Supplement

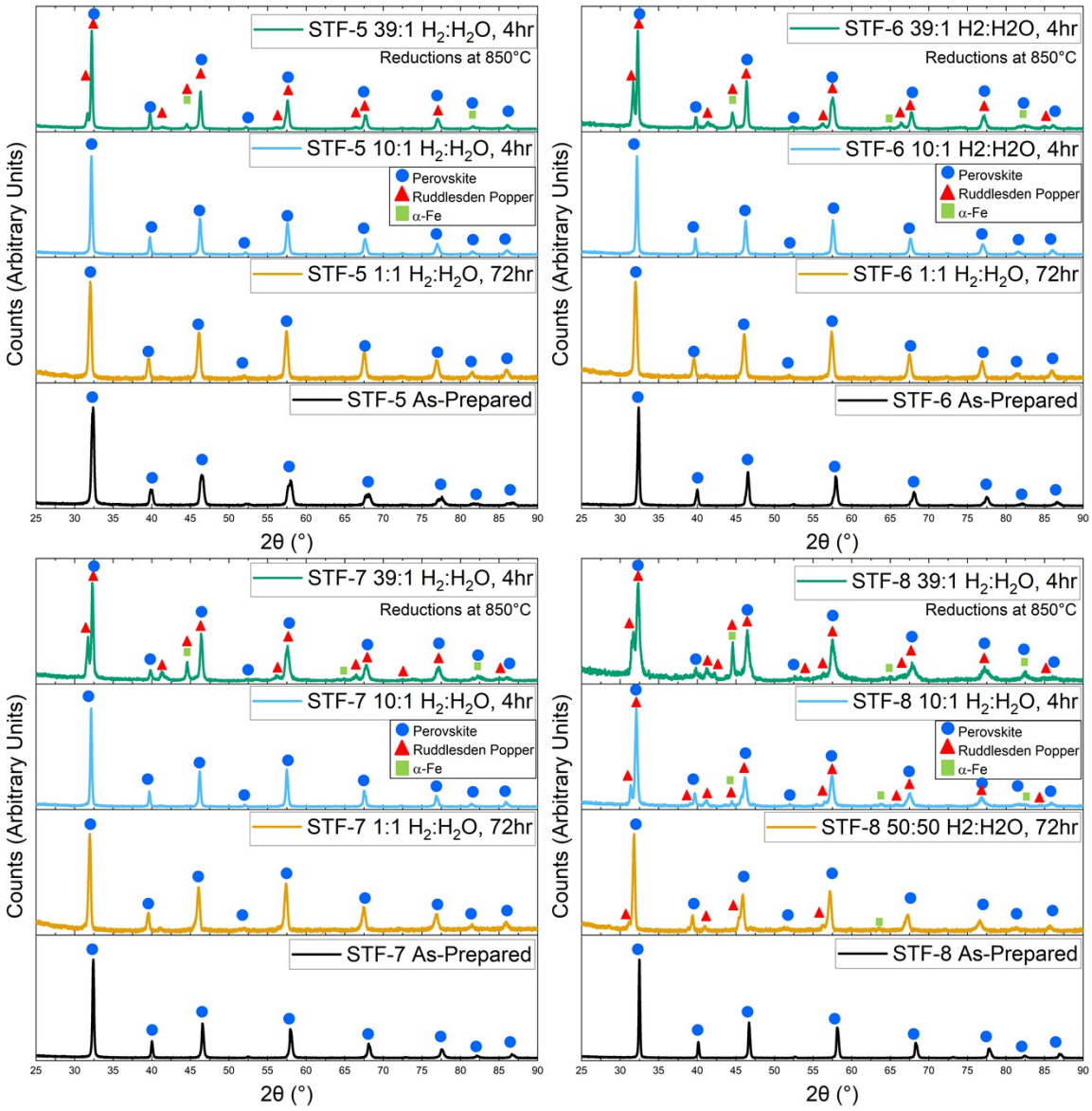

Fig. S1 Ex-situ XRD Plots for STF After Reduction at 850°C. Note that the 1:1 H_2:H_2O reduction was for 72hr rather than 4 to ensure sluggish kinetics under less reducing conditions do not cause a mischaracterization of the system

It is important to note that, while the reduction of STF-8 at 1:1 H_2:H_2O shows the appearance of a minimal R-P decomposition phase, this is not borne out under *in-situ* conditions. We therefore believe that this stems from the fact that cooling rate and p_{H_2}/p_{H_2O} were not controlled as closely for *ex-situ* powder reductions. The impact of cooling at the nominal rate utilized for powders characterized using *ex-situ* XRD is shown in Fig. S2

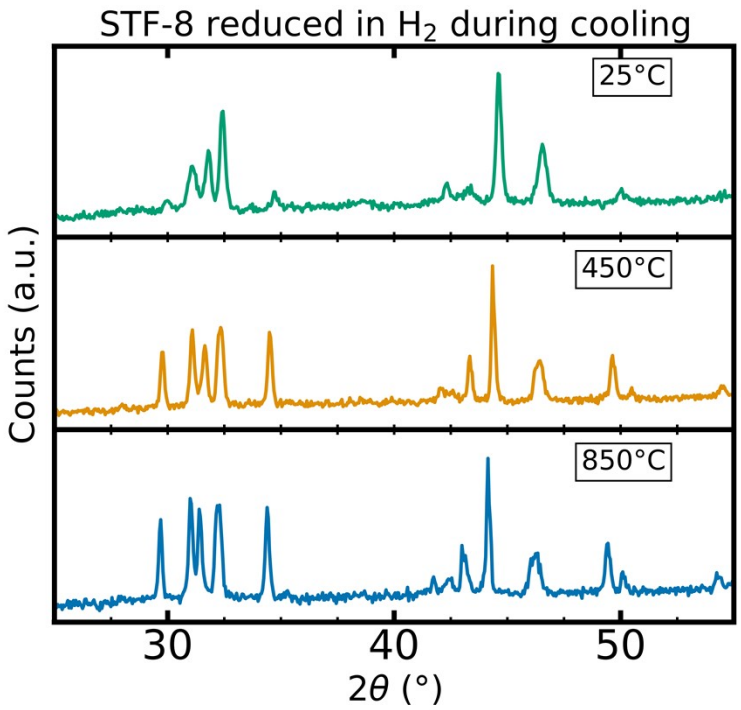

Fig. S2 X-ray Patterns of STF-8 after reduction in pure H_2 for 36 hours show clear phase changes during cooling at nominal cooling rate of 5°C/min

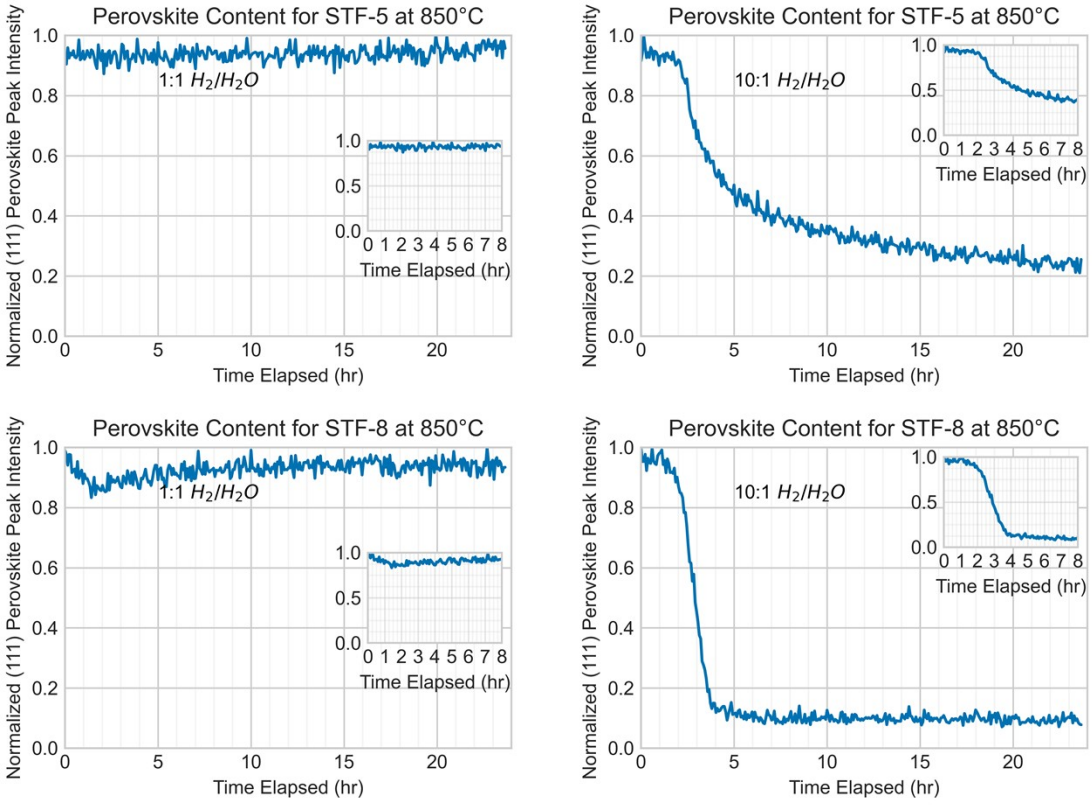

Fig. S3 Relative Intensity of (111) Perovskite Peaks during Powder Reduction under various reducing conditions

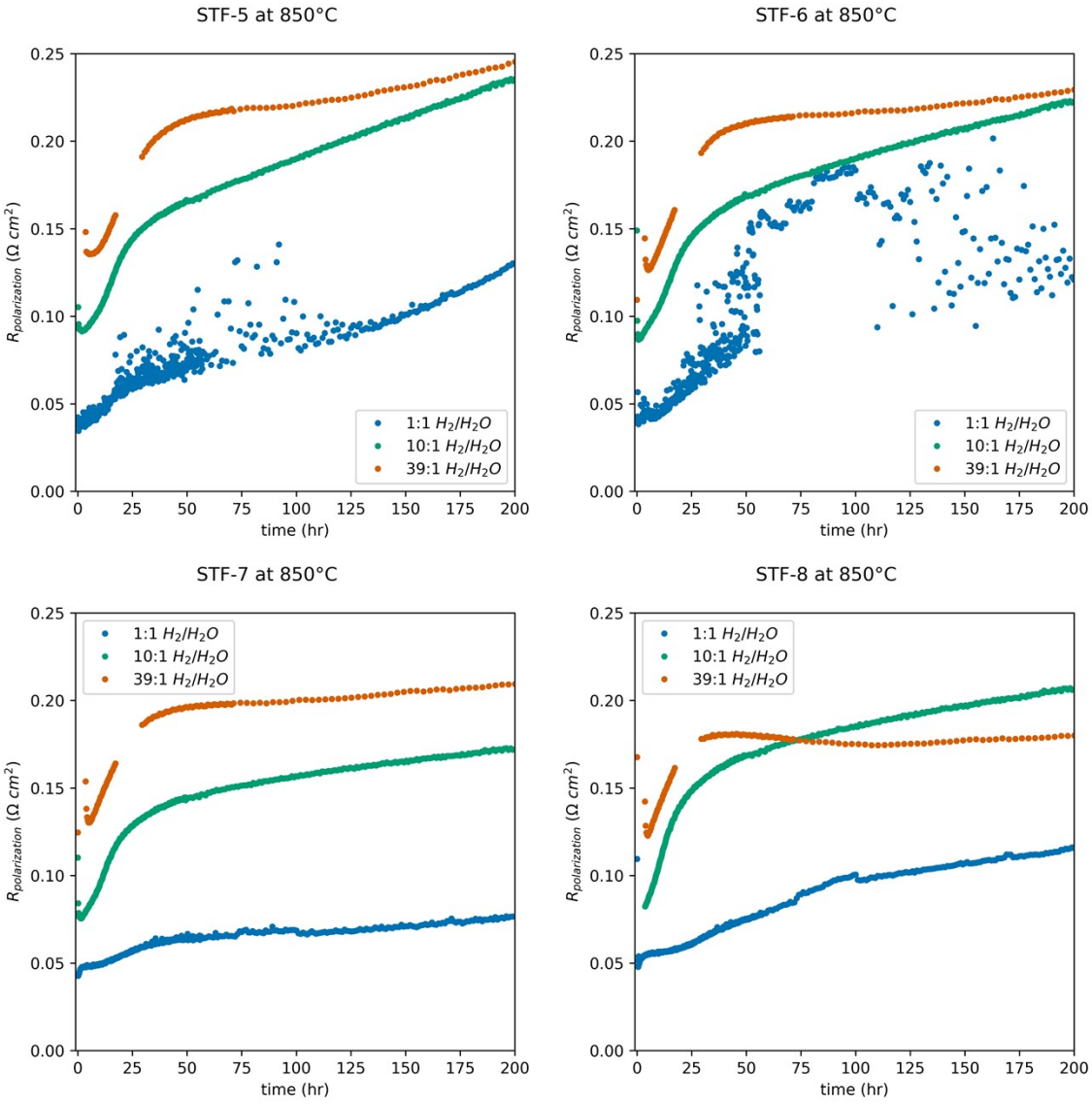

Fig. S4 Polarization Resistance for a) STF-5, b) STF-6, c) STF-7, and d) STF-8 under various reducing conditions.

Note that, due to changes in the high-frequency response for STF-5 and STF-6 at p_{H_2}/p_{H_2O} = 1, significant inconsistencies arise in the automatic identification of R_{Ohm}, leading to discrepancies in R_P. These are an artifact of the least squares fit, and not present in the raw impedance data. A similar inconsistency can be seen at p_{H_2}/p_{H_2O} = 39 for STF-8, where the polarization resistance appears to decrease between t≈50hr and t≈100hr which is not borne out by the trend in total resistance.