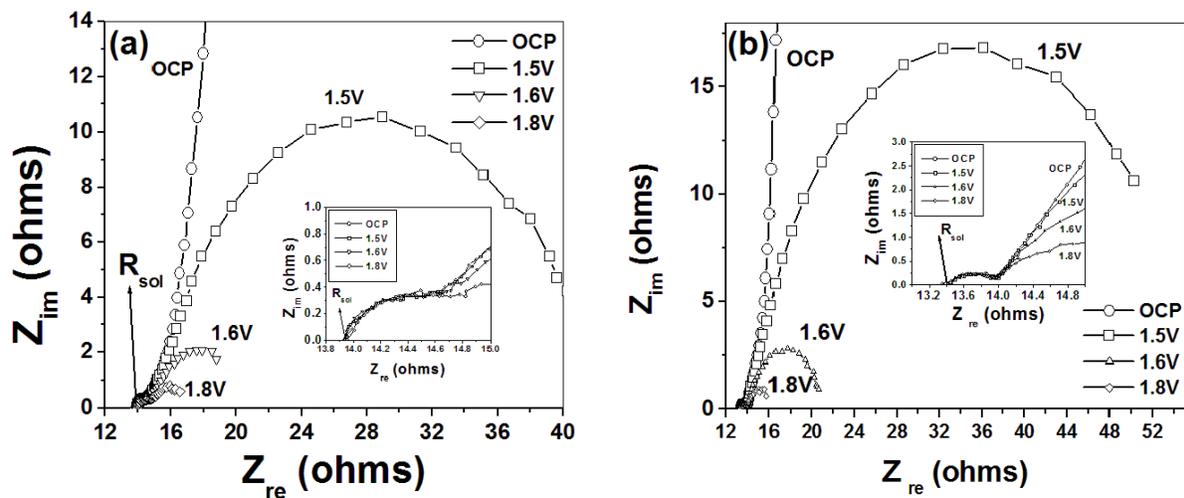
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**Fig. S1:** The unit cells for bulk (left) and (110) surface (right) calculations used in present study.

The atomic configurations shown correspond to  $\text{Ir}_{0.25}\text{Sn}_{0.75}\text{O}_{1.5}\text{F}_{0.5}$ .



**Fig. S2:** EIS spectra of pure  $\text{IrO}_2$  (a), and  $(\text{Sn}_{0.8}\text{Ir}_{0.2})\text{O}_2:10\text{F}$  (b) obtained at open circuit potential (OCP) and at different potentials (1.6V, 1.8 V and 2V) tested in 1N  $\text{H}_2\text{SO}_4$  at 40°C. The potentials are not  $iR_\Omega$  corrected. The zoomed x-axis in the inset figures clearly show that the value of solution resistance ( $R_s$ ) and electrode resistances ( $R_e$ ) are independent of potential.

### **Correction for the ohmic drop contribution:**

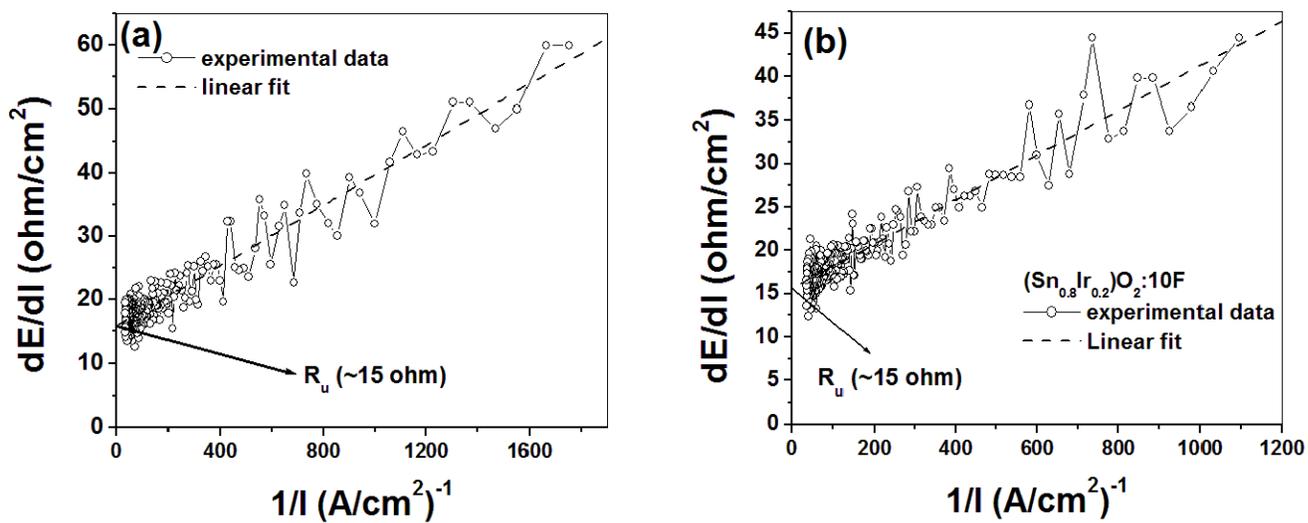
In addition to the EIS method, we also used a method proposed by Krastjic and Trasatti [27] to obtain the value of uncompensated ohmic resistance. In this method it has been assumed that the solution resistance is independent of potential and Tafel law is used to obtain the uncompensated resistance  $R_u$ :

$$E = a + b \log I + iR_u$$

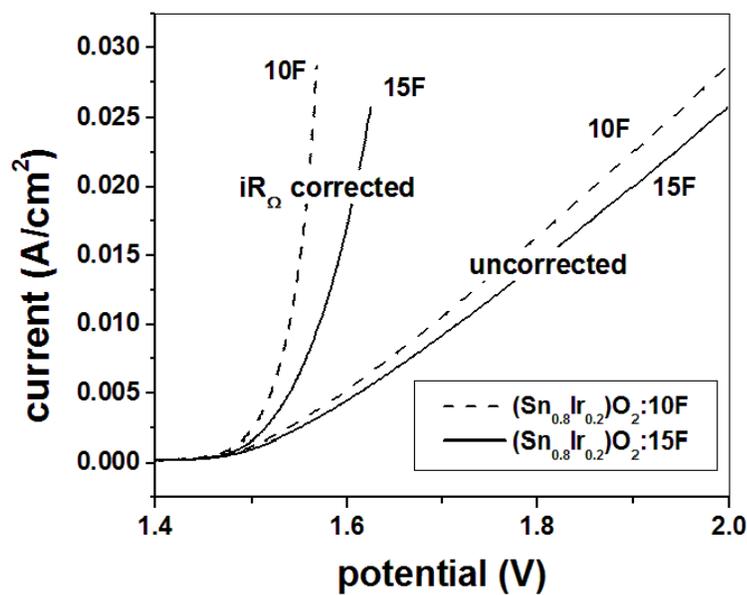
Taking the derivative of E with respect to I, the following relation has been obtained,

$$dE/dI = b/I + R_u$$

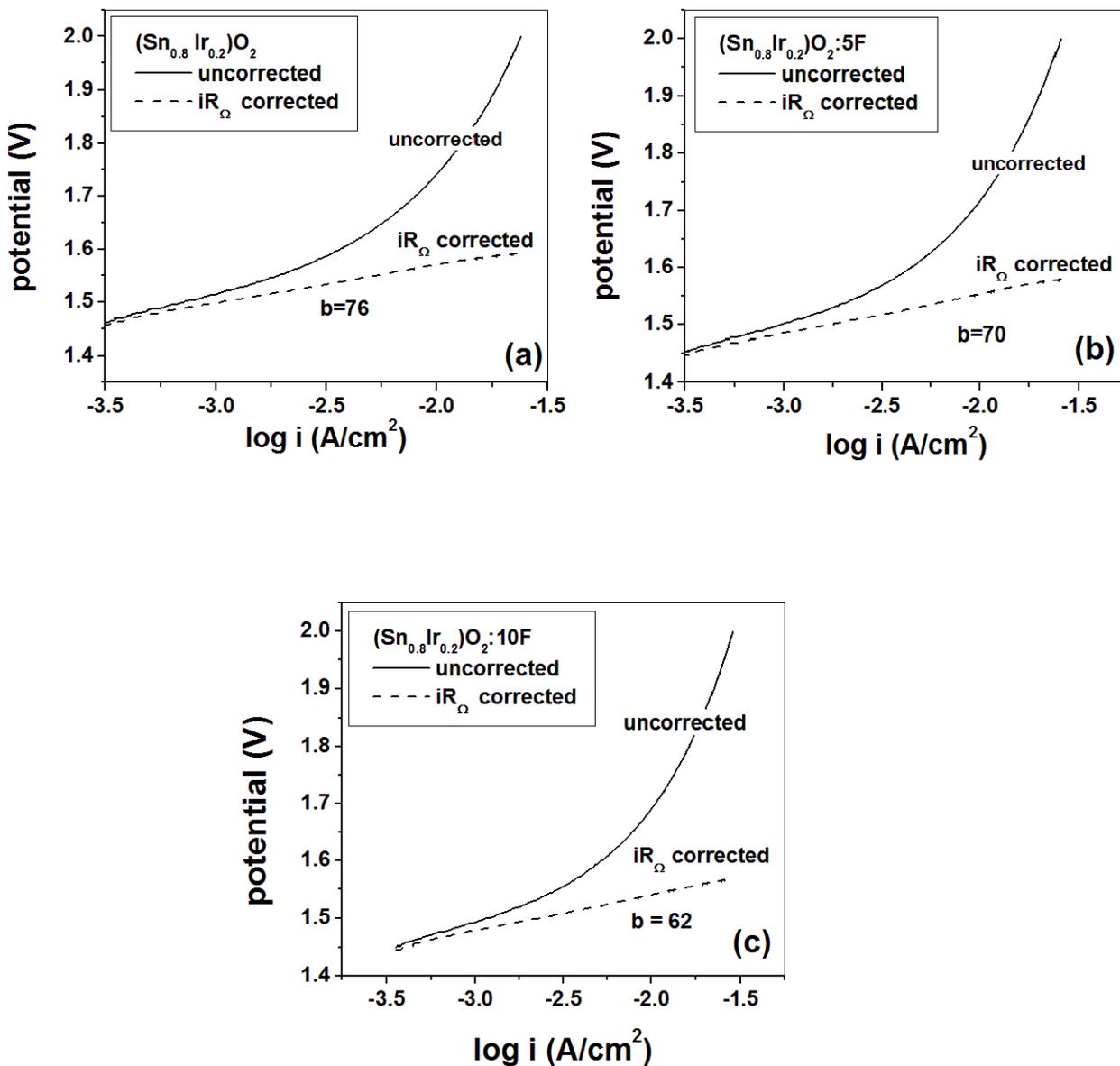
Therefore, by plotting the  $dE/dI$  as a function of  $1/I$ ,  $R_u$  can be obtained as the intercept at  $1/I = 0$  which can be used for calculating the ohmic drop ( $iR_u$ ).



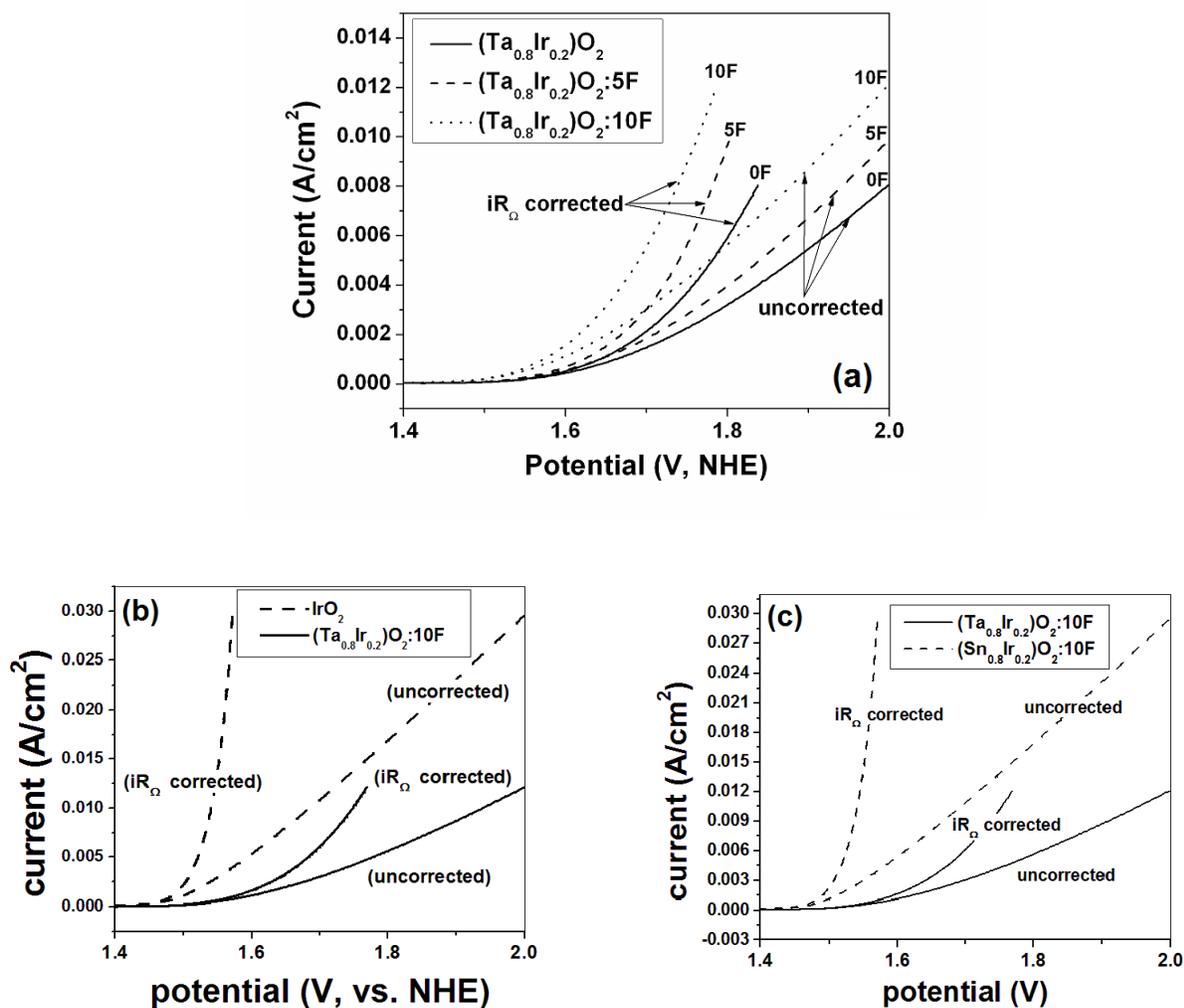
**Fig. S3:** The uncompensated resistance  $R_u$  of IrO<sub>2</sub> (a), and (Sn<sub>0.8</sub>Ir<sub>0.2</sub>)O<sub>2</sub>:10F (b), obtained from the method by plotting  $dE/dI$  with  $1/I$  and the intercept at  $1/I=0$  corresponding to  $R_u$ . The  $R_u$  value (~15Ω) obtained from this method is in good agreement with the ohmic resistance value obtained from the EIS study.



**Fig. S4:** The polarization curve of (Sn<sub>0.8</sub>Ir<sub>0.2</sub>)O<sub>2</sub>:15F film along with (Sn<sub>0.8</sub>Ir<sub>0.2</sub>)O<sub>2</sub>:10F conducted in the presence of 1N H<sub>2</sub>SO<sub>4</sub> solution at 40°C with a scan rate of 1mV/sec before and after iR<sub>Ω</sub> correction. The polarization curve shows that the electrochemical activity of (Sn<sub>0.8</sub>Ir<sub>0.2</sub>)O<sub>2</sub>:F decreases above 10wt.% F.



**Fig. S5:** The Tafel plot of (a)  $(\text{Sn}_{0.8}\text{Ir}_{0.2})\text{O}_2$ , (b)  $(\text{Sn}_{0.8}\text{Ir}_{0.2})\text{O}_2:5\text{F}$  (b) and (c)  $(\text{Sn}_{0.8}\text{Ir}_{0.2})\text{O}_2:10\text{F}$ , before and after  $iR_{\Omega}$  correction, showing the Tafel slope  $\sim 76$ ,  $70$  and  $62$  mV/dec, respectively. The Tafel slope of  $(\text{Sn}_{0.8}\text{Ir}_{0.2})\text{O}_2:10\text{F}$  is similar to pure  $\text{IrO}_2$  ( $\sim 60$  mV/sec).



**Fig. S6:** (a) The polarization curve of (Ta,Ir)O<sub>2</sub>:F film of different compositions conducted in the presence of 1N H<sub>2</sub>SO<sub>4</sub> solution at 40°C with a scan rate of 1mV/sec before and after iR<sub>Ω</sub> correction shows the electrochemical activity increases with increase in F content. The polarization curve of (Ta<sub>0.8</sub>Ir<sub>0.2</sub>)O<sub>2</sub>:10F, IrO<sub>2</sub> (b) and (Sn<sub>0.8</sub>Ir<sub>0.2</sub>)O<sub>2</sub>:10F (c) conducted in the presence of 1N H<sub>2</sub>SO<sub>4</sub> solution at 40°C with a scan rate of 1mV/sec before and after iR<sub>Ω</sub> correction. The plot shows that the electrochemical activity (Ta,Ir)O<sub>2</sub>:F is inferior than IrO<sub>2</sub> and (Sn,Ir)O<sub>2</sub>:F.