Supporting information

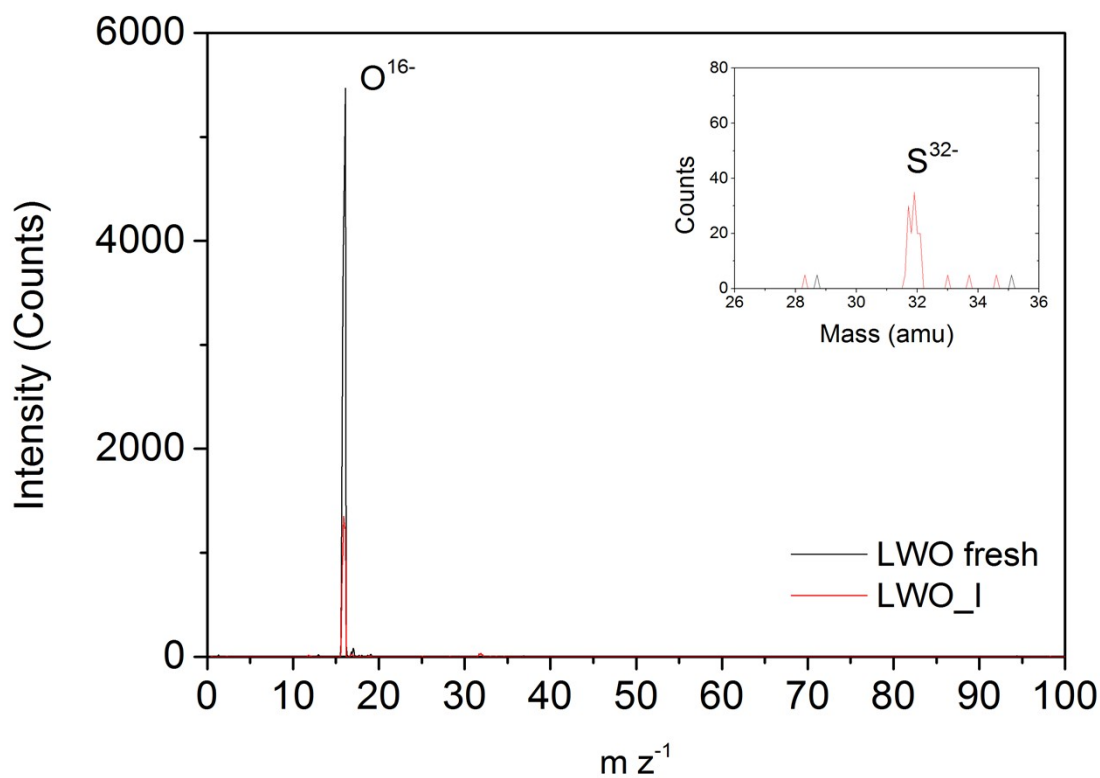
Figure S1: Negative FIB-SIMS spectrum in the range between m/z= 0 and 100, where $^{16}O^{-}$, $^{17}OH^{-}$ and $^{32}S^{-}$ (only for LWO_I) can be observed. The inset shows the FIB-SIMS spectrum in the range 26 to 36 to check the signal at m/z= 32 for a fresh sample and a sample treated with sulfur (LWO_I). The fresh sample has no signal for $^{32}O^{-}$ and therefore, the signal at m/z =32 for the sample treated with sulfur can be assumed that is due to $^{32}S^{-}$.
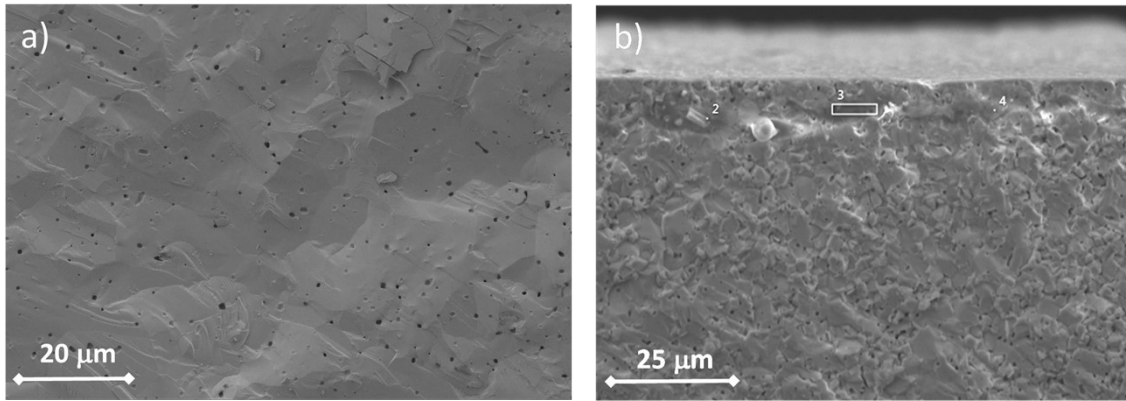
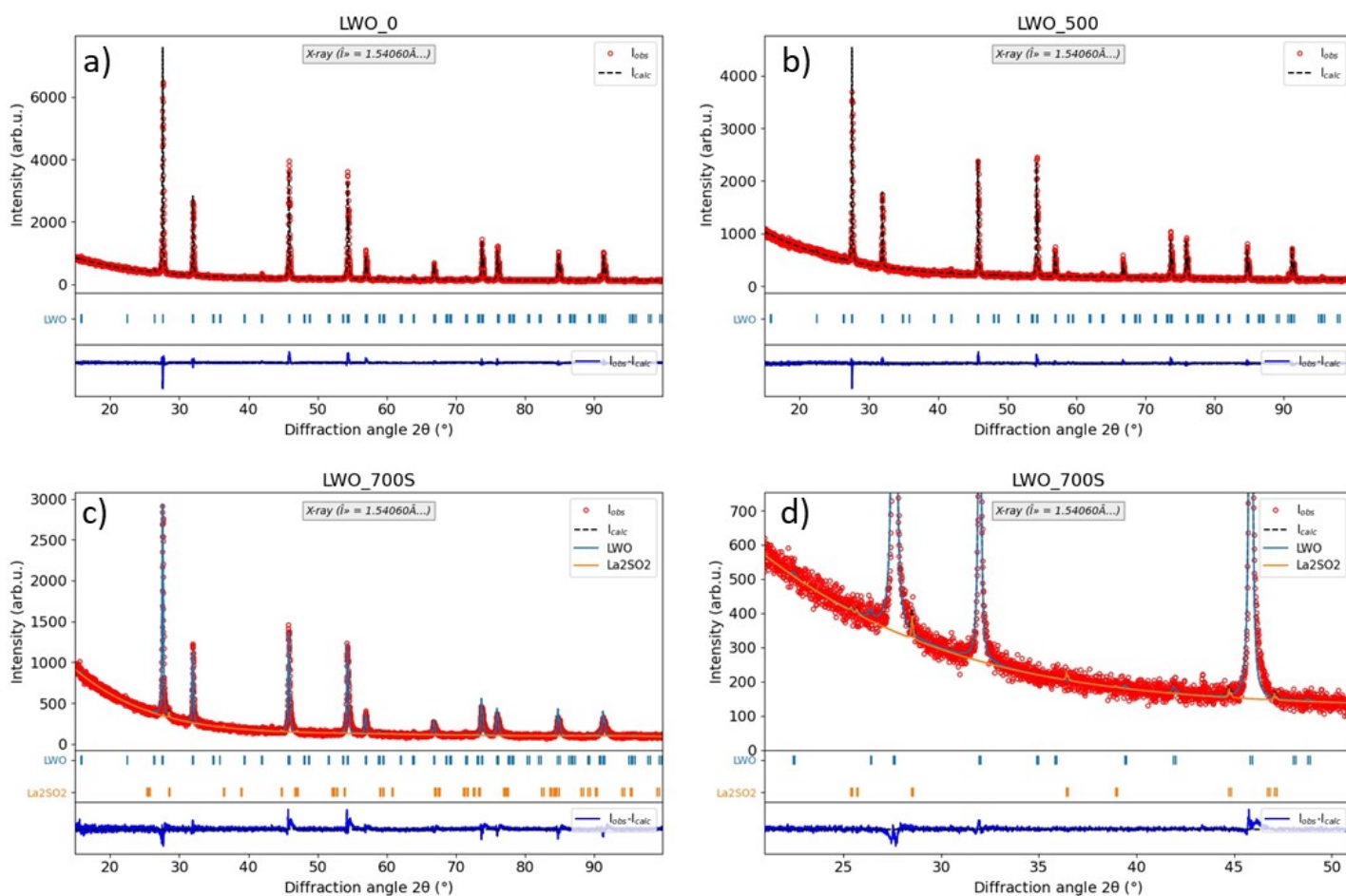Figure S2: SEM cross-sectional images of the membranes before (a) and after (b) the H_2 permeation measurements.

Figure S3: Rietveld refinements of sample LWO as prepared, LWO_0 (a) and treated at 500 °C, LWO_500 (b) and 700 °C, LWO_700S, (c and zoom in d) for 24 h with a stream consisting of ~2000 ppm H_2S and 10% H_2 saturated by water at room temperature (pH$_2$O= 0.025 atm). Structural models employed: LWO (La6.82 O13.52 W1.17), ICSD-189792 (Space group: F m - 3 m) and La_2O_2S: ICSD-260145 (Space Group: P 3 m 1).
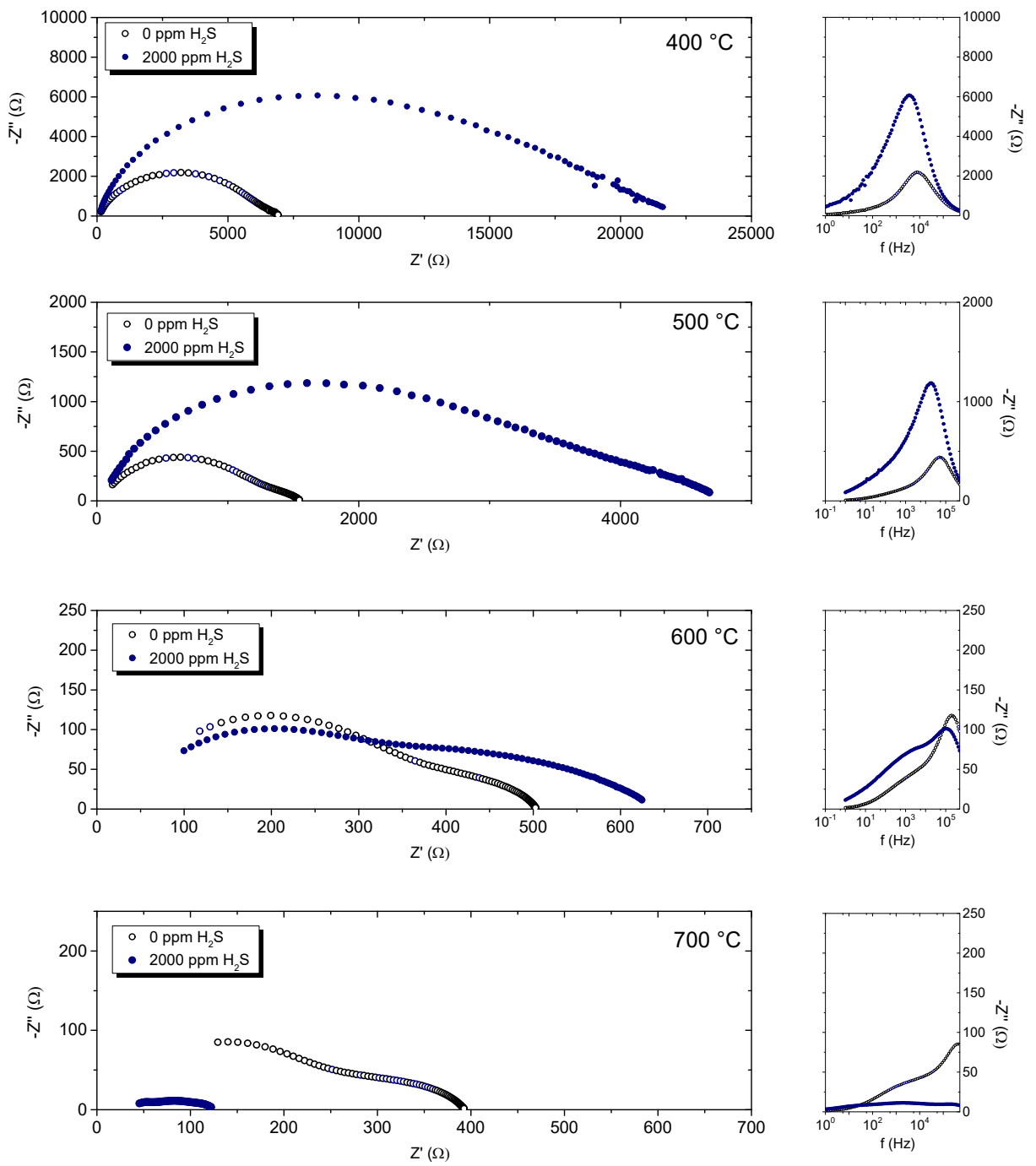
Figure S4: Impedance spectroscopy measurements under wet 10%H$_2$ in N$_2$ with 0ppm H$_2$S (open symbols) and 2000 ppm H$_2$S after 24 hours of exposure (filled symbols).
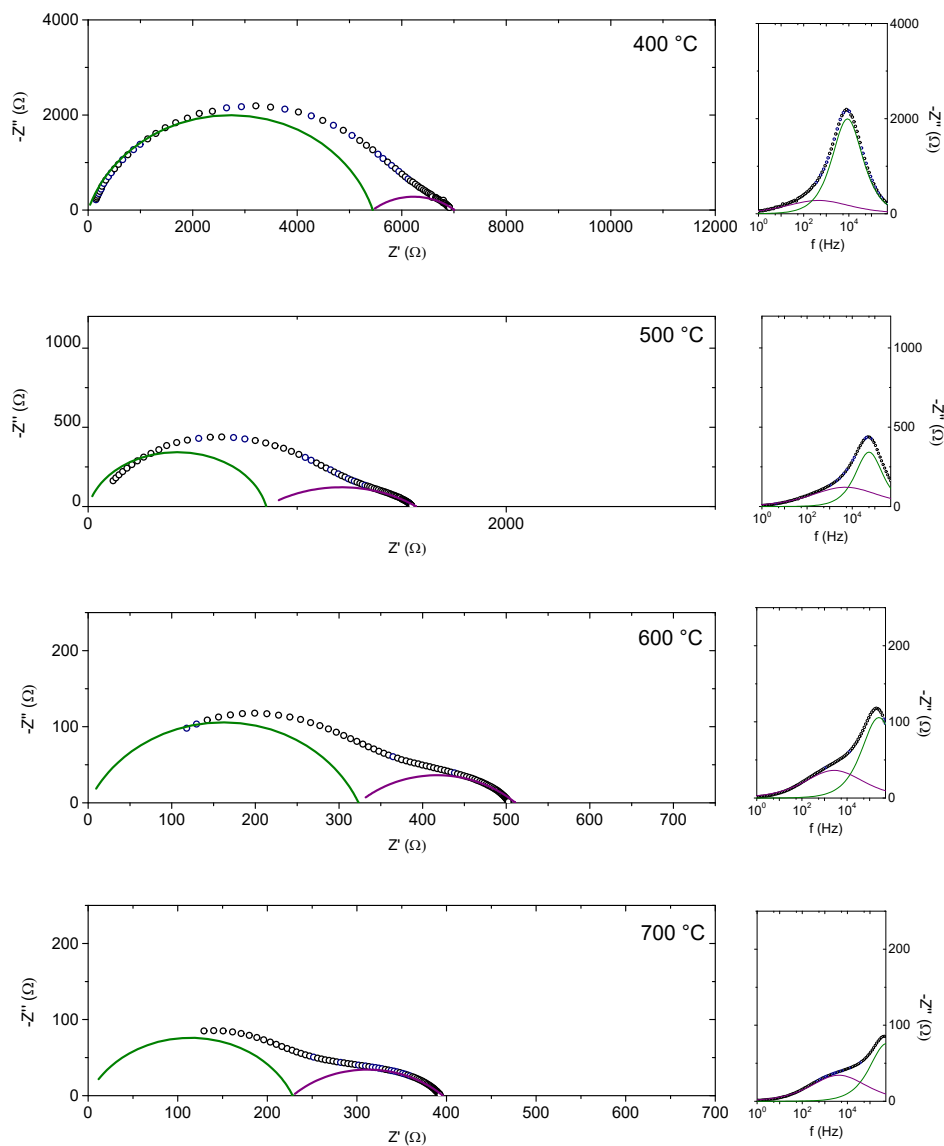
Figure S5: Impedance spectroscopy measurements under wet 10%H_2 in N_2 with 0ppm H_2S (open symbols). Solid lines correspond to the fit using the equivalent circuits explained in the main text.
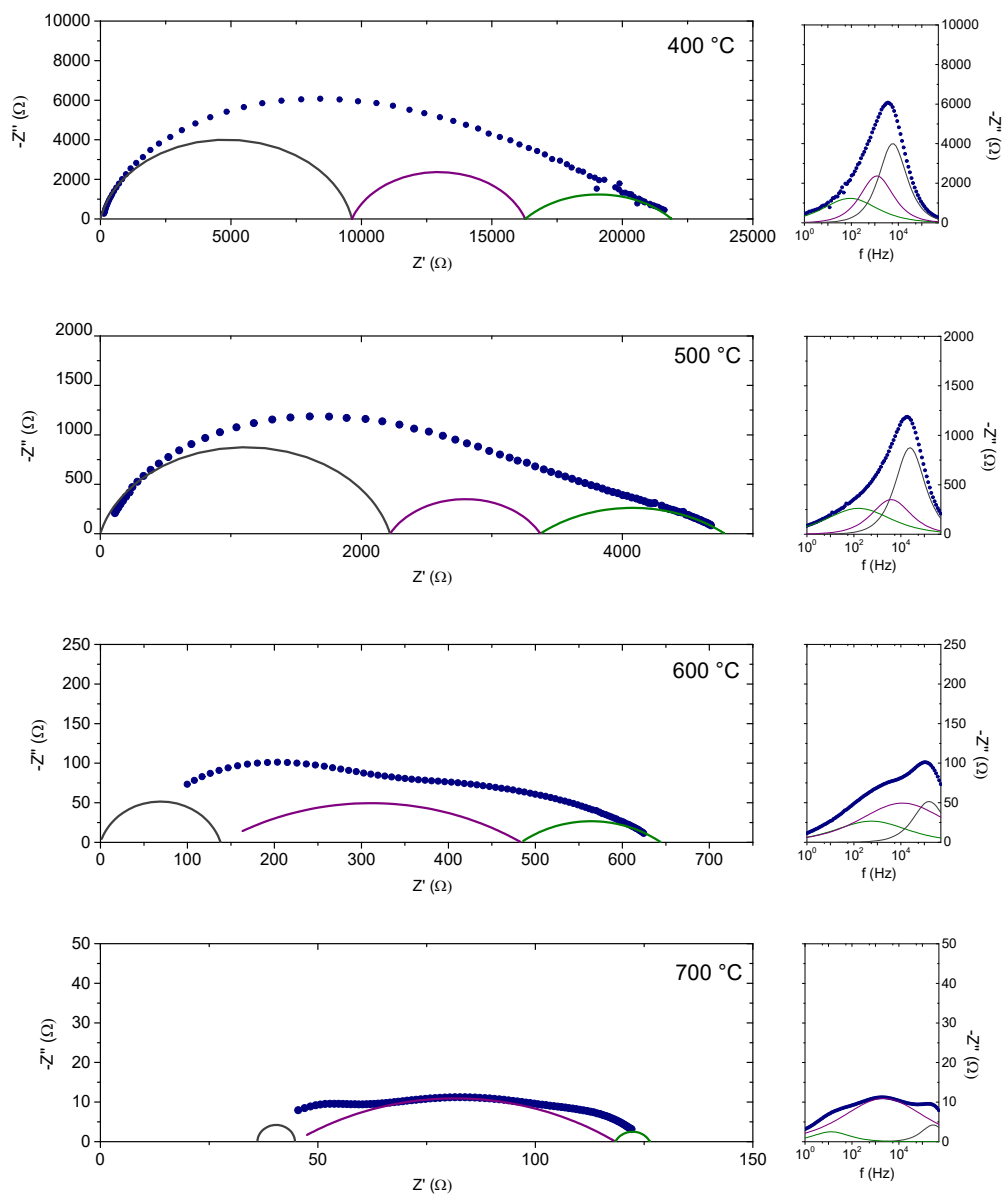
Figure S6: Impedance spectroscopy measurements under wet 10%H_2 in N_2 with 2000 ppm H_2S after 24 hours of exposure (filled symbols). Solid lines correspond to the fit using the equivalent circuits explained in the main text.
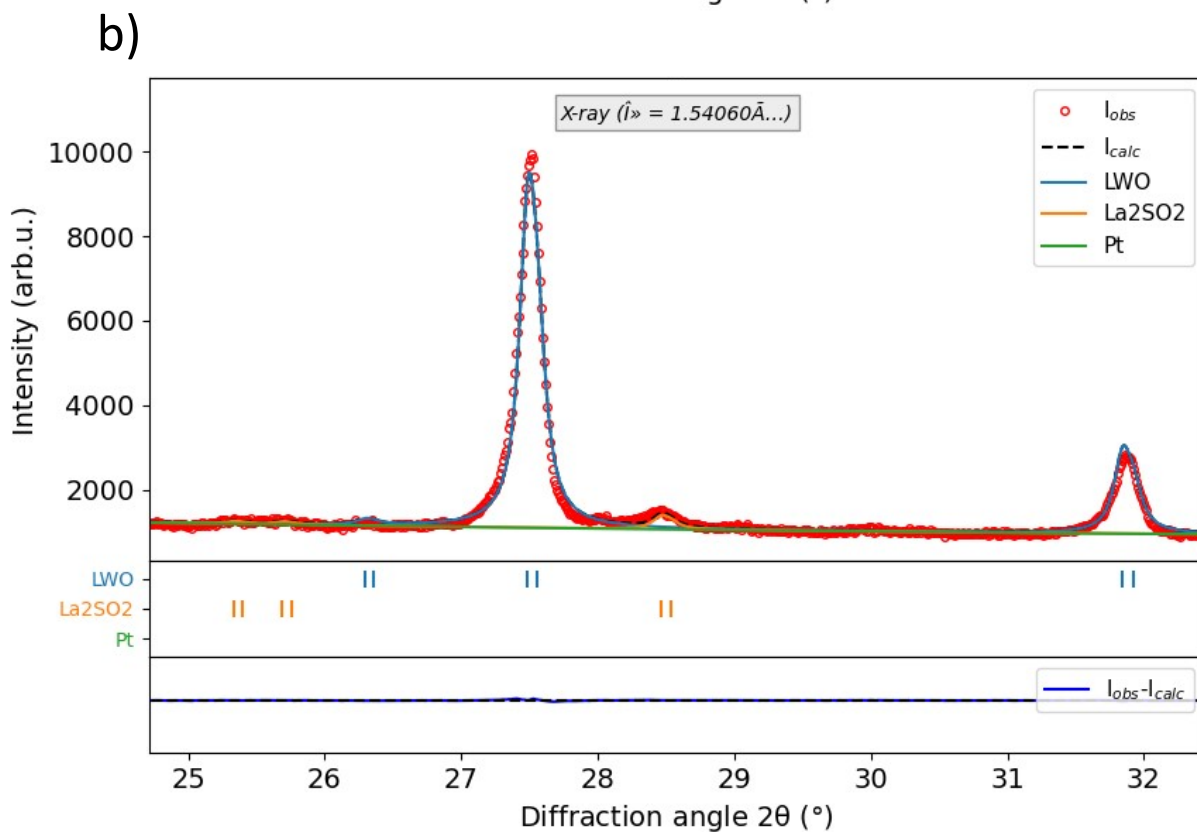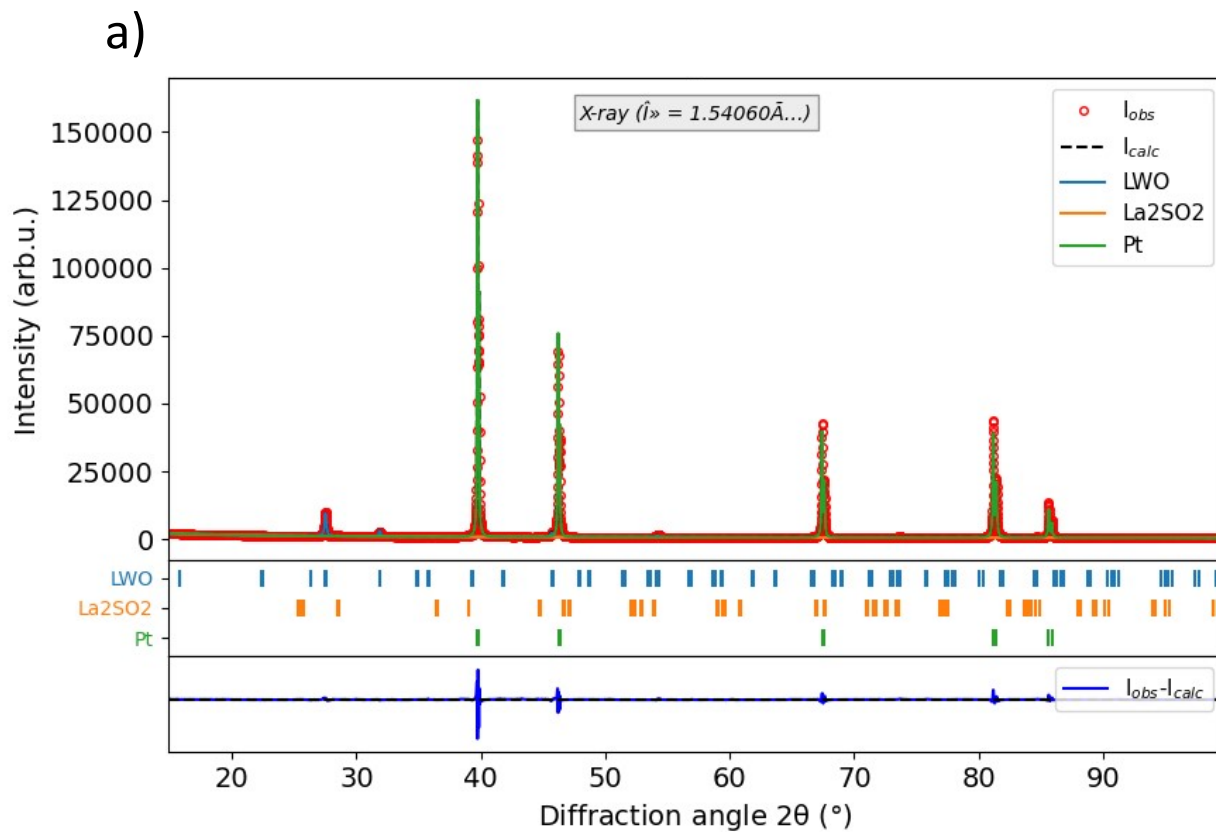
Figure S7: Rietveld refinements of sample LWO_I after the EIS measurements (a) and zoom in (b). Structural models employed: LWO (La6.82 O13.52 W1.17), ICSD-189792 (Space group: F m -3 m) and La$_2$O$_2$S: ICSD-260145 (Space Group: P 3 m 1).