Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

SUPPLEMENTAL INFORMATION

Photodeposited Ruthenium Dioxide Films for Oxygen Evolution Reaction Electrocatalysis

D.A. Salvatore[1], B. Peña,[2] K.E. Dettelbach,[2] C. P. Berlinguette[1,2,]*

[1]Department of Chemical and Biological Engineering, The University of British Columbia, 2360 East Mall, Vancouver, BC V6T1Z3, Canada.

[2]Department of Chemistry, The University of British Columbia, 2036 Main Mall, Vancouver, BC V6H1Z1, Canada.

*Correspondence to: cberling@chem.ubc.ca (CPB)

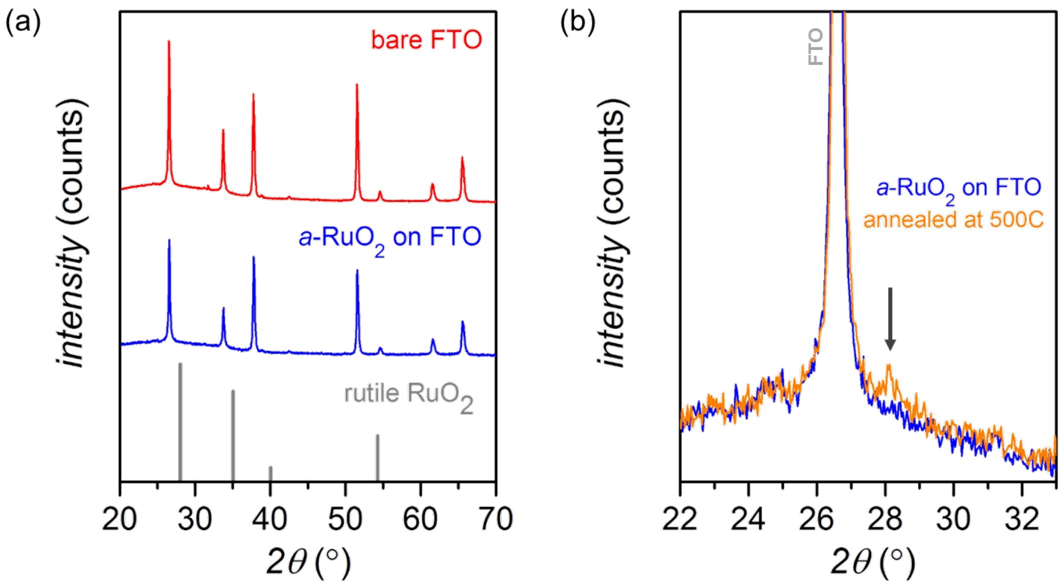


Figure S1. (a) Powder X-ray diffractograms for *a*-RuO_2 prepared by UVDD of $Ru(tmhd)_2(COD)$ on FTO (blue). The diffractogram for bare FTO (red) and a reference rutile RuO_2 pattern (gray bars, PDF # 00-043-1027) are also shown. (b) Diffractogram of a film showing the evolution of rutile RuO_2 (orange) when *a*-RuO_2 (blue) is heated to 500°C in a box furnace. The black arrow indicates the Bragg diffraction peak corresponding to the 110 reflection of rutile RuO_2 at $2\Theta = 28°$.

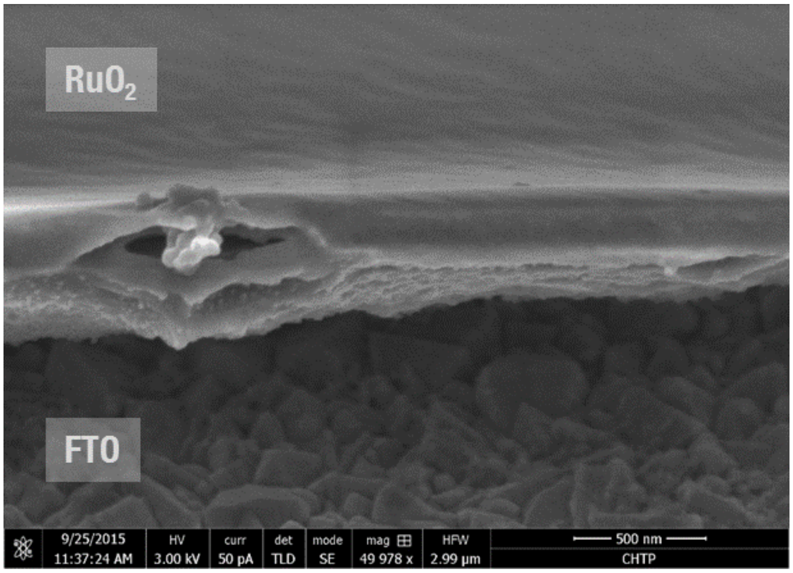


Figure S2. SEM image (side-view) of *a*-RuO_2 film (prepared by UVDD) that shows delamination from the FTO surface.

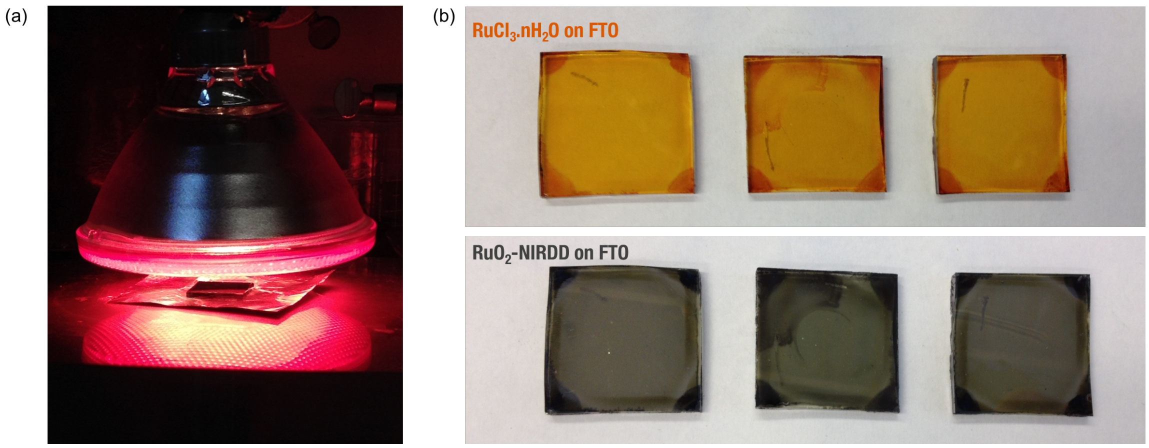


Figure S3. (a) Near-infrared-driven decomposition (NIRDD) of $RuCl_3{\cdot}nH_2O$ into RuO_2. The coated FTO susbtrate is placed under the NIR lamp at a distance of 1 cm from the bottom of the lamp. (b) Photographs of three samples of spin-cast films of $RuCl_3{\cdot}nH_2O$ on FTO that were subjected to the NIRDD process to produce films of RuO_2.

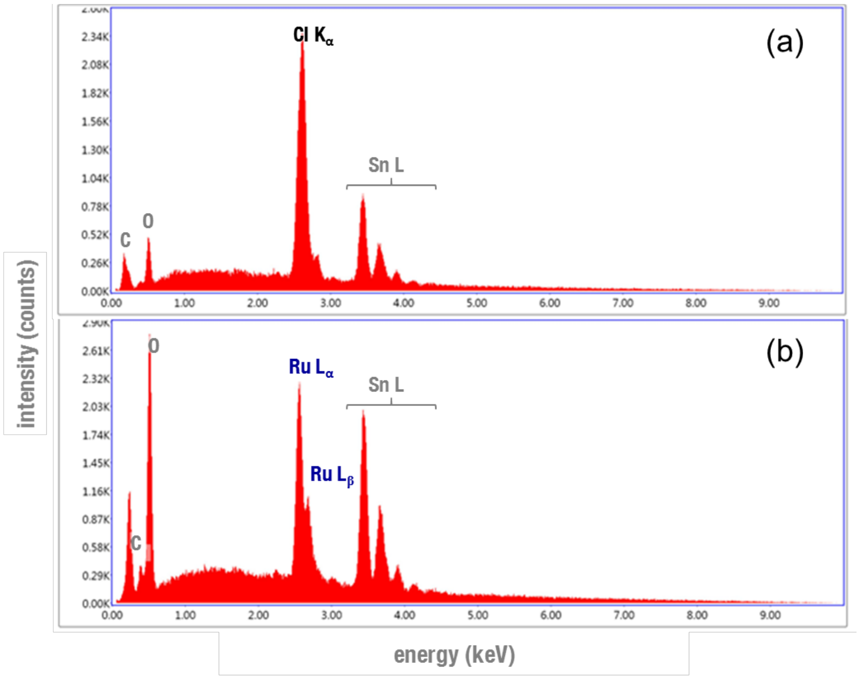


Figure S4. EDX spectrum (electron gun voltage = 10 keV) for (a) $RuCl_3$ on FTO and (b) **RuO_2-NIRDD** on FTO. The Sn L group of signals is sourced to the FTO underlayer.

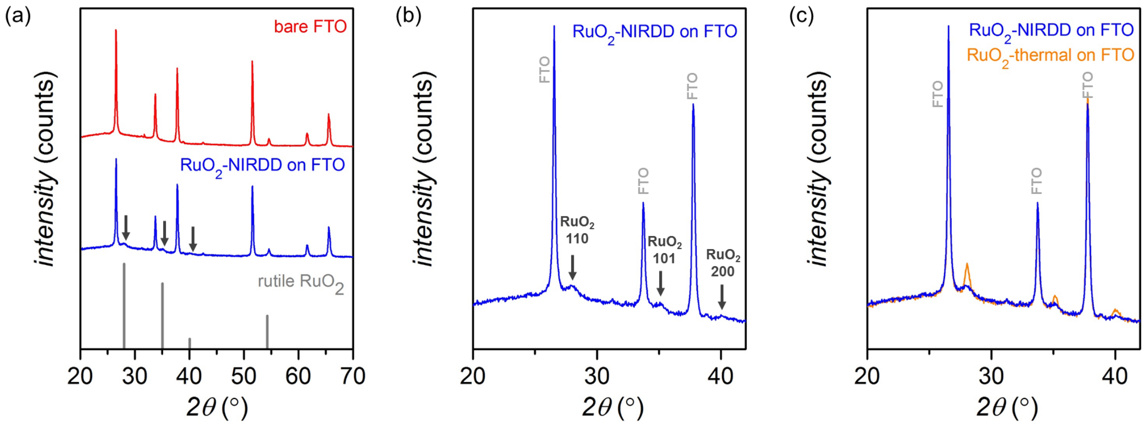


Figure S5. (a) Powder X-ray diffractograms for **RuO$_2$-NIRDD** prepared by NIRDD on FTO (blue). The diffractogram for bare FTO (red) and a reference rutile RuO$_2$ pattern (gray bars, PDF # 00-043-1027) are also shown. The black arrows indicate the diffraction peaks of **RuO$_2$-NIRDD**. (b) Expansion of the 20°-40° region of the diffractogram pattern of **RuO$_2$-NIRDD** on FTO showing broad diffraction peaks centered at 2Θ = 28° (110), 35° (101) and 40° (200). (c) Diffractogram patterns of **RuO$_2$-NIRDD** (blue) superimposed on **RuO$_2$-thermal** (prepared at 500°C, orange).

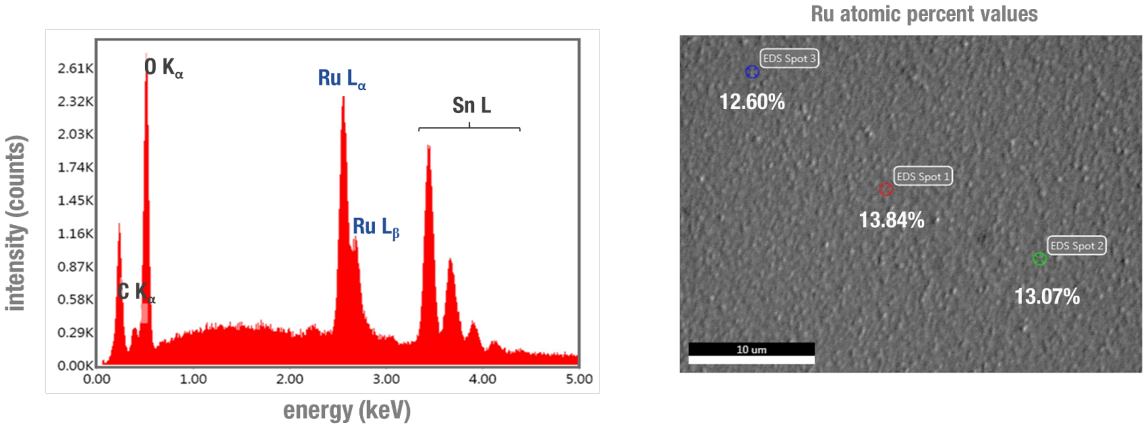
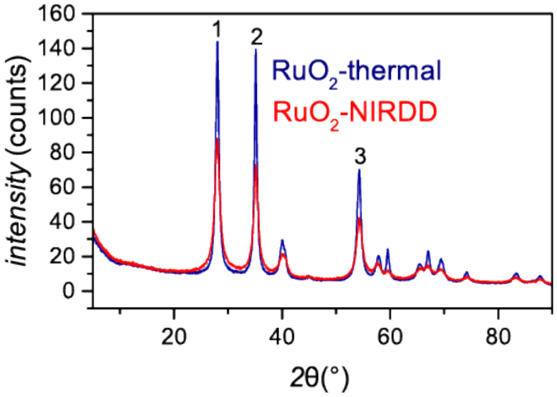


Figure S6. EDX spectrum (electron gun voltage = 10 keV) and corresponding Ru atomic percent values of three different spots on the **RuO$_2$-NIRDD** film showing reasonably uniform values.



crystallite size

Peak #	RuO$_2$-NIRDD	RuO$_2$-thermal
1	63.9 Å	101.4 Å
2	78.9 Å	128.3 Å
3	70.5 Å	95.6 Å

Figure S7. Powder X-ray diffractograms for **RuO$_2$-NIRDD** (red) and **RuO$_2$-thermal** (blue) on glass. The numbers correspond to the peaks that were used to determine crystallite size using the Sherrer equation.

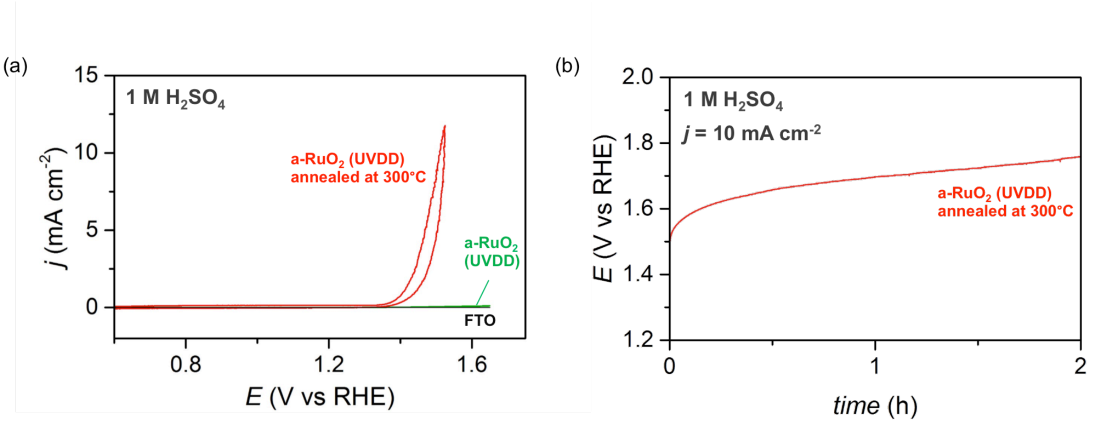


Figure S8. (a) Cyclic voltammograms (10 mV s^{-1}, 1 M H_2SO_4) of *a*-RuO$_2$ film on FTO prepared by the UVDD process (green) and *a*-RuO$_2$ film on FTO prepared by the UVDD process that was annealed at 300°C prior to the electrochemical studies (red). (b) Chronopotentiometry at j = 10 mA cm^{-2} in 1 M H_2SO_4.

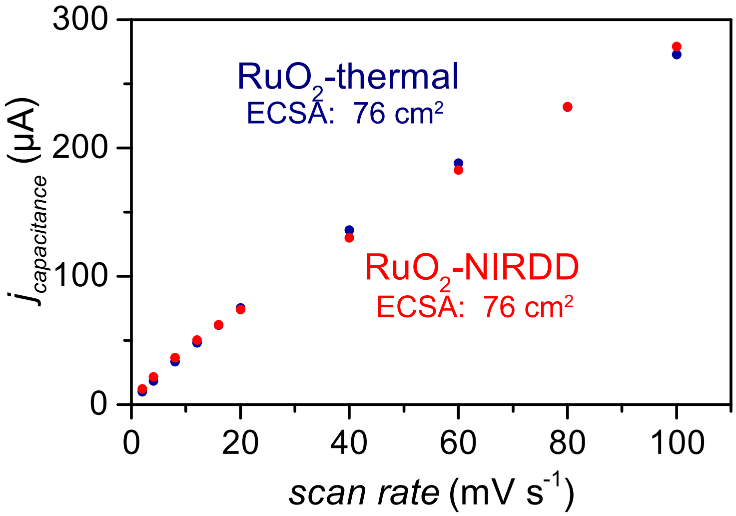


Figure S9. Double layer capacitance measurements of **RuO$_2$-NIRDD** and **RuO$_2$-thermal** in 1 M H_2SO_4. The electrochemically active surface area (ECSA) of the catalyst was calculated by dividing the slope of the above plot by the specific capacitance of the sample. Here we use a general specific capacitance of 0.035 mF cm^{-2} in 1 M H_2SO_4.

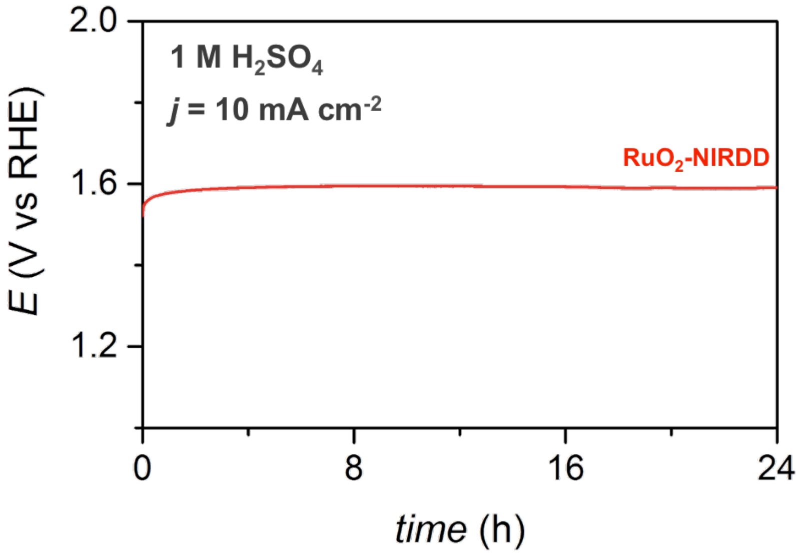
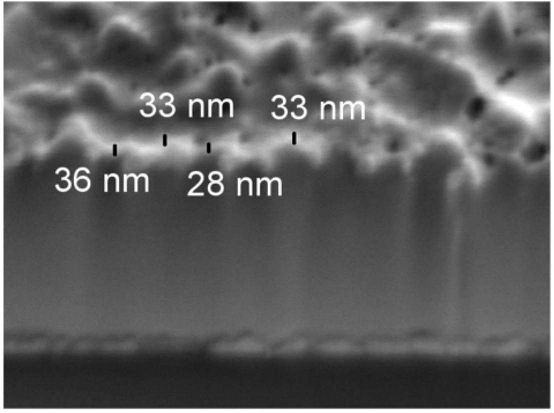
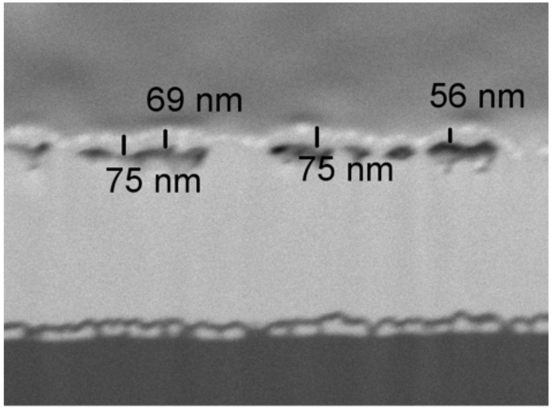


Figure S10. Chronopotentiometry experiment of **RuO$_2$-NIRDD** at j = 10 mA cm^{-2} in 1 M H_2SO_4.

a) RuO_2- NIRDD/2.5% w/w



b) RuO_2- NIRDD/5% w/w



c) RuO_2- NIRDD/10% w/w

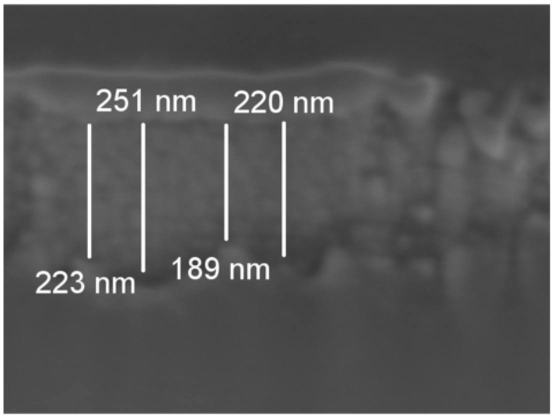


Figure S11. SEM cross-sections of **RuO_2-NIRDD** films on FTO with (a) 2.5, (b) 5 and (c) 10% *w/w*.

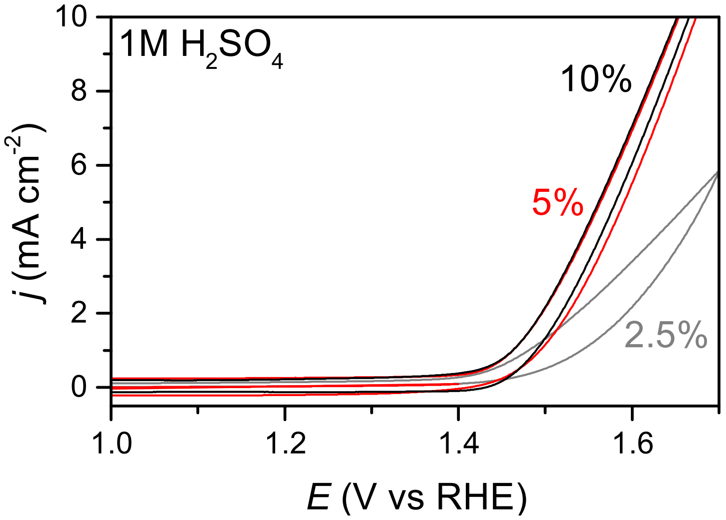


Figure S12. Cyclic voltammograms (10 mV s^{-1}, 1 M H_2SO_4) of **RuO_2-NIRDD** films on FTO with different precursor solutions: 2.5% *w/w* (grey), 5% *w/w* (red), and 10% *w/w* (black).